NELSON PSYCHOLOGY
VCE UNITS 3 + 4
3rd edition

HELENE VAN IERSEL
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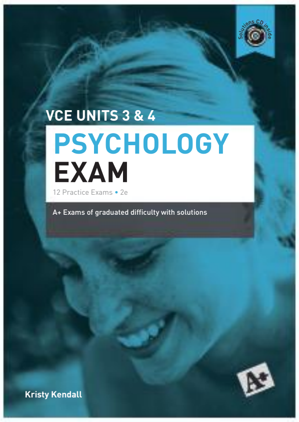

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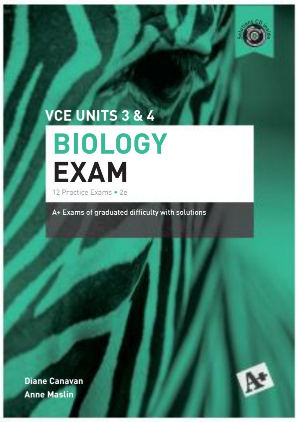

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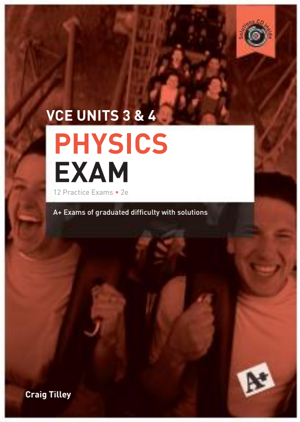

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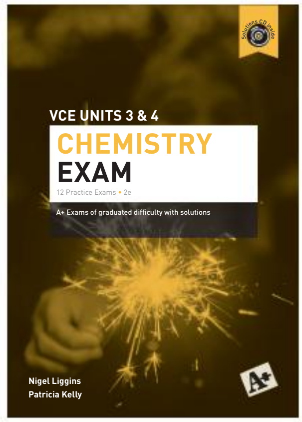

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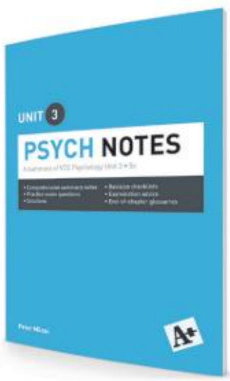

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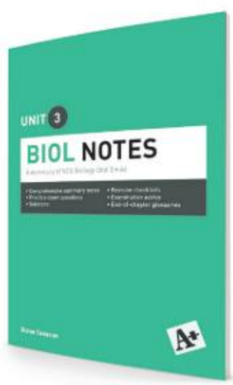

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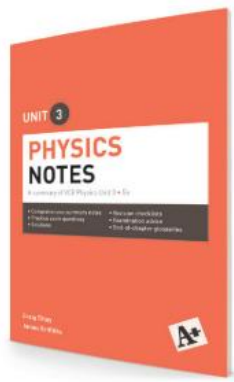

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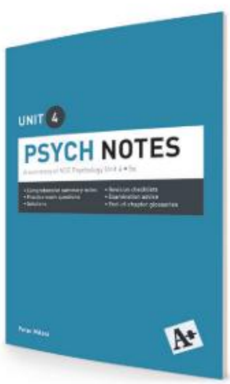

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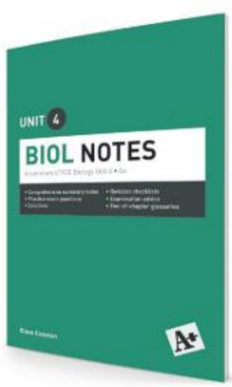

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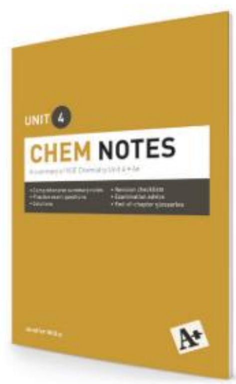

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Helene van Iersel
Andrea Blunden
Kenna Bradley
Leigh Park
Jessica Yancos
Natasha Young

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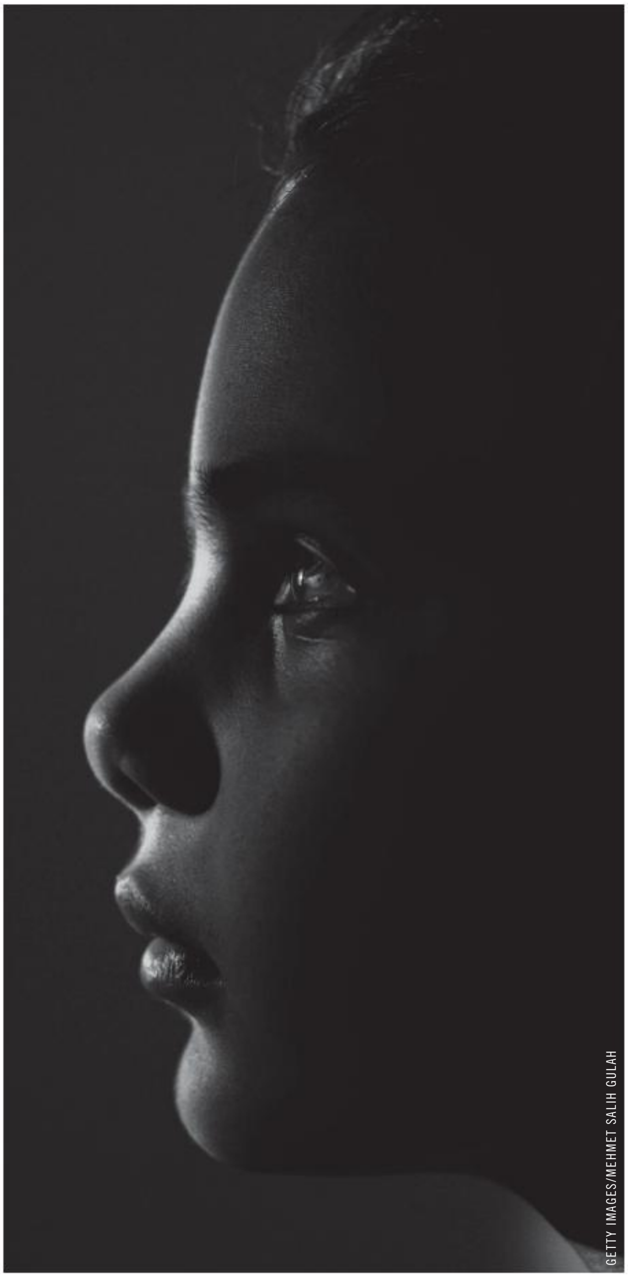
INTRODUCTION

Nelson VCE Psychology Units 3 & 4 (third edition) has been specifically written to the requirements of the VCE Psychology Study Design 2017–21. A highly experienced author team from diverse teaching backgrounds has written this comprehensive text as part of Nelson's VCE Psychology series.

The text covers all areas of study, outcomes, key knowledge and key skills for Units 3 and 4 Psychology stipulated by the VCE Psychology Study Design. Key knowledge, taken directly from the VCE Psychology Study Design, is listed on each chapter opening page. Each chapter contains sets of definitions to help students clarify their understanding of key psychological terms and concepts. In addition, a series of Check your understanding questions are strategically placed throughout each chapter so students can regularly review their understanding of core concepts as they progress through the chapter content. Extension opportunities for students who wish to explore concepts in more depth are also included throughout each chapter.

Our author team has developed their content within an Australian context. However, as the study of Psychology is universal, research and interesting examples from overseas have also been included. The key science skills associated with the scientific research that underpin the study of Psychology have been brought together in the chapter titled 'Scientific research methods'. This makes it easier for students to locate key concepts associated with scientific research as they regularly evaluate past research and design and carry out their own research. These skills have also been woven through all the chapters so students can practise applying them in context.

At the end of each chapter, students are provided with a chapter summary, a set of multiple-choice questions and short-answer questions that mirror the types of questions students will encounter in their VCE Psychology Units 3 & 4 exam. A practice extended-response question modelled on the question students will be presented with in their examination for VCE Psychology Units 3 & 4, and an assessment task in line with those stipulated in the VCE Psychology Study Design, have also been included.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Answers to the Check your understanding questions that appear throughout each chapter and the set of 15 multiple-choice questions included at the end of each chapter are provided at the end of the book.

Nelson VCE Psychology Units 3 & 4 (third edition) is written in a style that is engaging and easily accessible to all students of psychology. The user-friendly language and colourful design set the standard for Psychology texts in Victorian schools. *Nelson Psychology VCE Units 3 & 4 (third edition)* gives students a comprehensive grounding in psychology and thoroughly prepares them for success at Units 3 & 4.

Try it yourself boxes provide the opportunity to test out some of the ideas and concepts covered within the chapter.

6.1 TRY IT YOURSELF >>

EXPLORING YOUR CONSCIOUSNESS

If our consciousness is constantly changing, can we keep up with our own thoughts?

Key terms used in the previous two pages are identified in a glossary on the bottom right-hand corner. A full **glossary** containing these terms is found at the back of the book.

Check your understanding questions, spread throughout each chapter, provide the opportunity to review manageable sections of material. After completing these questions students can feel confident they have understood the material before they move on to new areas of content. Answers to Check your understanding questions can be found at the back of the book.

6.3 CHECK YOUR UNDERSTANDING >>

1 What is a psychometric vigilance test and why is it used?

Psychology is a body of knowledge accumulated through scientific research. **Focus on research** boxes relate the material contained within the chapter to an interesting piece of relevant research.

FOCUS ON RESEARCH 6.1

THE CASE OF TERRI SCHIAVO

FIGURE 6.13 Terri Schiavo with her mother, Mary

On 25 February 1990 in Florida, United States, a 26-year-old woman named Terri Schiavo collapsed in her home after suffering cardiac arrest. The cause of her cardiac arrest is still unknown; however, she sustained severe brain damage because of the loss of oxygen supply to the brain. She was admitted to hospital and was in a coma

The **Chapter summary** at the end of each chapter provides a summary of the content related to the relevant Key knowledge listed at the beginning of the chapter. This summary provides students with an excellent overview of the concepts that have been covered within the chapter.

CHAPTER SUMMARY

Consciousness

- Human consciousness is defined as all the perceptions, sensations, memories, thoughts and feelings one is aware of at any given moment.
- Human consciousness is divided into two main levels of consciousness: normal waking consciousness (NWC) and altered states of consciousness (ASCs).

Measuring consciousness

- Human consciousness is a psychological construct, which means it cannot be directly observed or measured. Thus, it has to be indirectly measured.
- Consciousness is measured indirectly using a variety of physiological devices, such as the electroencephalograph (EEG), electromyograph (EMG) and electrooculograph (EOG).
- An EEG detects, amplifies and records the brain's electrical activity and tells us which brainwaves are prominent at any given moment. The four types of brainwaves are beta, alpha, theta and delta waves.

This is followed by an Apply your knowledge section, which contains four parts:

- Section A: Multiple-choice questions
- Section B: Short-answer questions. These provide excellent practice and preparation for the formal written examination.
- Section C: Extended-response question
- Section D: Assessment task. A suggested assessment task designed to be completed in class. These activities provide a practical demonstration of one of the key concepts of the chapter. The assessment tasks are selected from the list provided by the VCAA in the VCE Psychology Study Design 2017–21.

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Thank you to my family for your support and encouragement, especially Craig and Isaac Osborne – you are my inspiration.

NATASHA YOUNG

Thank you to Sebastian – you gave me the encouragement and determination to complete my chapters.

OUTCOMES

		CHAPTER										
		1	2	3	4	5	6	7	8	9	10	11
UNIT 3	**AREA OF STUDY 1:** **How does the nervous system enable psychological functioning?** In this area of study, students explore the role of different branches of the nervous system in enabling a person to integrate, coordinate and respond to internal and external sensory stimuli. They explore the specialised structures and functioning of neurons that allow the nervous system to transmit neural information. Students evaluate how biological, psychological and social factors can influence a person's nervous system functioning. In particular, they consider the ways in which stress can affect the mind and body, the role that the nervous system plays in these processes and how stress can be managed.	●	●									
	AREA OF STUDY 2: **How do people learn and remember?** Memory and learning are core components of human identity: they connect past experiences to the present and shape futures by enabling adaptation to daily changes in the environment. In this area of study students study the neural basis of memory and learning and examine factors that influence the learning of new behaviours and the storage and retention of information in memory. They consider the influence of biological, psychological and social factors on the fallibility of memory.			●	●	●						

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		CHAPTER										
		1	2	3	4	5	6	7	8	9	10	11
UNIT 4	**AREA OF STUDY 1:** **How do levels of consciousness affect mental processes and behaviour?** Differences in levels of awareness of sensations, thoughts and surroundings influence individuals' interactions with their environment and with other people. In this area of study students focus on states of consciousness and the relationship between consciousness and thoughts, feelings and behaviours. They explore the different ways in which consciousness can be studied from physiological and psychological perspectives and how states of consciousness can be altered. Students consider the nature and importance of sleep and apply biological, psychological and social factors to analyse the effects of sleep disturbances on psychological functioning, including mood, cognition and behaviour.						●	●	●			
	AREA OF STUDY 2: **What influences mental wellbeing?** In this area of study, students examine what it means to be mentally healthy. They explore the concept of a mental health continuum and factors that explain how location on the continuum for an individual may vary over time. Students apply a biopsychosocial approach to analyse mental health and mental disorder, and evaluate the roles of predisposing, precipitating, perpetuating and protective factors in contributing to a person's mental state. Specific phobia is used to illustrate how a biopsychosocial approach can be used to explain how biological, psychological and social factors are involved in the development and management of a mental disorder. Students explore the concepts of resilience and coping and investigate the psychological basis of strategies that contribute to mental wellbeing.									●	●	

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		CHAPTER										
		1	2	3	4	5	6	7	8	9	10	11
UNIT 4	**AREA OF STUDY 3: Practical investigation** The investigation requires the student to identify an aim, develop a question, formulate a research hypothesis including operationalised variables and plan a course of action to answer the question and that takes into account safety and ethical guidelines. Students then undertake an experiment that involves the collection of primary qualitative and/or quantitative data, analyse and evaluate the data, identify limitations of data and methods, link experimental results to science ideas, reach a conclusion in response to the question and suggest further investigations which may be undertaken. Results are communicated in a scientific poster format according to the template on page 13 of the Study Design.											●

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UNIT 3

HOW DOES EXPERIENCE AFFECT BEHAVIOUR AND MENTAL PROCESSES?

AREA OF STUDY 1:
HOW DOES THE NERVOUS SYSTEM ENABLE PSYCHOLOGICAL FUNCTIONING?

AREA OF STUDY 2:
HOW DO PEOPLE LEARN AND REMEMBER?

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CHAPTER 01

NERVOUS SYSTEM FUNCTIONING

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KEY KNOWLEDGE INCLUDES:

- the roles of different divisions of the nervous system (central and peripheral nervous systems and their associated sub-divisions) in responding to, and integrating and coordinating with, sensory stimuli received by the body
- the distinction between conscious and unconscious responses by the nervous system to sensory stimuli, including the role of the spinal reflex
- the role of the neuron (dendrites, axon, myelin and axon terminals) as the primary cell involved in the reception and transmission of information across the synapse (excluding details related to signal transduction)
- the role of neurotransmitters in the transmission of neural information between neurons (lock-and-key process) to produce excitatory effects (as with glutamate) or inhibitory effects (as with gamma amino butyric acid [GABA])
- the effects of chronic changes to the functioning of the nervous system due to interference to neurotransmitter function, illustrated by the role of dopamine in Parkinson's disease.

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THE HUMAN NERVOUS SYSTEM: OUR COMMUNICATION NETWORK

The human **nervous system** is a delicate and complex communication system. It is made up of billions of **neurons**, all working together to transmit information around the body. These neurons are the basic building blocks of the nervous system because they form an interconnected network so that messages can be conveyed rapidly and continuously throughout the nervous system. Each neuron receives information from an adjacent neuron, processes that information and then sends the information onto the next neuron. On their own, neurons are inadequate, but when they form vast interconnected networks they enable the mental processes and behaviours that we are capable of.

The nervous system is a hierarchical structure. It is the physiological system we depend on to receive sensory information, process and integrate it, and then transmit motor messages around our body that, in turn, determine our reaction to that information. The nervous system initially receives information from the external environment in the form of raw energy, such as light waves and soundwaves. This raw sensory energy is converted into electrochemical energy, a single energy form that the nervous system is equipped to process. Messages are then sent around the nervous system, from neuron to neuron in the form of electrochemical messages.

For individuals to function at full capacity and in a coordinated way, the nervous system must fulfil three major functions: first, it must receive sensory information from either our external or internal environment; second, it must process this information so that we understand it; third, it must then organise a coordinated response to this information by our muscles, organs and glands (see Figure 1.1). For example, if your phone rings, your nervous system receives this sensory auditory information from the external environment. It processes and integrates this information – my phone is ringing and I would like to answer it. On recognising the phone is ringing and making the decision to answer the call, a coordinated response is made to reach out and pick up the phone.

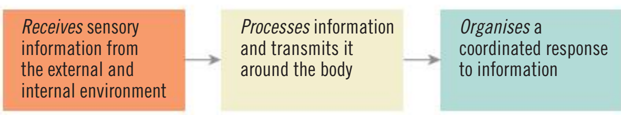

FIGURE 1.1 Functions of the human nervous system

FIGURE 1.2 The ability for us to answer our phone when it rings is due to the three main functions of our nervous system: the ability to receive, process and respond to sensory stimuli.

There are two major divisions of the nervous system: the *central nervous system (CNS)* and the *peripheral nervous system (PNS)*. These divisions contain different physiological structures and components; however, they are interconnected and function collaboratively to determine our psychological and physical responses. The CNS and PNS are further divided into structural components and subdivisions (see Figures 1.3 and 1.4).

nervous system A communication system that consists of networks of neurons that connects the brain, spinal cord and different parts of the body to each other via electrochemical signals

neuron An individual nerve cell that receives, transmits and processes information

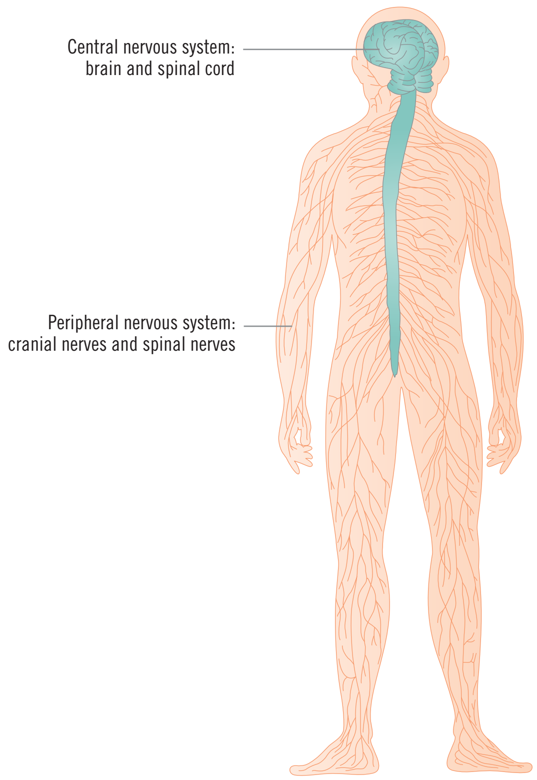

FIGURE 1.3 The two major divisions of the nervous system and their associated structural components

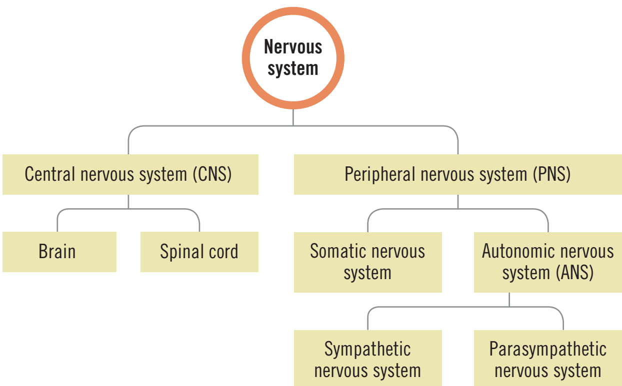

FIGURE 1.4 The divisions of the nervous system

THE CENTRAL NERVOUS SYSTEM (CNS)

The central nervous system (CNS) is composed of the brain and the spinal cord (see Figure 1.5). The brain is the 'engine room' of the nervous system. It receives, processes and integrates information from the rest of the body and generates responses to it. The spinal cord, an intricate and delicate cable of nerve fibres stretching from the base of the brain to the lower back, connects the brain to the rest of the body via its connection to the peripheral nervous system (PNS).

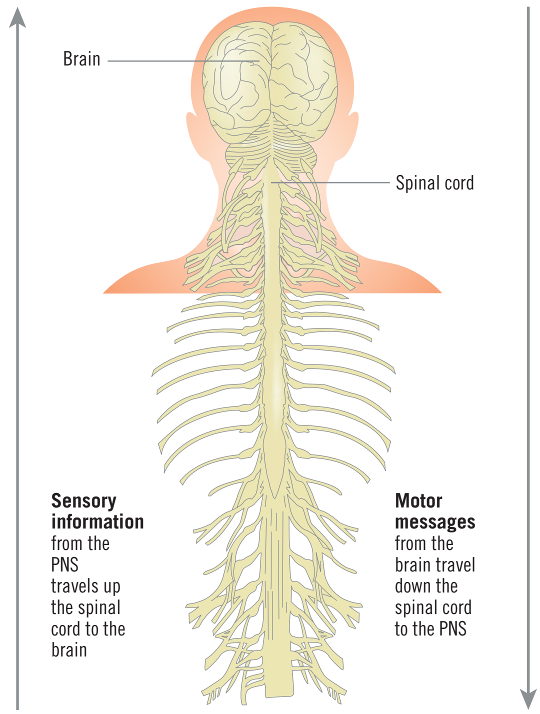

FIGURE 1.5 The CNS – sensory information travels up the spinal cord to the brain; motor messages travel down to the muscles

THE BRAIN: MASTER AND COMMANDER

The brain is about the size of a large grapefruit and weighs approximately 1.5 kilograms. This complex structure consists of some 100 billion neurons, an almost infinite number of synaptic connections and contains more than 90 per cent of the CNS's neurons. The mass of neurons we call the human brain is responsible for how we think and feel, how we perceive and react to the world around us, and how we construct our sense of who we are. It enables us to make decisions, solve problems, fall in love or read a book. Thus, everything you do, think or feel can be traced back to these tiny cells.

Structurally, the brain can be subdivided into three main regions: the hindbrain, the midbrain and the forebrain (see Figure 1.6). Each region has its own purpose that is vital for everyday functioning. The hindbrain, often referred to as the brainstem, is the region located at the base of the brain near the back of the skull. The hindbrain consists of the pons, the medulla and the cerebellum. These structures are responsible for the control of our basic survival functions including heart rate, breathing, sleep and arousal, and coordinating voluntary muscle movement, and reflexive actions such as coughing, swallowing and vomiting. The midbrain is the region of the brain between the hindbrain and the forebrain. Midbrain

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structures and systems include the reticular formation and they help to keep us alert, awake and vigilant. The forebrain is located above the midbrain towards the top of the brain, and it is the largest, most complex and highly developed region of the brain. It controls higher cognitive functions and processes including emotions, motivations, sensations, perceptions, learning, memory and reasoning. This region contains three distinct structures: the hypothalamus, the thalamus and the cerebrum.

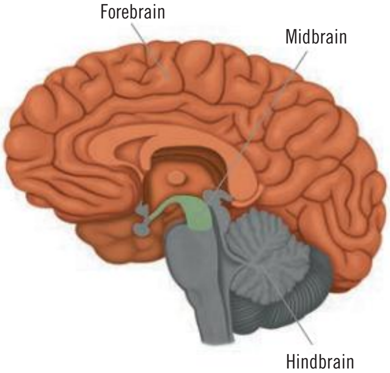

FIGURE 1.6 The three main regions of the brain

Since the brain is the body's master information-processing and decision-making organ, it has an important role in communicating information to the rest of the body. The brain does this by receiving and interpreting information received from the body's sensory systems, which it integrates and forms a response to, then sends motor messages out to all parts of the body so that coordinated and appropriate responses can be made. As a result, the brain is responsible for coordinating all the activities of the nervous system. So how does your brain communicate this information to the various body parts? Your brain communicates with the rest of your body through a large cable-like structure called the spinal cord.

THE SPINAL CORD: THE BODY'S INFORMATION HIGHWAY

If you were to cut through the spinal cord, in its centre you would find grey matter (see Figure 1.7). This grey matter is made of cell bodies, their axons and their dendrites. In the outer layers of the spinal cord you would see columns of white matter running the length of the spinal cord. This white matter is made up entirely of myelin-coated axons. These axon columns are called *tracts*. There are two types of tracts involved in the transmission of information up and down the spinal cord; ascending tracts and descending tracts.

The delicate structure of the spinal cord is protected by a ring of bone known as vertebrae, which forms the spinal column. On the outside of the spinal cord, the axon columns are bundled together into spinal nerves that branch off between the gaps in the vertebrae into the arms, legs and torso. These spinal nerves carry messages to and from the spinal cord, connecting the brain with the PNS.

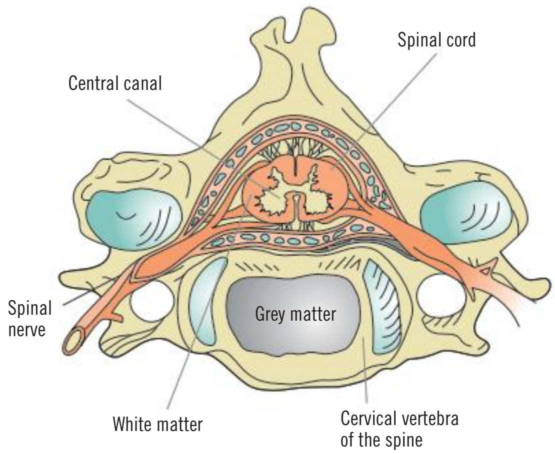

FIGURE 1.7 A spinal cord section (top view). The spinal column (or backbone) encloses the spinal cord to protect it and consists of 33 vertebrae, each of which has a cavity through which the spinal cord passes. From each vertebra, spinal nerves emerge.

central nervous system (CNS) A major division of the nervous system consisting of all the nerves in the brain and spinal cord

brain The master organ of the nervous system responsible for receiving and processing information from the rest of the body and generating responses to it

spinal cord A part of the CNS that consists of a cable of nerve fibres stretching from the base of the brain to the lower back, that transmits sensory information from the PNS to the brain and motor messages from the brain to the PNS

peripheral nervous system (PNS) A major division of the nervous system consisting of all the nerves outside of the CNS; transmits sensory information inwards to the CNS and transmits motor messages from the brain outwards to the rest of the body

hindbrain A region of the brain located at the base of the brain that includes the cerebellum, pons and medulla and is responsible for controlling our basic survival functions

midbrain A region of the brain located between the hindbrain and forebrain; consists of many nerve fibre systems connecting these, including the reticular formation

forebrain A region of the brain that consists of the thalamus, hypothalamus and cerebrum; located above the midbrain, it is the largest and most highly developed part of the brain responsible for our most complex processes

grey matter The centre area of the spinal cord that contains cell bodies, their axons and their dendrites

white matter The outer layer of the spinal cord that contains only myelin-coated axons

ascending tracts Axon columns in the spinal cord that sensory information is sent through from the PNS up the spinal cord to the brain for processing

descending tracts Axon columns in the spinal cord that motor messages are sent through from the brain down the spinal cord to the PNS and the rest of the body

vertebrae Rings of bone surrounding the spinal cord that form the spinal column (backbone)

This complex structure allows the spinal cord to fulfil its two key roles in communicating neural information. Firstly, the spinal cord receives sensory information from the PNS and transmits it in a chain along the *ascending tracts* of the spinal cord up to the brain for further processing and interpretation. Secondly, it carries motor information from the brain back to the PNS in a chain along the *descending tracts* of the spinal cord where it is relayed to our muscles, organs and glands so they can react in specific ways. This happens so rapidly and continuously that we are barely aware of it. For example, you would not be aware that your shoelaces were tied too tight unless the sensory information about your foot hurting was transmitted to your brain along the ascending tracts of the spinal cord. If you make the decision to bend down to loosen your shoelaces, then the motor instructions would be transmitted from your brain to the PNS along the descending tracts of the spinal cord.

The spinal cord plays a crucial role in behaviour. If we did not have a spinal cord to transport sensory information to and motor messages from our brain, we would not experience any bodily sensations and we would not be able to make voluntary movements. We wouldn't feel a feather tickling our toes. We wouldn't be able to pick up a fork to feed ourselves. If neurons in the spinal cord are damaged by infection or injury, the flow of information between the brain and the rest of the body is interrupted. This may result in a loss of sensation in a specific body part or an inability to move a specific body part. For example, paraplegia occurs when there is damage to the middle or lower section of the spinal cord. As a result, both legs and part of the torso may be paralysed, resulting in loss of sensation from, and inability to move, the hips and legs. The higher up the damage to the spinal cord is, the more extensive the paralysis. For example, quadriplegia occurs when there is damage to the nerves in the lower neck, causing paralysis from the neck down. This loss, or paralysis, is usually permanent because damaged neurons in the spinal cord cannot be repaired or replaced (Carter, Aldridge, Page, & Parker, 2014).

FIGURE 1.8 The response of loosening your shoelaces is due to the spinal cord transmitting sensory information received from the PNS up ascending tracts to the brain and transmitting motor messages from the brain down descending tracts to the PNS.

1.1 CHECK YOUR UNDERSTANDING >>

1 With reference to an example, identify and describe the three main functions of the nervous system.

2 Which statement about the brain is incorrect?
   - A It weighs approximately 1.5 kilograms.
   - B It is part of both the central nervous system and the peripheral nervous system.
   - C It is divided into three main divisions: hindbrain, midbrain and forebrain.
   - D It has an important role in making decisions and solving problems.

3 Explain why the brain is referred to as 'the engine room' of the nervous system.

4 Which of the following statements about the function of the spinal cord is correct?
   - A The spinal cord relays sensory messages to and motor messages from the brain.
   - B The spinal cord transmits sensory messages from the brain to the PNS and motor messages from the PNS to the brain.
   - C The spinal cord interprets sensory messages coming in from the PNS.
   - D The spinal cord interprets motor messages coming in from the PNS.

5 Which statement about the structure of the spinal cord is correct?
   - A There are 21 pairs of spinal nerves that leave the sides of the spinal cord.
   - B Grey matter is made of cell bodies, their axons and their dendrites.
   - C The spinal cord is made up of descending tracts that send information from the PNS to the brain.
   - D The delicate structure of the spinal cord is protected by myelin.

6 Explain the difference between the grey and white matter of the spinal cord.

7 Explain the difference between the ascending tracts and the descending tracts of the spinal cord.

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THE PERIPHERAL NERVOUS SYSTEM (PNS)

Many of our body parts are located outside the CNS. Therefore, the CNS needs a support network of information-carrying nerves to connect the various body parts to it. This network is provided by the peripheral nervous system (PNS). The PNS consists of all the nerves (apart from those within the CNS) that extend from the brain and spinal cord throughout the body (see Figure 1.3). These nerves connect with muscles, organs and glands that are located throughout the body (spinal nerves), as well as nerves connected to the organs located in the head (cranial nerves). The main role of the PNS is to convey sensory information from the body's internal and external environments to the CNS and transmit motor commands from the CNS to the rest of the body. An example of the way the PNS and CNS work together is when a musician is tuning their guitar and must listen carefully to the pitch of each string. Auditory information about the sound is transmitted from sensory receptors in the ear via the PNS to the brain, which interprets the pitch. A response (to tighten or loosen the string) is then sent from the brain to the spinal cord and on to the PNS, so that the muscles of the hands and arm can make the action.

FIGURE 1.9 When tuning his guitar, this musician's CNS and PNS are working together to interpret the stimulus and direct the body's muscles in response.

Therefore, the CNS and PNS work in an integrated way to enable us to produce the variety of mental processes and behaviours that we execute on a daily basis.

The PNS transfers sensory information from the rest of the body to the CNS, and motor information from the CNS to the rest of the body via its connection to the spinal cord. As discussed earlier, the outside of the spinal cord has axon columns that are bundled together into nerves that branch off between the gaps in the vertebrae of the spinal cord into the arms, legs and torso. If you look at Figure 1.10, you will see that 30 pairs of spinal nerves leave the sides of the spinal cord. Another pair (not shown) leaves the bottom tip.

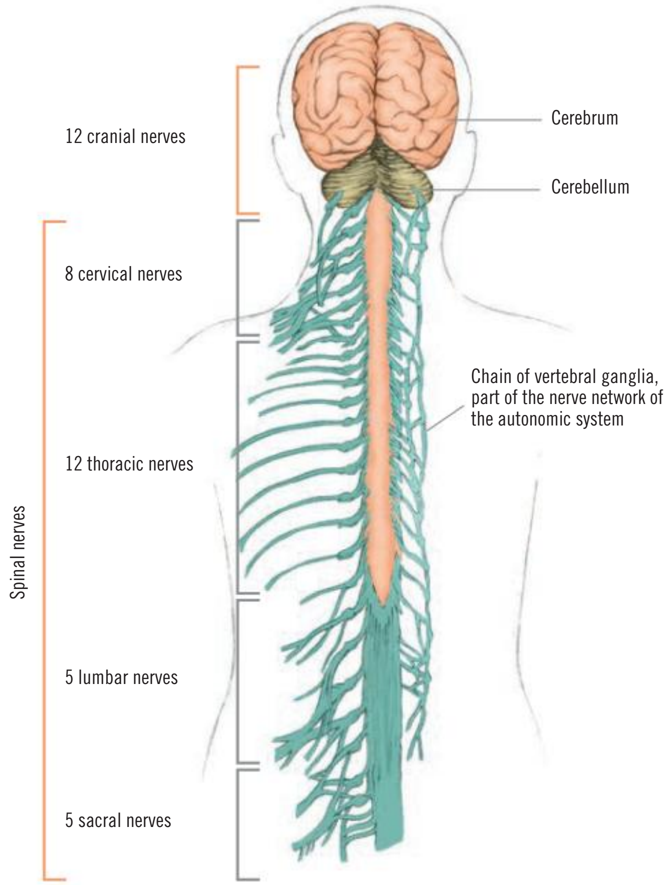

FIGURE 1.10 The cranial and spinal nerves that directly connect the PNS with the CNS

paraplegia Damage to the middle and lower parts of the spinal cord, resulting in paralysis to both legs and part of the torso

quadriplegia Damage to nerves in the lower neck resulting in paralysis of the body below the neck

spinal nerves Part of the PNS; form a direct connection between spinal cord and muscles, organs and glands throughout the body, allowing sensory and motor messages to travel to and from the brain

cranial nerves Linked directly to the brain, allowing sensory and motor messages to travel directly to and from the organs located in the head

These 31 pairs of *spinal nerves* are part of the PNS and are directly connected to the spinal cord, in order to carry sensory and motor messages to and from the brain. In addition, there are 12 pairs of *cranial nerves* that are linked directly to the brain. These cranial nerves allow sensory and motor messages to travel directly to and from organs in the head such as our eyes, ears and mouth (Carter et al., 2014). Together, these spinal and cranial nerves keep your entire body in constant communication with your brain.

The PNS is composed of two subdivisions: the *somatic nervous system* and the *autonomic nervous system (ANS)*.

THE SOMATIC NERVOUS SYSTEM

The **somatic nervous system** (also known as the skeletal nervous system) is the subdivision of the PNS that is responsible for sensing external stimuli and controlling voluntary responses. Therefore, like all parts of the nervous system, it has both a sensory role and a motor role. Its sensory role consists of **sensory neurons** receiving sensory information from receptor cells located throughout the body such as in the skin, joints, eyes and tongue and transmitting this information inwards to the CNS. Experiencing sensations such as touch, pain, heat, cold, balance, sight, taste, smell and sound are all part of the sensory function of the somatic nervous system. The somatic nervous system also controls the skeletal muscles attached to bones, enabling voluntary movements. To fulfil this motor role, the **motor neurons** receive commands from the CNS and then the information is transferred to the appropriate skeletal muscles located throughout the body to enable appropriate and coordinated responses. Therefore the somatic nervous system is responsible for all our voluntary actions such as walking, talking, eating and playing sports.

An example of the way the sensory and motor function of your somatic nervous system operates is if your pet cat rubs up against your leg. Sensory receptors in your skin register the touch sensation and that information is transmitted by sensory neurons in the somatic nervous system up the spinal cord and on to the brain. The brain then identifies your cat as the source of the sensation and decides to pick up the cat. The brain then sends messages via motor neurons down the spinal cord to muscles in your legs, arms and hands to enable the coordinated movements required to lean down and pick up your cat.

FIGURE 1.11 The ability to detect the sensation of your cat rubbing up against your leg and making the decision to pick it up is due to the sensory and motor functions of your somatic nervous system.

THE AUTONOMIC NERVOUS SYSTEM (ANS)

Imagine that you are strolling along the street and you are about to cross the road. Your somatic nervous system is controlling the many muscles needed to execute this activity. You are in conscious control of these actions because they are voluntary. Suddenly, a large truck screeches around the corner, catching you by surprise and only just missing you. As a result your heart rate and breathing rate instantly increase and you begin to sweat. You do not consciously decide to react like this; it is not a voluntary decision. This happens automatically and quickly in order to aid survival. This behaviour is due to your **autonomic nervous system (ANS)**.

The ANS is the division of the PNS that controls the activity level of our internal organs and glands, such as our heart, pupils, salivary glands, adrenal glands, stomach and bladder, all of which are essential for survival. It contains nerves that transmit motor messages from the brain to the body's involuntary (or smooth) muscles that control the activity level of these internal organs and glands. It also transmits messages back to the brain about the activity level of these organs and glands.

The word 'autonomic' means 'self-regulating', consistent with its name, the ANS functions automatically. The activities controlled by the ANS are involuntary and operate continuously and independently of the brain. Imagine if you had to consciously think about controlling the activities of your ANS such as blinking your eyes, controlling

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your breathing or even ensuring that your internal organs are functioning. By automatically regulating the activity level of survival-related internal systems, the ANS leaves our mind free to focus on important external or internal stimuli. For example, can you imagine what might happen if you were sitting your final Psychology exam and, at the same time, you also had to concentrate on controlling your heartbeat and remembering to breathe? Because our ANS functions independently and constantly during the exam we do not need to focus on controlling our vital organs and body systems, leaving us free to consciously focus on other important external and internal stimuli required to complete the exam effectively.

NEWSPIX/JUSTIN LLOYD

FIGURE 1.12 This student does not have to control the functions of her ANS, leaving her free to consciously focus on her exam.

Even though the ANS is 'self-regulating', it does still communicate with the brain. Some ANS neurons send motor messages from the brain to the involuntary muscles to regulate the activity level of internal organs and glands. The ANS also sends information to the brain about the activity level of internal organs and glands. For example, if you are woken by someone shouting 'There's an intruder in the house!', sensory neurons in your ears would send this message to the brain. Your brain would interpret this as a threat and would send an emergency command to the ANS. The ANS can increase arousal levels by activating the involuntary muscles that control our internal organs and glands. As a result our body's internal resources can be used to provide the extra energy that is required to deal with the 'threatening' situation.

The activity of the ANS ensures that our changing energy requirements are met and our body is maintained in proper working order according to the demands placed on it. The messages relayed by the autonomic nervous system automatically increase, decrease or otherwise regulate the activity of our internal organs and glands. The ANS energises us so we are aroused when we need to be, and so that we can physically deal with a variety of situations whether they be vigorous, demanding, threatening or stressful. The ANS also has the essential role of lowering our arousal level and calming us when less energetic behaviour is required. The two divisions of the ANS that perform these functions are the *sympathetic nervous system* and the *parasympathetic nervous system*.

1.2 CHECK YOUR UNDERSTANDING >>

1 Which statement about the peripheral nervous system is incorrect?
   - A The PNS consists of all the nerves outside the CNS.
   - B The PNS transfers sensory information from the rest of the body to the CNS, and motor information from the CNS to the rest of the body.
   - C The PNS is connected directly to the spinal cord via 21 pairs of spinal nerves.
   - D The divisions of the PNS include the somatic nervous system and the autonomic nervous system.

2 The somatic nervous system is:
   - A also known as the skeletal nervous system and it controls involuntary muscles.
   - B also known as the skeletal nervous system and it controls voluntary responses.
   - C self-regulating and controls involuntary activity.
   - D self-regulating and operates independently from the brain and spinal cord.

3 Explain the purpose of the 12 cranial nerves.

4 With reference to your own example, explain how the somatic nervous system operates in terms of its sensory and motor functions.

somatic nervous system The division of the PNS that transmits sensory information received from sensory receptor cells inwards towards the CNS, and motor messages from the CNS to the body's voluntary skeletal muscles; also known as the skeletal nervous system

sensory neurons Specialised neurons (afferent) that carry sensory information from internal and external environments inwards towards the CNS

motor neurons Specialised neurons (efferent) that carry motor commands from the CNS to muscles, glands and organs

autonomic nervous system (ANS) The division of the PNS that transmits motor messages from the brain to the body's internal organs and glands, which results in involuntary activity of internal organs and glands, and transmits messages back to the brain about the activity level of these organs and glands

5 Identify which division of the PNS (somatic or autonomic) is at work during each of the following actions:
   a You sneeze in response to dust.
   b It starts raining and you put up your umbrella.
   c The sun comes out and your pupils constrict.
   d Your heart rate increases when you go for a jog.
   e You roll up your sleeves when it gets hot.
   f Your tummy grumbles at the smell of food.

6 Explain the difference between the autonomic nervous system and the somatic nervous system.

7 Which statement about the autonomic nervous system is incorrect?
   A The activities controlled by the ANS are self-regulating and operate independently of the brain.
   B At times the ANS will communicate with the brain by sending information about the activity level of internal organs and glands.
   C The ANS is responsible for controlling the activity level of internal organs and glands.
   D The ANS is responsible for controlling involuntary muscles that regulate the activity level of internal organs and glands and controlling voluntary muscles that enable skeletal movements.

The sympathetic nervous system: Arousing effect

The sympathetic nervous system is the branch of the ANS that dominates when we experience heightened emotions or during times of vigorous physical activity. When the sympathetic nervous system is activated it uses the body's internal resources to provide the extra energy that is required for increased physical activity or to deal with intense emotions (such as fear) or stressful and threatening stimuli and situations. Just as a car's accelerator pumps more petrol through the engine to create energy for the car to move faster, the sympathetic nervous system changes the activity level of our internal systems so we have a sudden increase in our energy levels when needed.

Therefore, the sympathetic nervous system acts like the body's 'emergency' or 'arousal' system by activating and preparing the body for emergency action, such as fighting or running away. This emergency reaction is referred to as the 'fight–flight response'.

When we engage in physical activity such as playing sport or if we experience intense fear when watching a scary movie, our sympathetic nervous system is dominant. It prepares our body for action by increasing the activity level of some bodily systems while slowing down others (see Figure 1.15 and Table 1.1).

FIGURE 1.13 For these people, their sympathetic nervous system would be dominant when watching a scary movie.

For example, imagine if we were walking in the bush and suddenly we saw a snake moving fast towards us. This perceived threat would automatically activate our sympathetic nervous system preparing our body for emergency action. Initially a motor message would be sent to the adrenal glands to stimulate the release of the stress hormones adrenalin and noradrenalin into our bloodstream. Our heart rate and blood pressure would then increase, causing the blood carrying the adrenal hormones to move rapidly around our body. As a result a range of other bodily systems are activated in order to deal with the threat of the snake. Extra oxygen would be available because of the increase in our heart rate and breathing rate, and this extra oxygen would also help to convert the fats and sugars that have been released into energy. Our skeletal muscles would benefit from this increase in energy-charged blood, enabling them to move at a fast rate to respond to the snake. Our pupils would dilate to allow extra light to enter the eye so that we can see our surrounding environment and any other perceived obstacles. Our sweat glands would also produce more perspiration and our mouth would feel quite dry because the activity level of our salivary glands has slowed. We would also be unaware that our bladder has relaxed and that our digestion has slowed as our stomach decreases its contraction rate. Therefore, the sympathetic nervous system energises us and physically prepares us for action: to stay and 'fight' the snake or to engage in 'flight' by running away from the snake to safety.

Sometimes the sympathetic nervous system can stay 'switched on' for a long time, even once a perceived stressor or threat has passed. If this happens, then

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FIGURE 1.14 If you perceived this snake coming towards you as a threat, then your sympathetic nervous system would automatically be activated.

we experience stress (see Chapter 2), which is a state of intense arousal that causes our internal systems to operate at abnormally high levels. If we remain stressed for a prolonged period, we are in danger of developing a range of physiological and psychological disorders that could lead to a complete breakdown.

The parasympathetic nervous system: Calming effect

The parasympathetic nervous system has the opposite effect of the sympathetic nervous system by maintaining a level of homeostasis. It keeps our internal systems in a balanced and healthy state by maintaining vital functions such as heart rate, breathing rate, blood pressure and digestion at their regular level of operation. Therefore, the parasympathetic nervous system is accompanied by a normal level of arousal or a more relaxed state, which is a benefit because this is the physiological state that we mostly experience.

Once the need for high arousal is over and it is no longer necessary for the sympathetic nervous system to dominate, the parasympathetic nervous system is activated and a normal level of arousal is experienced. The parasympathetic nervous system also returns our body's internal systems to their natural level of functioning. For example, our heart and breathing rates would decrease and return to their normal level of functioning, our pupils would constrict, our sweat glands would inhibit the amount of perspiration that is produced and the activity level of our salivary glands would return to normal so our mouth no longer feels dry. Likewise, the functioning of other internal organs including liver, stomach and bladder would all return to their normal levels of functioning (see Figure 1.15 and Table 1.1). In this way, the parasympathetic nervous system acts like our car's brakes. We apply the brakes when we want our car to slow down, and the parasympathetic nervous system usually dominates when we need to be less energised or active.

The sympathetic nervous system and parasympathetic nervous system not only differ in their effects on arousal levels and internal bodily systems, but also in their response rate. Increased levels of adrenalin and other hormones (that arouse and prepare the body for sudden increases in activity) instantly enter our bloodstream once the sympathetic nervous system has been activated. However, these hormones take some time to disappear, which is why the effects of the parasympathetic nervous system take longer to occur. The effects of the sympathetic nervous system and high levels of arousal usually do not fade for 20 or 30 minutes after the need for extra energy has passed.

As we have seen, both the sympathetic and parasympathetic nervous systems directly influence the activity level of our internal organs, glands and non-skeletal muscles. While both of these divisions are always active, one usually dominates, functioning similarly to the accelerator and brakes on a car. For example, when you are about to run in a 100-metre race, you don't decide to increase your heart rate, tense your muscles, start perspiring or increase the amount of adrenalin in your system. The sympathetic branch of the ANS does this for you automatically so that you are physically prepared for action. Likewise, when the race is over and your body no longer needs to operate at a highly aroused level, you do not decide to lower your heart rate, relax your muscles or decrease your adrenalin output. Your body is automatically calmed by the parasympathetic nervous system.

sympathetic nervous system The branch of the ANS that alters the activity level of internal muscles, organs and glands to physically prepare our body for increased activity during times of high emotional or physical arousal

parasympathetic nervous system The branch of the ANS that maintains an energy level appropriate for normal bodily functioning and physically calms us after high arousal by reversing the changes in bodily functioning caused by the domination of the sympathetic nervous system

homeostasis The body's balanced and healthy state

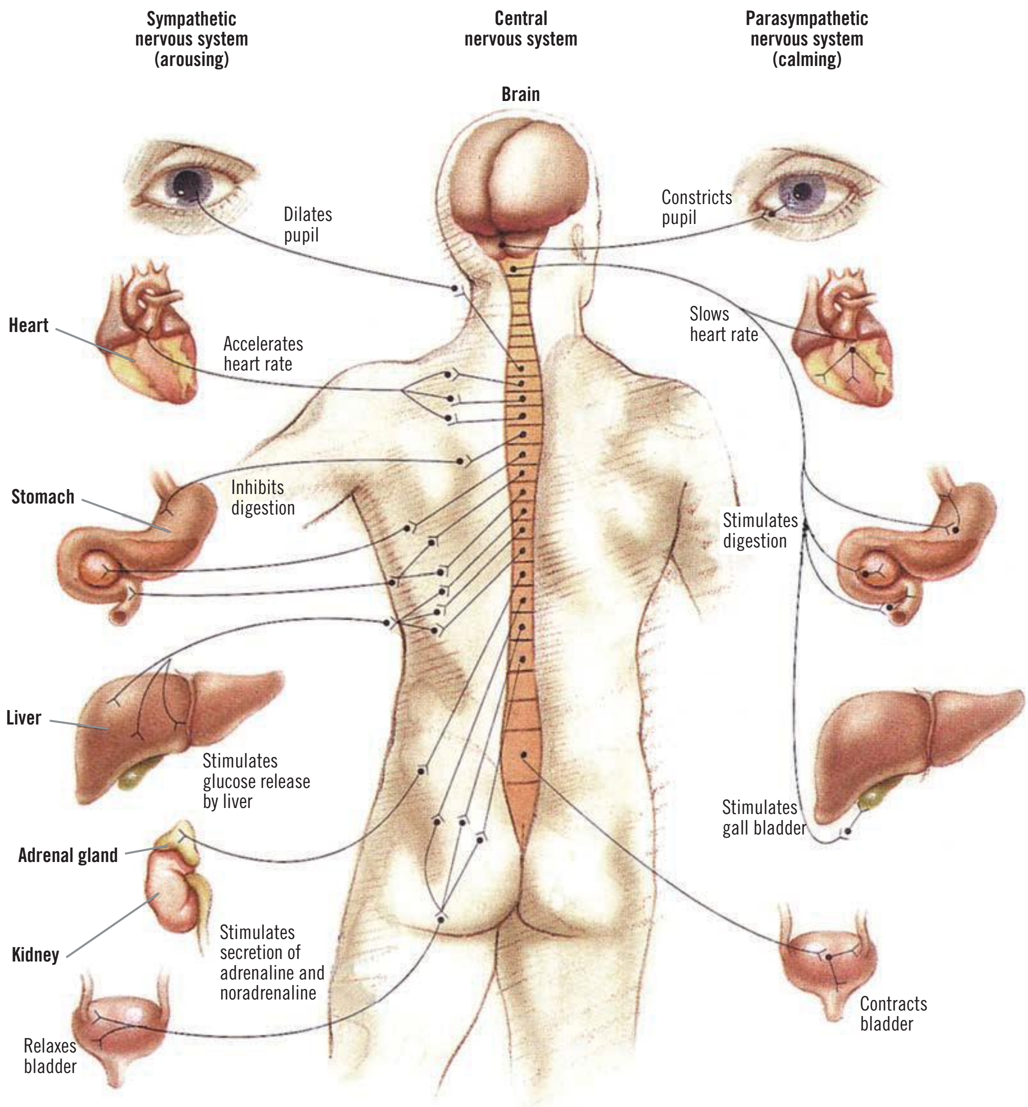

FIGURE 1.15 The sympathetic and parasympathetic divisions of the ANS have different effects on organs to arouse and increase energy or calm and conserve energy.

TABLE 1.1 Physiological changes of internal organs and glands due to the activation of the sympathetic and parasympathetic nervous systems

INTERNAL ORGANS AND GLANDS	SYMPATHETIC RESPONSE	PARASYMPATHETIC RESPONSE
Adrenal glands attached to kidneys	Releases hormones (adrenalin and noradrenalin) to stimulate or repress activity of internal organs	Decreases hormone activity
Heart	Increases heart rate and pumps blood faster	Decreases heart rate to normal functioning
Lungs	Increases expansion and rate of oxygen production; relaxes the airways	Decreases oxygen production; constricts airways
Liver	Produces and releases increased level of sugar	Returns to normal functioning
Stomach	Decreases contractions and slows digestion	Stimulates digestion
Salivary glands	Decreases production of saliva	Normal production of saliva
Sweat glands	Increases perspiration	Inhibits perspiration
Gall bladder	Inhibits production of bile	Stimulates gall bladder to produce bile
Eyes	Dilates pupils to take in more light	Constricts pupils; gives near vision
Bladder	Slows contraction rate and relaxes	Contracts, returning to normal functioning
Sex organs	Stimulated	Unstimulated

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FIGURE 1.16 For these athletes, their sympathetic nervous system is dominant while they are running in the race, and their parasympathetic nervous system dominates once the race has finished.

1.1 TRY IT YOURSELF >>

THE INTERACTIVE NATURE OF THE NERVOUS SYSTEM

Read the following scenario and then respond to the question that follows.

Craig is walking home after a night at his friend's house. As he is walking along, his phone beeps and he pulls out his phone from his back pocket and checks the message he has received. Once he has read the message, he puts his phone back in to his pocket. As he continues to walk along past the local park, he hears a sudden loud noise that sounds like a gun firing. His heart rate quickens as he looks around to see if he can see anyone in the park. He then runs as fast as he can towards his own house. When he arrives at his front door, he stops and realises his heart is racing and he is breathing heavily. He takes a deep breath and counts to 10. When he feels calm again and his heart rate has slowed he puts the key in the lock and opens his front door.

QUESTION

Explain the interactive response of Craig's nervous system on his walk home. In your response, ensure you discuss the role of the various components of the central nervous system and the peripheral nervous system, including the brain, spinal cord, somatic nervous system and autonomic (sympathetic and parasympathetic) nervous system.

1.3 CHECK YOUR UNDERSTANDING >>

1 Which of the following is not likely to occur when the parasympathetic nervous system is dominant?
   - A Pupils constrict.
   - B Sweat glands inhibit the amount of perspiration.
   - C A decrease in oxygen production
   - D A decrease in contractions and digestion of the stomach

2 Which statement about the fight–flight response is incorrect?
   - A The fight–flight response arouses us and prepares the body for emergency action.
   - B The sympathetic nervous system is dominant when the fight–flight response is activated.
   - C When the fight–flight response is activated, adrenalin and noradrenalin are released.
   - D The fight–flight response is the combined action of the sympathetic and parasympathetic nervous systems.

3 Identify the division of the autonomic nervous system (sympathetic or parasympathetic) that is most at work during the following situations.
   - a Your breathing rate slows after doing 20 star jumps.
   - b Your pupils dilate when you become scared.
   - c Your pupils return to normal size when you are no longer scared.
   - d You sweat when it gets hot.
   - e Your heart rate elevates as you enter your psychology exam.
   - f Your stomach digests your lunch.

4 While playing in his football grand final, Isaac is likely to be experiencing a high level of arousal. Explain three physiological responses that he might experience and how they will assist him in playing in the grand final.

5 Once the football grand final has finished, Isaac's physiological responses take some time to return to normal. Explain why this occurs and the division of the nervous system responsible for this.

6 Describe the effects that can occur when our sympathetic nervous system is activated for a prolonged period of time.

7 Explain the difference in the response rate between the sympathetic and parasympathetic nervous systems.

THE NERVOUS SYSTEM'S CONSCIOUS AND UNCONSCIOUS RESPONSE TO SENSORY STIMULI

As we have already seen in this chapter, the nervous system is the body's communication system. The brain responds to our internal and external environments through its connection to the PNS and its two branches; the somatic nervous system and the ANS. Sensory information is constantly being relayed from our sensory organs and receptors to our brain. The brain is inundated with all types of sensory information; however, not all the sensations we experience will reach our consciousness (Carter et al., 2014). For example, if you are studying for your psychology exam you may be so focused studying that you don't notice other sensory information around you, such as birds chirping outside your window. Alternatively, other sensations can capture our attention and we will become consciously

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aware of them and will therefore be able to respond accordingly. For example, if your favourite song comes on the radio while you are studying, auditory sensory information in the form of soundwaves will be sent to your brain and your brain will recognise that this is your favourite song. Your brain might respond by sending messages via your spinal cord to motor neurons in your somatic nervous system so that you are able to turn up the volume and enjoy the song. This sensory information has captured your attention and you have become consciously aware of it and, as a result, it has guided your behaviour and movements.

However, there are some sensations that we may not become consciously aware of that still play a role in influencing our behaviour. For example, some sensations relating to our body's position in space are registered unconsciously so that we move without thinking about it (Carter et al., 2014). Furthermore, our internal organs and glands that are controlled by the ANS will respond to sensory information automatically without us having to think consciously about activating them. For example, you can raise your hand and shade your eyes from bright light because this behaviour is voluntary and controlled by the somatic nervous system. However, the automatic constriction of your pupils to limit the amount of light entering the eye is an automatic reaction that is not under voluntary or conscious control and therefore is controlled by the ANS.

CONSCIOUS RESPONSES: CONTROLLED BY THE BRAIN

As human beings we are moving all the time, whether we are consciously aware of this or not. For example, we blink, talk and walk, our muscles contract and twitch, our balance and body position shifts and changes. The majority of our responses to sensory stimuli are voluntary and occur as a result of communication between the brain and the somatic nervous system. We are aware of this stimuli and make a conscious decision about what our response will be. For example, if we are cooking soup and we decide to do a 'taste test', our brain makes this decision and sends messages to the motor neurons in our somatic nervous system to pick up a spoon and taste the soup. The taste sensation of the soup is then sent to the brain. We might decide that the soup requires more salt, so the brain then sends a message back to the motor neurons to enable a response of picking up the salt and adding more to the soup. This voluntary response requires conscious thought and therefore the interaction of the somatic nervous system with the brain is required. In this instance, the brain guides the actions of the somatic nervous system.

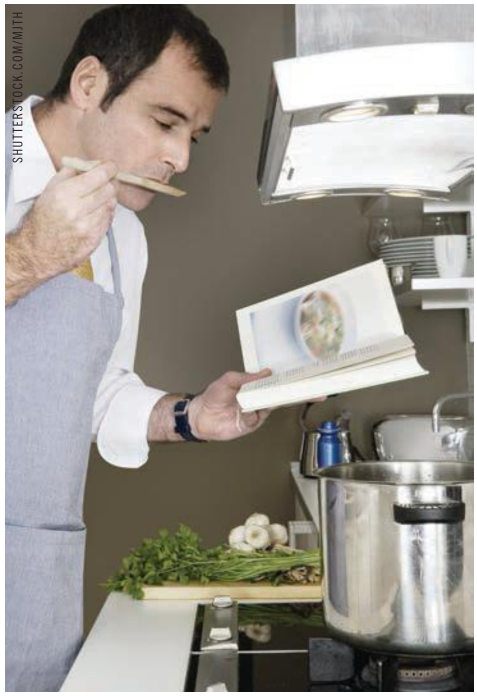

FIGURE 1.17 The activity of 'taste testing' while cooking and adding more ingredients as needed is a conscious response that requires the brain to direct the movements of the somatic nervous system.

Sensory information is required for us to plan and execute movements. We are constantly exposed to all types of sensory information such as light, soundwaves and pressure. Sensory receptors in our sense organs are the first point of contact for receiving this information. Once the sensory information is transmitted via the spinal cord to the brain, specialised areas of the brain are then responsible for processing the information. Different types of sensations all have a specific cortex area responsible for processing the information. For example, sensory information about touch is processed in the primary somatosensory cortex in the parietal lobe, whereas visual information is processed in the occipital lobe's primary visual cortex, while auditory information is processed in the temporal lobe's primary auditory cortex (see Figure 1.18). Once sensory information has been received and processed, the brain is responsible for planning and executing a response. This involves higher cognitive brain areas of the frontal lobe including the primary motor area, which is responsible for all voluntary body movements

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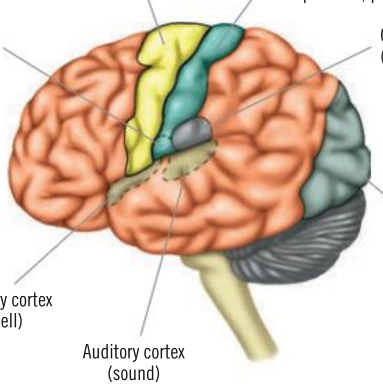

FIGURE 1.18 The specialised areas of the brain's cortex responsible for processing different types of sensory information and the primary motor cortex that is responsible for all voluntary body movements

(see Figure 1.18). Other areas of the brain that are also active include the thalamus and basal ganglia (midbrain structures that act as filters for the information so it is directed to appropriate cortical areas), as well as the cerebellum (a hindbrain structure that connects with the motor cortex to ensure our response is coordinated) (see Figure 1.19). Once the brain has planned the execution of a response, the information is sent back via the spinal cord to the somatic nervous system where motor neurons controlling the relevant muscles can implement the response. So, as you can see, making a conscious and planned response to sensory stimuli is a complex process that involves a range of nervous system divisions (Carter et al., 2014).

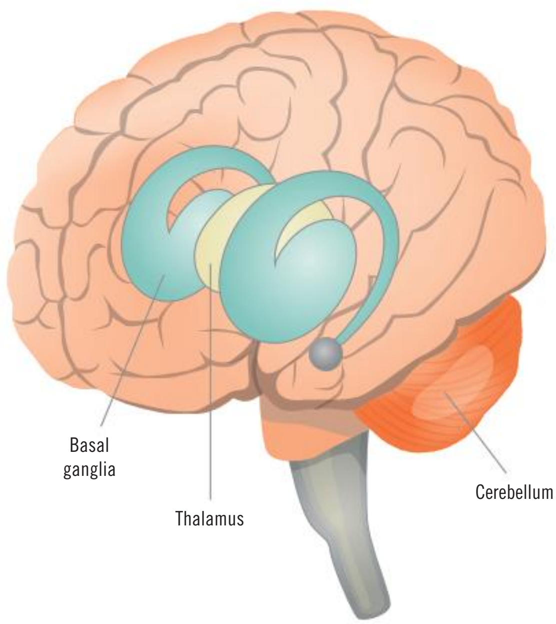

FIGURE 1.19 Areas of the brain that are active when we receive sensory information and plan and execute a response

UNCONSCIOUS RESPONSES: BYPASSING THE BRAIN (THE SPINAL REFLEX)

When we become consciously aware of a particular sensation, this awareness produces a voluntary response. As discussed earlier in the chapter, the somatic nervous system (a division of the PNS), via its communication with the brain, is responsible for all voluntary responses. However, not all responses performed by the somatic nervous system are conscious voluntary responses involving the brain. Some simple responses that are essential for survival occur automatically by the somatic nervous system and the spinal cord, and therefore operate independently from the brain.

For example, if while we are cooking soup we remove the pot from the hotplate and our hand brushes the hotplate, we withdraw our hand instantly. Such a rapid response occurs independently of the brain. A response like this is deemed essential for survival and involves communication only between neurons in the spinal cord and somatic nervous system; as a result the response can occur quickly. These simple involuntary responses to stimuli are known as reflex actions. Reflexes are 'hardwired' into our nervous system and aid our survival because they allow us to make rapid responses to stimuli that may be potentially dangerous, without us having to think about it. There are many types of reflex actions, including automatically blinking when a puff of air is blown into your eye.

The simplest stimulus–response behaviour pattern, called a spinal reflex (sometimes referred to as a reflex arc), occurs in the spinal cord, independently of the brain and involves three types of specialised neurons: sensory neurons, interneurons and motor neurons (discussed in more detail later in the chapter). For example, a sensory neuron is responsible for detecting intense sensations (such as a hot flame) and the information is then sent via interneurons, which form a direct connection to motor neurons to enable a response (withdrawing). Depending on the type of stimulus, a spinal reflex can be monosynaptic or polysynaptic.

reflex action A simple automatic response that is hardwired into our nervous system

spinal reflex The simplest stimulus response that occurs in the spinal cord

interneuron A specialised neuron that links sensory and motor neurons in the spinal cord

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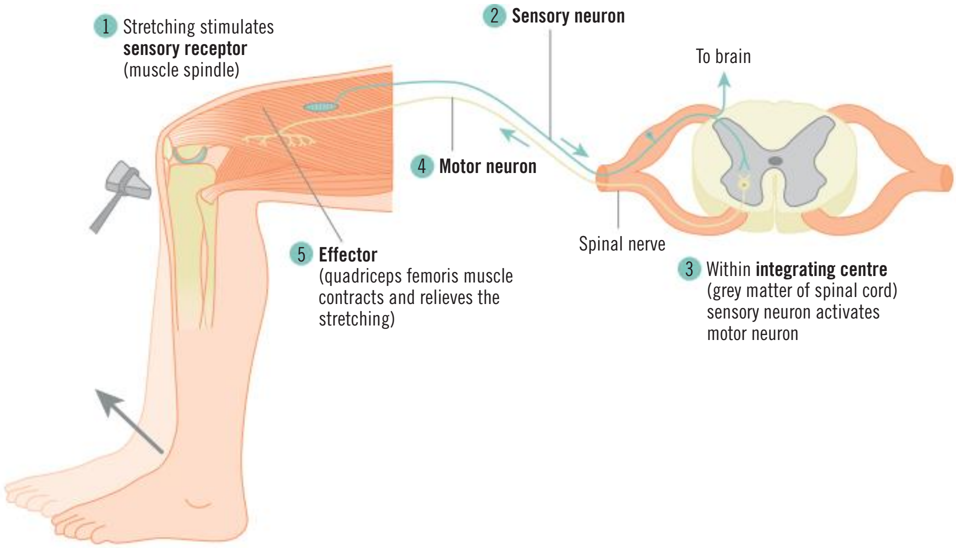

FIGURE 1.20 An example of a monosynaptic reflex occurring when the tendon under the patella is struck

An example of a **monosynaptic reflex** is the patellar 'knee-jerk' reflex or stretch reflex (see Figure 1.20). This reflex is often used by doctors to test spinal nerve function. It occurs when the patella tendon, located under the kneecap, is struck. The patella nerves are directly connected to the spinal cord, so when pressure is applied to the tendon its nerve receptors fire. This causes the lower half of the leg to automatically kick out and stretch the thigh muscle. Because the patella nerves are directly connected to the spinal cord, this reflex is programmed into the spinal cord. The reflex is the result of the information travelling along a sensory neuron to a motor neuron in the spinal cord and thereby activating only one synapse between these two neurons. As a result, the response is rapid (Barnes, 2013; Carter et al., 2014).

By contrast, a **polysynaptic reflex** involves the activation of more than one synapse in the spinal cord. An example of a polysynaptic reflex is the withdrawal reflex (also known as the flexion reflex) that occurs when we experience an intense sensation. For example, imagine that you are walking barefoot in the garden and you step on a sharp nail (see Figure 1.21). Initially, an intense sensation is detected in your foot by a sensory neuron. Instantly, the sensory neuron fires off a message to your spinal cord and activates an interneuron, which in turn activates a motor neuron, causing your foot muscles to contract and allowing you to withdraw your foot from the sharp nail. Polysynaptic reflexes involve more than one synapse because they involve interneurons in the spinal cord sending the message between sensory and motor neurons. Polysynaptic reflexes result in a more complicated response when compared to monosynaptic reflexes because they usually result in additional reactions. For example, when you step on the sharp nail your muscle contracts instantly to remove your foot, this then leads to the muscles in your other leg contracting to support

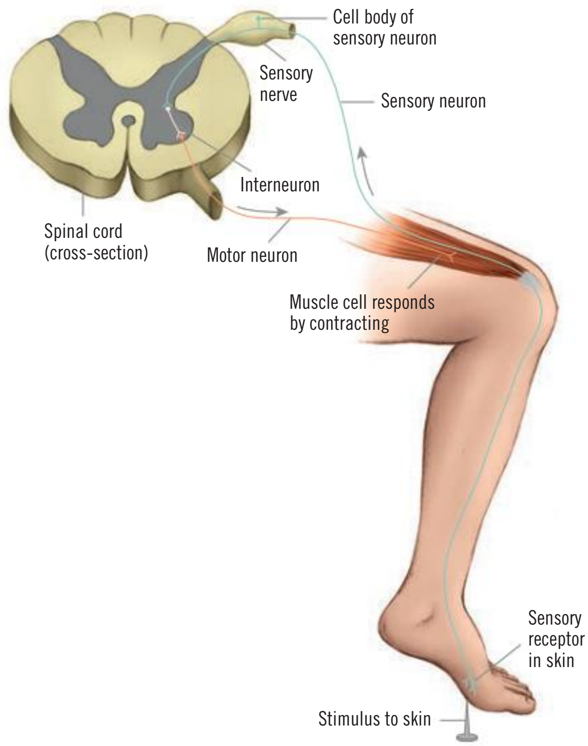

FIGURE 1.21 An example of a polysynaptic reflex is the withdrawal reflex experienced when we step on something sharp.

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you as you shift your weight. Although this activity can also just be directed by the spinal cord, it usually involves many more cells and several spinal nerves. As a result, polysynaptic reflexes can be slower than monosynaptic reflexes. However, in both examples your body initiates a rapid and instant spinal reflex, reacting automatically to protect itself, independently of the brain (Barnes, 2013).

By bypassing the brain, spinal reflexes help us automatically adapt to changing conditions, which in turn assists our survival. This automatic response system allows quicker reaction times when confronted with sudden hazards. In addition, these automatic responses leave our brain free to deal with more important information. However, even a simple spinal reflex usually triggers more complex activity. The spinal cord will normally send secondary signals to the brain during the reflex action so that the brain becomes aware of the actions it has taken. As your foot pulls away from the nail you have stepped on in the garden, you will feel the pain and think, 'Ouch! What was that?'

While a reflex action is a fixed unconscious response, emerging research evidence is demonstrating that the ability to consciously control a knee-jerk reflex through training can be useful in treating hyperactive reflexes common in spinal cord injuries (see Focus on research 1.1).

FOCUS ON RESEARCH 1.1

REFLEX CONTROL COULD IMPROVE WALKING AFTER INCOMPLETE SPINAL INJURIES

A research study supported by the US National Institutes of Health investigated whether people with incomplete spinal injuries are able to control hyperactive reflexes they experience by using a training technique that suppresses these reflexes. While some injuries of the spinal cord involve complete paralysis below the point of damage, other common injuries of the spinal cord are considered 'incomplete injuries' as they involve less disability, with some feeling or movement still evident below the point of damage. Incomplete injury of the spinal cord can result in classic symptoms that include the exaggeration of some spinal reflexes leading to muscle stiffness, an unusual pattern of movements and a reduced ability to walk.

The study by Aiko Thompson and Jonathan Wolpaw is the first to investigate if people are able to consciously control their 'knee-jerk' reflex that can become exaggerated during incomplete spinal injuries.

They investigated this by using an H-reflex, a response caused by electrical stimulation of the nerves behind the knee, which is similar to the automatic tendon stretch that occurs during a 'knee-jerk' reflex. The study involved 13 participants with the classic symptoms of an incomplete spinal injury. The participant injuries had occurred somewhere in the 8 months to 50 years before the study.

Initially, baseline data of the reflex response was taken over a 2-week period, while the participant received an electrical stimulation to the calf muscle of their weaker leg. Over the next 10 weeks, nine participants underwent training that encouraged them to suppress their reflex when it was stimulated. The training occurred for three sessions per week and involved the participants viewing the size of their reflex on a monitor. The other four participants received no training. The participants' walking speed over a 10-metre distance and their gait symmetry was measured both before and after the sessions.

The result showed that six out of the nine participants who received the training were able to suppress their reflexes. Their walking speed increased by 59 per cent on average and their gait became more symmetrical. Three of the participants who received training and the four participants who received no training were unable to suppress their reflexes and showed no improvements in walking speed or symmetry.

While this was a small study, the results are encouraging and they offer hope that patients with incomplete spinal cord injuries may be able to improve their walking speed and symmetry by controlling reflexes that become overexaggerated.

Source: Adapted from NIH/National Institute of Neurological Disorders and Stroke. (2013, February 5). Reflex control could improve walking after incomplete spinal injuries. *ScienceDaily*.

QUESTIONS

1 Explain the difference between a complete and an incomplete spinal injury.
2 What was the aim of this research?
3 Identify the independent variable (IV) and the dependent variable (DV) of the research.
4 What is the purpose of the baseline data?
5 Was there a control group in this experiment? Explain your answer.
6 Explain the results that were obtained.
7 Identify a limitation associated with this study.

monosynaptic reflex A reflex response that involves one synapse and the interaction between a sensory neuron and a motor neuron

polysynaptic reflex A reflex response that involves the activation of more than one synapse; it includes an interneuron making a connection between a sensory and a motor neuron

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THE AUTONOMIC NERVOUS SYSTEM: SELF-REGULATING VERSUS CONSCIOUS CONTROL

As we saw earlier in the chapter, the ANS is responsible for controlling involuntary muscles that regulate the activity level of our internal organs and glands, such as heart rate and body temperature. The activities controlled by the ANS are mostly self-regulating and generally operate constantly and independently of the brain, whether we are awake or asleep. An independent and constantly functioning ANS means that the vital organs and body systems we depend on for physical survival are kept functioning more or less automatically and without any conscious effort.

The dual role of the ANS to stimulate activity (sympathetic nervous system) and then calm us down (parasympathetic nervous system) is also self-regulating and occurs independently of the brain. While most of the time our parasympathetic nervous system dominates and our body is in a state of homeostasis, when we are exposed to sensory stimuli that may be perceived as a threat, the sympathetic nervous system is quickly and automatically activated, eliciting the emergency fight–flight response. Our automatically functioning ANS therefore allows us to survive in a constantly changing external environment and enables us to adapt the activity level of our internal body system as well as our behaviour to suit these changes.

For example, if we notice a vicious dog charging towards us, our fight–flight response will be automatically activated by the sympathetic branch of our ANS, causing a change in the activity level of our internal organs and glands. Our heart rate and breathing rate would increase, we would start to sweat and adrenalin would be released so that we are able to respond to the threat. This response by our internal organs and glands has occurred automatically without us having to consciously think about it.

While our ANS is mostly self-regulating and not under voluntary control, there are times when we can practise certain techniques that can control our ANS. For example, you may have 'forced' yourself to stop blinking for a period of time by consciously thinking about it and by intentionally controlling the muscles around your eye. What is normally an automatic response has become a consciously controlled response. Likewise, while our fight–flight response is automatically activated in response to being chased by a vicious dog, once our brain has registered the threat we may decide to try and remain calm so that the dog doesn't sense that we feel threatened. To do this we may try to gain conscious control over our ANS, by controlling our breathing by taking a number of slow, deep breaths. As we begin to lower our breathing we can bring about a sense of calmness to our body and in turn lower our heightened arousal and physiological responses.

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FIGURE 1.22 If a vicious dog is running towards us, our fight–flight response will be automatically activated by the sympathetic branch of our ANS to deal with the threat. We may also try to remain calm and control the response of our ANS.

So, while it is beneficial for our ANS to self-regulate and operate automatically, sometimes it is also beneficial for us to control some of its responses. For example, when we experience acute or prolonged stress, an imbalance of the functioning of the ANS occurs, with the sympathetic nervous system activating the fight–flight response and dominating over the parasympathetic nervous system. Techniques such as meditation and yoga are effective at reducing stress because they help us gain control over our ANS. For example, meditation involves deliberately inducing a state of deep physical and mental relaxation brought about by mental exercises that focus attention away from the typical flow of thoughts, worries and analysis to an internal place of 'calmness' (Wilson, 1986). Meditation has been found to elicit the relaxation response by deactivating the body's fight–flight response and thereby lowering heart rate, blood pressure, muscle tension and other physiological signs of stress. As well as these techniques, people can also use biofeedback, which is a process that allows them to receive information about their autonomic physiological activity (measured using precise instruments), in order to learn how to change and control these. Try it yourself 1.2 gives you the opportunity to try to control your ANS by engaging in meditation.

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FIGURE 1.23 Techniques such as meditation can help us to gain control over some of the responses of the ANS.

1.2 TRY IT YOURSELF >>

TAKE SOME TIME OUT: MEDITATION

For this activity you will need a watch with an alarm, a recording of guided meditation or slow music or soothing sounds, a quiet space where you will not be disturbed and lights off or blinds drawn.

During the 30 minutes before you begin your meditation, while you are engaged in normal activity, record your heart rate for one minute at 10-minute intervals and work out an average of the three readings.

Now, set your alarm to a low tone so that it will ring in 20 minutes, turn on your recording (not too loud), arrange yourself in a comfortable position on the floor, close your eyes and relax.

Make a conscious effort to block out all sounds so that you are only listening to the music or guided meditation. While you do this, concentrate on slowing your breathing and relaxing all your muscles. If you are listening to music and not a guided meditation, focus your thoughts on the image of a beautiful location (perhaps a beach at sunset or a rainforest). Once this image is clear, imagine yourself wandering in this place and concentrate only on the sensations you are experiencing there, such as smells, sounds, tastes, sights and feelings.

When your alarm rings, do not open your eyes. Slowly re-establish yourself by focusing on the smells, sounds, tastes, feelings and thoughts that you are experiencing in your actual physical location. Open your eyes and slowly rise from the floor. Turn off the recording.

Now, take your heart rate and compare it with your average before the meditation. Is there any difference? If so, how can you account for this? If you have been able to slow your heart rate, you have been able to control a process governed by your ANS.

1.4 CHECK YOUR UNDERSTANDING >>

1 Which brain area is not thought to be involved in the planning and execution of movements?
   A The thalamus
   B The cerebellum
   C The medulla
   D The basal ganglia
2 Which statement about a spinal reflex is incorrect?
   A A spinal reflex involves three types of specialised neurons: sensory neurons, interneurons and motor neurons.
   B A spinal reflex occurs only in the somatic nervous system.
   C A spinal reflex is an automatic involuntary response.
   D A spinal reflex can be monosynaptic and polysynaptic.
3 Explain the purpose of a spinal reflex.
4 Explain the difference between a monosynaptic reflex and polysynaptic reflex.
5 Ivan was baking some biscuits for his afternoon snack. When he pulled the biscuit tray from the hot oven his arm accidentally brushed against the oven door. Ivan immediately moved his arm away in a reflex action that was the result of a spinal reflex. Identify and explain the processes involved in Ivan's spinal reflex. In your answer, mention the role of sensory neurons, motor neurons and interneurons.
6 Explain why the activities of the autonomic nervous system are mostly self-regulating.
7 Explain when we may want to control the activities of our autonomic nervous system and how we may do this.

NEURONS: THE NERVOUS SYSTEM'S INTERCONNECTED BUILDING BLOCKS

Neurons are the basic building blocks of the nervous system and they are specialised to receive, process and transmit information. The nervous system is made from billions of interconnected neurons that communicate with each other in an electrical and chemical form, transmitting information all around the brain and body. Neurons carry out this complex task with the assistance of a range of supporting cells known as glial cells. Glial cells are found throughout the nervous system and assist in repair and

biofeedback A process by which a person receives information about their autonomic physiological activity (measured using precise instruments) in order to learn how to control these

glial cells Nervous system cells that are specialised to provide structural and nutritional support to neurons and maintain a healthy environment for neurons

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maintenance, provide essential metabolic functions and provide a structural framework that allows the network of neurons to stay connected.

Neurons are produced in the brain within the first 10 to 26 weeks of gestation, and once they are formed they migrate to their final location in the nervous system, and this location determines their function. Once a neuron's location and function has been established, they start to make connections with other neurons. These connections create an interconnected network so that messages can be continuously communicated around the nervous system.

HOW THE STRUCTURE OF NEURONS INFLUENCES THEIR FUNCTION

No two neurons are exactly alike in size or shape, but most are composed of common basic structural parts that play a specific role in communicating information throughout the body (see Figure 1.24). Each neuron has a **soma** (cell body) that contains a nucleus. The **nucleus** is the control centre for processing and also contains DNA. Extending from the soma are protrusions that look like the roots of a tree, called **dendrites**. These dendrites are responsible for first receiving the message from other neurons and transmitting the message inwards to the soma. The more dendrites a neuron has, the more information it can receive. Sometimes incoming messages can also be received directly by the soma. Extending from the other end of the soma is a single protrusion called an **axon**. Axons are thin fibres that carry messages, in the form of electrical nerve impulses, away from the cell body. Some axons are also coated with a **myelin sheath**, which is an insulating fatty layer that protects the axon and speeds transmission of the information (action potential) down the axon. At regular intervals in the myelin sheath are small gaps, called **nodes of Ranvier**. Instead of passing down the entire length of the axon, the speed of the nerve impulse is increased because it leaps from gap to gap. These nodes also allow nutrients and waste products to enter and leave the axon. Each component of a neuron has a unique structure that specifically allows it to fulfil its role in transmitting information.

When the electrical impulse travels down the axon it is known as an **action potential** or **neural impulse**. When the action potential reaches the end of the axon, the axon branches out into a number of **axon terminals** that link with the dendrites of other neurons. This linking allows the impulse to pass from neuron to neuron. The axon terminals of one neuron do not physically connect with the dendrites of another neuron. A microscopic gap, or **synapse**, exists between the axon terminals of the sending neuron (**pre-synaptic neuron**) and the dendrites of a receiving neuron (**post-synaptic neuron**). When the action potential reaches the end of the axon, or axon terminal, the axon terminal releases chemicals known as **neurotransmitters** into the synapse (see Figure 1.25). Transmission of the message between neurons begins when neurotransmitters carry the messages across the synapse to the dendrite (or in some cases the soma) of the post-synaptic neuron. This part of transmission is therefore chemical. Neurotransmitters are then absorbed by **receptor sites** in the receiving dendrite (or soma) sensitive to specific neurotransmitters. This re-uptake process alters the post-synaptic neuron's activity level and ensures that the message will continue to be transmitted.

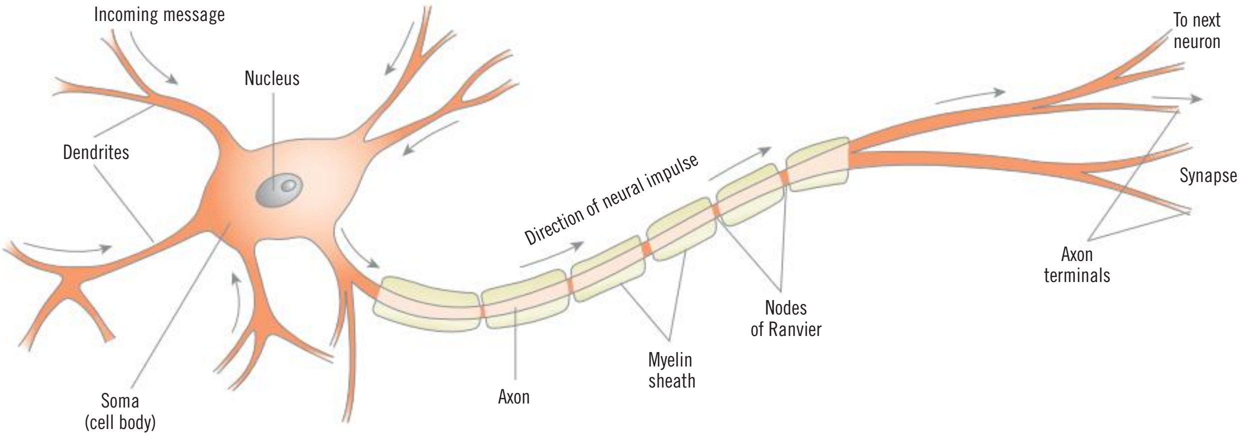

FIGURE 1.24 A typical neuron's basic structural parts

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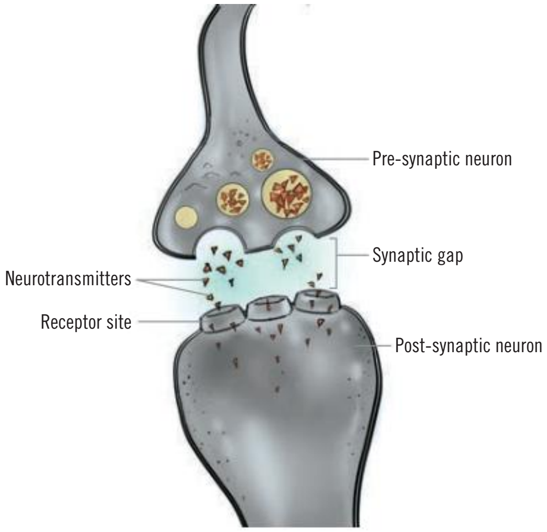

FIGURE 1.25 The synaptic gap between pre-synaptic and post-synaptic neurons, where neurotransmitters are released and absorbed by the receptor sites on the post-synaptic neuron. The size of the gap is exaggerated here; it is actually only about two millionths of a centimetre.

Since neurons do not physically touch, the synapse is the vital communication site for neurons to pass messages between each other. Most neurons have thousands of synaptic connections with other neurons. When we are born, not all neurons have developed these synaptic connections; rather, these connections form as our brain develops. This process is referred to as **synaptogenesis** (see Figure 1.26). Synaptogenesis occurs throughout a healthy person's lifespan, but it occurs most rapidly during early brain development, beginning at about 2 months before birth until approximately 2 years after birth. Synaptogenesis allows us to form many new synaptic connections between neurons and to establish the neural pathways that allow different brain areas and structures to communicate. Those pathways that are most often stimulated and strengthened (because they are used most often) become a permanent part of the brain. New synapses are constantly created and strengthened as a result of learning, exposure to new experiences and even in the formation of memories. Likewise, the brain automatically undergoes a process of **synaptic pruning** where excessive and non-essential synaptic connections are removed, allowing the remaining synaptic networks to strengthen and expand.

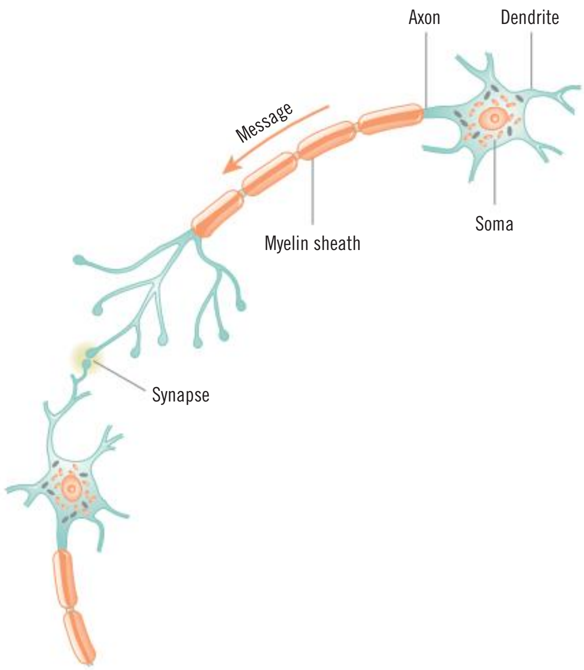

FIGURE 1.26 Synaptogenesis has occurred to produce the synapse between these two cells to enable them to communicate.

1.5 CHECK YOUR UNDERSTANDING >>

1 Which of the following is not a structural component of a basic neuron?
   A Dendrites
   B Axon
   C Synapse
   D Soma

2 What is the fibre that carries information away from the cell body of a neuron?
   A Dendrite
   B Axon
   C Myelin
   D Neural impulse

3 Which statement about the myelin sheath is incorrect?
   A The myelin sheath is an insulating fatty layer that protects the dendrites.

soma The main cell body of a neuron that contains the nucleus

nucleus The control centre of the neuron; also contains DNA

dendrite A neuron fibre that is connected to the soma and receives incoming messages

axon The fibre that carries information away from the cell body of the neuron

myelin sheath A fatty layer coating some axons that protects the axon and assists with the speedy delivery of the nerve impulse

nodes of Ranvier Small gaps that occur at regular intervals in the myelin sheath that speed the transmission of the nerve impulse

action potential (neural impulse) An electrical charge that sweeps down the axon of a neuron, prompting the release of neurotransmitters

axon terminals Fibres that branch out from the end of the presynaptic neurons axon and link with the dendrites of the postsynaptic neuron; responsible for releasing neurotransmitters into the synapse

synapse The microscopic gap between neurons, over which messages pass

pre-synaptic neuron The neuron that sends the impulse

post-synaptic neuron The neuron that receives the impulse

neurotransmitter A chemical messenger synthesised within a pre-synaptic neuron and transmitted across the synapse

receptor sites Tiny areas on the cell membrane that are sensitive to certain neurotransmitters, located mainly on dendrites but also on the soma of neurons and in muscles and glands

synaptogenesis The process by which synapses are formed between neurons

synaptic pruning A process of removing extra, weak or unused synaptic connections so that neural transmission is as efficient as possible

B The myelin sheath speeds the transmission of an electrical impulse.
C Small gaps occur at regular interval in the myelin sheath.
D Axons are coated with myelin.

4 Which statement is true about neural transmission?
A The transmission of an impulse occurs only within the central nervous system.
B The transmission of an impulse within neurons is chemical.
C The transmission of an impulse between neurons is chemical.
D The transmission between one neuron and another relies on the electrical conductivity of the neuron.

5 Explain the function of axons and dendrites in the reception and transmission of information.

6 Explain how a message is sent from a pre-synaptic neuron to a post-synaptic neuron.

7 Explain the importance of synaptogenesis.

TRANSMISSION OF INFORMATION ALONG A NEURON

As we have seen, neurons are specialised to receive, process and transmit information, and it is the structural component of a neuron that assists it in achieving this specific role of communicating information. For information to travel from neuron to neuron all through the nervous system, the information must first activate an individual neuron and then be transmitted down its axon in the form of an electrical message. Each neuron is like a tiny biological battery. Electrically charged atoms called ions are found in and around nerve cells. Some ions have a positive charge, while others have a negative charge.

The electrical charge of a neuron at rest is called its resting potential. At rest, the inside of an axon is minus 60–70 millivolts. (A millivolt is one thousandth of a volt.) When there isn't a neural impulse passing down the axon, the axon is said to be *polarised*. This process of polarisation means that not only is the axon at rest but that there is an increase in negative ions inside the axon compared with positive ions outside. However, neurons seldom get much rest with messages arriving from other neurons constantly altering the resting potential. If it changes enough, the cell reaches a threshold, or trigger point, for firing. The threshold for human neurons is approximately minus 50 millivolts. When a neuron reaches minus 50 millivolts, the action potential sweeps down the axon (at up to 333 kilometres per hour) and the axon *depolarises*. When this process of depolarisation occurs, positively charged sodium ions (Na^+) rush into the cell and its interior briefly becomes positive compared to the outside. The axon membrane is pierced by tiny molecular tunnels called ion channels. Normally, these channels are blocked by molecules that act like gates or doors; however, during a neural impulse, the gates open to allow these positively charged sodium ions (Na^+) to rush into the axon. The channels open up first near the soma. Then, gate after gate opens down the axon, as the action potential rushes along. At this very instant, millions of these action potentials are firing in your brain. Once the action potential has passed, a process of repolarisation occurs with an outward flow of positive ions so that the negative charge and resting potential inside the axon can be restored (Carlson, 1998; Carter et al., 2014).

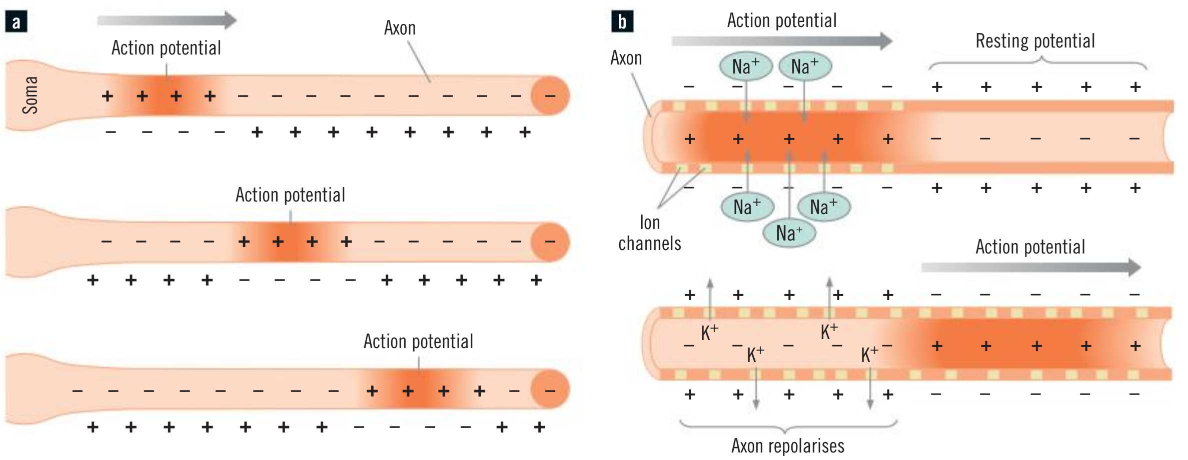

FIGURE 1.27 (a) As an action potential passes along the axon, the interior of the axon briefly becomes positive compared to the outside of the cell. (b) Cross-sectional views of an axon. In the top axon, an action potential begins when the ion channels open and sodium ions (Na^+) enter the axons. In the lower axon, the action potential has moved to the right. After it passes, positive ions flow out of the axon, this quickly renews the negative charge inside the axon.

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The action potential is an all-or-nothing event, meaning that an impulse occurs completely or not at all. You might find it helpful to picture the axon as a row of dominoes set on end. Tipping over the dominoes is an all-or-nothing act. Once the first domino drops, a wave of falling blocks moves rapidly to the end of the line. Similarly, when a nerve impulse is triggered near the soma, a wave of activity (the action potential) travels down the length of the axon (see Figures 1.27a and 1.27b).

TYPES OF NEURONS AND THEIR FUNCTION

While all neurons share a common basic structure and their overall function is consistent with receiving, processing and transmitting information, they are specialised in a range of different functions and can vary in the type of information they detect and respond to. As a result, their shape can also vary. The three main types of neurons located throughout the nervous system are sensory neurons, motor neurons and interneurons (see Table 1.2).

TABLE 1.2 The role of sensory neurons, motor neurons and interneurons

TYPE OF NEURON	LOCATION	ROLE
Sensory neuron (afferent)	Located primarily in the PNS	Sensory neurons detect energy from the external environment and stimulation from the internal environment and carry information about it to the CNS.
Motor neuron (efferent)	Located primarily in the PNS	Motor neurons carry commands from the brain to the body's muscles, organs and glands to enable movement.
Interneuron	Located primarily in the spinal cord	Interneurons carry information directly between sensory and motor neurons. They are involved in reflex actions.

Sensory (afferent) neurons

Sensory neurons (see Figure 1.28) are specialised neurons that detect and respond to energy from our external environment. These energy sources can include sound, light and chemical energy. For example, the sound of a police siren would activate the sensory neurons in your ears to respond to the sound energy. Likewise, sensory neurons in your nose would respond to chemical energy elicited by the smell of food. The image of a plane in the sky would trigger the sensory neurons in your eyes to respond to the light energy. Sensory neurons also respond to stimulation from the body's internal muscles, organs and glands. For example, they would detect the sensation experienced from a muscle strain. Sensory neurons are also referred to as afferent neurons because the term 'afferent' means carrying towards or inwards. This name is consistent with their role because sensory neurons send the information inwards to the spinal cord.

Sensory information about the environment is first detected by specialised receptor cells located in our various sensory organs. Once received, this information is then transmitted by sensory neurons in the peripheral nervous system inwards to the spinal cord (CNS). Once the information enters the spinal cord through the spinal nerves, it is transmitted to the brain for higher processing by these specialised afferent neurons located in the spinal cord. The information travels up the spinal cord along the ascending tracts, which are composed of bundles of axons, towards the brain for higher processing.

Motor (efferent) neurons

Motor neurons, also known as efferent neurons (see Figure 1.28), are specialised neurons that carry motor messages (related to movement and how the body should respond to sensory information) from the CNS to the rest of the body. These messages cause the muscles to relax or contract, glands to increase or decrease their secretions, and they affect the activity level of internal organs so a specific response can be enacted.

When sensory information carried by afferent neurons reaches the brain, it is interpreted and decisions are made about an appropriate response. Usually this response involves some degree of movement. The information about this movement is known as motor information or efferent information. This is because 'efferent' means moving away from or outwards. Once the brain has decided on the appropriate response to sensory information, the motor message is relayed to motor neurons located

ion An electrically charged atom

resting potential The typical internal environment (negatively charged) of a neuron in comparison to external environment (positively charged)

polarisation When an axon is at rest there is an increase in negative ions inside the axon compared with positive ions outside

threshold The point at which a nerve impulse is triggered

depolarisation When an action potential travels down the axon and its interior briefly becomes positive compared to the outside

ion channels Molecular tunnels in the axon membrane

repolarisation When the resting potential of the neuron is restored

all-or-nothing event An event that happens completely or not at all

receptor cells Cells located in the sense organs that are specialised to detect (receive) specific types of sensory information

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in the *descending tracts* of the spinal cord. From here it is transmitted to motor neurons located in the body's relevant muscles, glands and organs so the response can be enacted. For example, when you brush your teeth, your brain sends the messages needed to perform this action via efferent neurons. These neurons carry the information down the spinal cord and out to the muscles in your arms, hands and fingers so that you are able to manipulate your toothbrush to clean your teeth.

Interneurons

Located primarily in the spinal cord of the CNS are specialised nerves called interneurons, which form a direct connection between motor neurons and sensory neurons (see Figure 1.28). As we saw in the previous section, some simple behaviours, called involuntary reflex actions, do not involve interpretation and decision-making by the brain. Because these basic behaviours operate independently from the brain, they are triggered automatically by the somatic nervous system and the spinal cord, and are made possible by sensory neurons and motor neurons communicating directly via the interneurons located in the spinal cord.

When sensory neurons receive an intense sensation such as your hand brushing up against a hot iron, your automatic response is to pull your hand away, which is important for survival. Such a reaction occurs quickly because interneurons in your spinal cord have relayed the information directly from sensory neurons to motor neurons. The involvement of the brain in interpreting the sensory information and deciding on an appropriate response has been bypassed. As a result of interneuron activity you are able to respond instantly in a manner that enhances your survival.

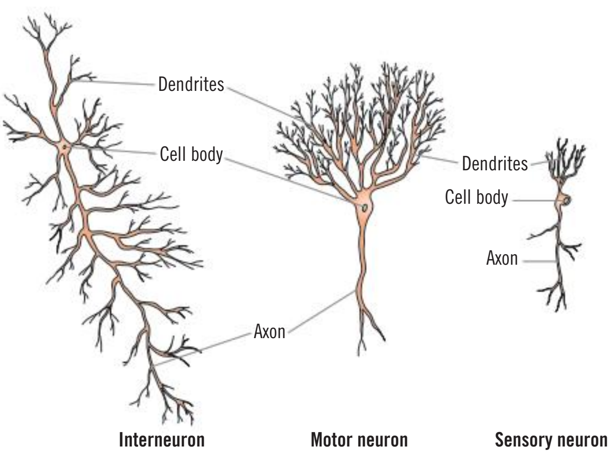

FIGURE 1.28 An example of an interneuron, a motor neuron and a sensory neuron

1.6 CHECK YOUR UNDERSTANDING >>

1 The electrical charge of a neuron at rest is its:
   A action potential.
   B resting potential.
   C threshold.
   D all-or-nothing potential.

2 The point at which the electrical charge of a neuron is changed so much that it will fire is called the neuron's:
   A action potential.
   B resting potential.
   C threshold.
   D all-or-nothing potential.

3 The following steps make up the sequence of events in an action potential. Place them in the order in which they occur.
   a When the electrical charge of the neuron reaches minus 50 millivolts, an action potential occurs.
   b A neuron at rest has an electrical charge of approximately minus 70 millivolts.
   c During an action potential, ion channels open up, one by one, along the axon.
   d Messages arriving from other neurons alter the electrical charge of the neuron.

4 _________ neurons transmit information about external stimuli to the central nervous system and _________ neurons transmit instructions about movement from the central nervous system to muscles, organs and glands.
   A Efferent; motor
   B Motor; afferent
   C Sensory; ascending
   D Sensory; motor

5 Explain why sensory neurons are also referred to as 'afferent' neurons and motor neurons as 'efferent' neurons.

6 Explain two differences between sensory neurons and motor neurons.

7 Explain the importance of interneurons, referring to both their role and location.

NEUROTRANSMITTERS: CHEMICAL MESSENGERS AT THE SYNAPSE

The neural impulse that travels within the neuron is primarily *electrical*. In contrast, communication between neurons is *chemical*, because the message is carried by neurotransmitters released by the pre-synaptic neuron. As we discovered earlier, the microscopic space between two neurons, over which messages pass, is called a synapse. When an action potential reaches the tips of the axon terminals of the pre-synaptic neuron, neurotransmitters are released into the synaptic gap. These neurotransmitters are stored in the neuron in tiny sacs called synaptic

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vesicles. It is only when the action potential reaches the axon terminal that these synaptic vesicles move to the surface of the membrane and release the neurotransmitter. The neurotransmitter will then carry the chemical message across the synapse to the receptor site on the dendrite of the post-synaptic neuron, thereby altering activity in that post-synaptic neuron (see Figure 1.29). Neurotransmitters therefore enable communication between neurons around the nervous system, thus enabling messages to travel from sensory receptor sites to the brain for processing and from the brain to muscles, organs and glands to enable a response.

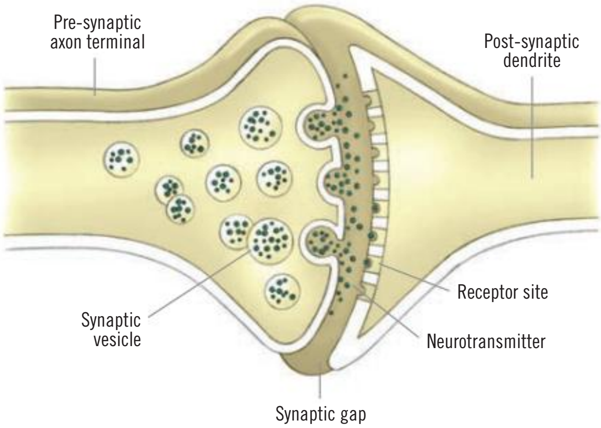

FIGURE 1.29 When a nerve impulse arrives at an axon terminal, the synaptic vesicles move to the surface and release neurotransmitters. These transmitter molecules cross the synaptic gap to influence the next neuron.

THE ACTION OF NEUROTRANSMITTERS: LIKE A KEY IN A LOCK

As discussed previously, neurotransmitter molecules travel across the synaptic gap and attach to special receptor sites on the receiving neuron. Receptor sites are tiny areas on the cell membrane that are sensitive to certain neurotransmitters. These sites are found in large numbers on the dendrites as well as the soma of neurons. Muscles and glands have receptor sites too.

Neurotransmitters attach themselves to quite specific receptor sites in a way that resembles a key fitting a specific lock, as shown in Figure 1.30. This similarity between a neurotransmitter and a key is that just like a key has its own patterns and shape that fit into a specific hole in a lock, so too does each neurotransmitter. The neurotransmitter's distinct molecular shape fits into a specific receptor site. Likewise, just as the correct key successfully opens the right lock, a neurotransmitter that attaches to the specific receptor site sensitive to that neurotransmitter will be successful at influencing and altering that neuron's activity level (Seung, 2012). Therefore, receptor sites that are sensitive to a particular neurotransmitter will ignore all other neurotransmitters and only respond to the particular neurotransmitter it is sensitive too.

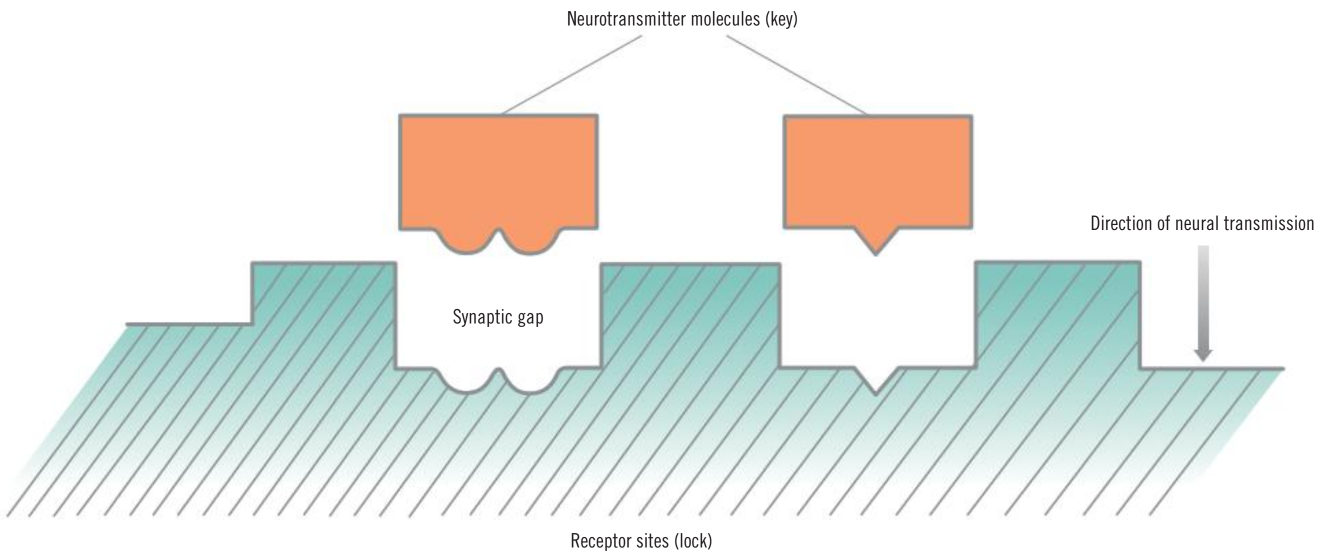

FIGURE 1.30 The 'lock-and-key' mechanism at the synapse. The neurotransmitter fits its specific receptor site in a similar way to a key fitting a lock.

synaptic vesicles Sacs that store neurotransmitters, these vesicles move to the surface and release a neurotransmitter when a neural impulse arrives at an axon terminal

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THE EXCITATORY AND INHIBITORY EFFECTS OF NEUROTRANSMITTERS

Neurotransmitters may act in one of two ways when they arrive at the post-synaptic neuron. Some neurotransmitters have an excitatory effect because they stimulate the next neuron causing depolarisation. This means that they make it more likely for the post-synaptic neuron to fire an action potential. Other neurotransmitters have an inhibitory effect because they block the activity levels of the next neuron. This means they make it less likely for the post-synaptic neuron to fire and pass on the neural impulse. At any instant, a single neuron may receive hundreds or thousands of messages from adjacent neurons. However, whether the result of synaptic transmission will be excitatory or inhibitory depends on the type of neurotransmitter used and the electrically charged receptors (ion channel receptors) they interact with. Also, if several **excitatory messages** arrive close in time, the neuron fires – but only if it hasn't been pushed away from its receptor sites by incoming **inhibitory messages**. In this way, messages are combined before a neuron 'decides' to fire its all-or-nothing action potential. When a neuron is stimulated, a lasting change in the efficiency of the synapse is produced (Kandel & Schwartz, 1982). The receiving neuron becomes more likely to fire again in the future, thus making it easier for neural impulses to travel the same pathway again.

As you can see, the activity at the synapse between two neurons can be very complex. There are many possible neurotransmitters crossing the synapse at the same time, and each neurotransmitter has a specific receptor site to fit into. Furthermore, transmission of the information to the post-synaptic neuron and beyond is dependent on whether the neurotransmitter is transmitting an excitatory message or an inhibitory message. To complicate this activity at the synapse even further, other chemicals can also interfere with the transmission of the message. These chemical substances are known as **neuromodulators** and they act by modifying the response of neurons to a specific neurotransmitter. Neuromodulators work by acting together with neurotransmitters to enhance the excitatory or inhibitory responses of the receptor sites on the post-synaptic neuron. In doing so they can affect the functioning of the nervous system, including the experience of pain, pleasure, moods, hunger and emotions as well as cognitive processes such as memory.

An example of neuromodulators are drugs including prescription medications. Most people will be aware of the effects of taking a painkiller on the transmission of pain messages through the nervous system. Like neurotransmitters, drugs have their own molecular shape and can be classified as either agonist or antagonists. Drugs that are classified as **agonists** are known to either increase the release of neurotransmitters or imitate certain neurotransmitters by binding to the receptor sites and causing the post-synaptic neuron to fire an action potential. By contrast, drugs that are classified as **antagonists** are known to either inhibit the release of neurotransmitters or block the receptors sites for these neurotransmitters (Gazzaniga, Heatherton, & Halpern, 2011).

1.7 CHECK YOUR UNDERSTANDING >>

1 Neurotransmitters:
   - A are chemicals released at the synapse of a nerve cell.
   - B can stimulate activity in an adjacent neuron.
   - C can inhibit activity in an adjacent neuron.
   - D All of the above

2 Which statement about neuromodulators is incorrect?
   - A Neuromodulators are chemical substances that act by modifying the response of a neuron to a specific neurotransmitter.
   - B Prescription medications are an example of a neuromodulator.
   - C Neuromodulators do not have an impact on the functioning of the nervous system.
   - D Neuromodulators can interfere with the transmission of messages.

3 Which statement about excitatory and inhibitory neurotransmitters is correct?
   - A Excitatory neurotransmitters cause depolarisation for the post-synaptic neuron, whereas inhibitory neurotransmitters make the post-synaptic neuron more likely to fire.
   - B Excitatory neurotransmitters block activity in the post-synaptic neuron, whereas inhibitory neurotransmitters make the post-synaptic neuron polarise.
   - C Excitatory neurotransmitters make it more likely for the post-synaptic neuron to fire an action potential, whereas inhibitory neurotransmitters block the activity level of the next neuron.
   - D Excitatory neurotransmitters make it more likely for the activity level of post-synaptic neuron to be inhibited, whereas inhibitory neurotransmitters make it more likely for the next neuron to fire.

4 All the following statements about neural transmission are true except:
   - A The transmission of an impulse occurs only in the central nervous system.

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B The transmission of an impulse within a neuron is electrical.
C The transmission of an impulse between neurons is chemical.
D The transmission of information between one neuron and another relies on the release of neurotransmitters.

5 Explain the role of the synaptic vesicles.
6 Explain how a neurotransmitter and receptor site act like a key and a lock.
7 Explain the difference between agonist and antagonist drugs.

TYPES OF NEUROTRANSMITTERS

There are more than 100 neurotransmitters (and their receptors) located throughout the brain. These neurotransmitters are responsible for the vital physical and psychological functions we are capable of, such as behaviours, movements, emotions and thoughts. As discussed earlier, some neurotransmitters can be excitatory and some inhibitory. Others can have both an excitatory and inhibitory response depending on the receptor the neurotransmitter binds to and its location in the brain (Gazzaniga et al., 2011).

Glutamate: The major excitatory neurotransmitter

The major excitatory neurotransmitter in the CNS is glutamate, which is a type of amino acid extensively found throughout neurons and synapses in the brain, in particular in the hippocampus and outer layers of the cerebral cortex. Given that glutamate is an excitatory neurotransmitter it is involved in high-speed neural transmission. The main receptor sites for glutamate include NMDA, AMPA and kainite. When glutamate is released at the synapse it binds to one of these glutamate receptor sites located on the post-synaptic neuron. As a result it activates these receptor sites and makes it more likely for the post-synaptic neuron to fire an action potential. You may have experienced the effects of caffeine-based drinks or even the caffeine in chocolate on the activity of your nervous system. This is because caffeine can increase glutamate activity (Hudspith, 1997).

Because of its widespread location throughout the CNS, it is no surprise that glutamate has a key role in the neurological functioning characteristic of a normal brain, including cognition, memory, learning, behaviour, movement and sensations (Sundaram, Gowtham & Nayak, 2012). Glutamate's vital role in cognitive functions such as learning and memory occurs in some areas of the hippocampus during *long-term potentiation (LTP)*. LTP occurs when memories are being formed and a group of neurons 'fire together.' If the same neurons continue to 'fire together' in the future, then they become synchronised to each other, so when one neuron fires it also triggers the other neurons that previously fired with it to also fire (Barnes, 2013; Carter et al., 2014). In some areas of the hippocampus, glutamate binds to NMDA receptors to generate LTP and strengthen synaptic connections. It has also been found that when antagonists for NMDA bind to the receptor sites, they block transmission, making it difficult to generate LTP (Rosenzweig, Leiman & Breedlove, 1999). In addition, it has been recently found that glutamate also has a key role in neurogenesis that occurs in the CNS. This includes not only the production and growth of new cells but also cell migration, synaptogenesis and the development of neural circuits and connections (Sundaram et al., 2012).

As we have seen, glutamate is essential for neurological functioning. However, excessive amounts of glutamate can be toxic to neurons causing a range of impacts. Too much glutamate can affect the development of neural circuits leading to inappropriate connections being formed. Likewise excessive glutamate has a possible connection to neurodegenerative diseases such as motor neuron disease and Huntington's disease (Sundaramet al., 2012).

Gamma-amino butyric acid (GABA): The primary inhibitory neurotransmitter

The major inhibitory neurotransmitter is gamma-amino butyric acid (GABA), which is also a type of amino acid and extensively found throughout the

excitatory messages Messages transmitted by neurotransmitters that stimulate the next neuron to fire

inhibitory messages Messages transmitted by neurotransmitters that make the next neuron less likely to fire

neuromodulator Chemical substance that modifies the response of a neuron to a specific neurotransmitter

agonist A substance that increases the release of a neurotransmitter or imitates its activity by causing the post-synaptic neuron to fire

antagonist A substance that inhibits the release of a neurotransmitter or blocks receptor sites, making the post-synaptic neuron less likely to fire

glutamate The primary excitatory neurotransmitter in the brain responsible for the fast transmission of neural messages and involved in cognitive functions

neurogenesis The production of new brain cells

gamma-amino butyric acid (GABA) The primary inhibitory neurotransmitter; its overall effects are to calm or slow neural transmission and therefore the body's response

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nervous system. Given that GABA is an inhibitory neurotransmitter, its overall effect is to calm and slow neural transmission and the body's response, therefore it counteracts the excitability of neurons. The main receptor sites for GABA are GABAa, GABAb and GABAc. When GABA activates one of these receptor sites, the cells that have those receptors are inhibited and therefore less likely to fire an action potential (Rosenzweig et al. 1999).

As a result of its effects, GABA has been identified as one of the neurotransmitters influential in the development and treatment of anxiety disorders. Studies have shown that when GABA activates its receptors, the body's response becomes calm or slows down. This means that specific features of the stress response that are associated with anxiety, such as increased heart rate, respiration or blood pressure, are blunted. Therefore, a lack of the neurotransmitter GABA can lead to overstimulation and our body's responses becoming heightened, leading to anxiety. Treatments often target the enhancement of GABA neurotransmission, in order to inhibit the hyper and over-excited bodily responses seen in anxiety. A group of drugs known as benzodiazepines, which include medications such as Valium and Xanax, can be used in the treatment of anxiety. These types of drugs are agonists because they increase the activity of GABA, thereby inhibiting post-synaptic action potentials and as a result calming down the body's responses (Gazzaniga et al., 2011). Likewise, alcohol can increase GABA activity. This accounts for some of the sedative effects of alcohol, which can lead to a blunting of the features associated with the stress or anxiety response. This may explain why some people believe they need alcohol to 'calm down'.

The role of GABA has also been associated with some types of seizures. During an epileptic seizure normal brain function is disrupted because neurons start firing in an abnormal way. It has been found that low levels of GABA can be associated with the onset of epileptic seizures because low levels mean less inhibition of neurons firing, thus an excess of action potentials are fired throughout the brain causing a seizure (Carter et al., 2014). Furthermore, when the activity of GABA is blocked by particular drugs, seizures can be provoked (Rosenzweig et al., 1999).

FIGURE 1.31 Valium is an example of a benzodiazepine that is used to treat anxiety by increasing the levels of GABA and calming down the body's response.

A balancing act: Glutamate versus GABA

As we have seen, glutamate and GABA have opposing effects. Glutamate has an excitatory effect causing neurons to fire an action potential and to speed up neural transmission. GABA has the opposite effect by causing neurons to inhibit the firing of an action potential and slow down neural transmission. Therefore, a reasonable assumption can be made that if there is too much glutamate and not enough GABA, neural transmission will be out of control. Neural transmission requires a balance between these neurotransmitters so that they can work together to regulate the flow of messages around the brain, just as traffic lights regulate the flow of traffic (see Figure 1.32) (University of Utah, 2016).

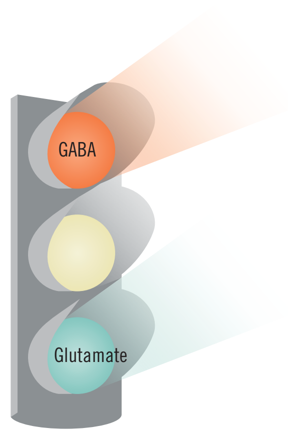

FIGURE 1.32 GABA and glutamate regulate the flow of messages like traffic lights regulate the flow of traffic. GABA acts like a red traffic light by stopping action potentials from firing, while glutamate acts like a green traffic light by allowing action potentials to fire.

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The evidence of the balance required between GABA and glutamate in normal brain function is apparent in the experience of epileptic seizures. As discussed earlier, low levels of GABA can be associated with the onset of epileptic seizures. However, emerging evidence is starting to demonstrate that seizures can also be linked to the functioning of glutamate. Excessive activation of glutamate receptors can occur during some epileptic seizures and, as a result, death of affected neurons can occur (Sundaram et al., 2012). Likewise, in the case of some types of epileptic seizures, excess glutamate can produce abnormal excitatory responses in neural transmission. Furthermore when there is a lack of GABA it is difficult for neural activity to be slowed down, and glutamate (with its opposing effects) continues to be released, causing an imbalance of brain chemicals and activity leading to overstimulation in some forms of epileptic seizures (NIH, 2011; Tufts University, 2014). Therefore, the treatment for some types of seizures may not just involve addressing the insufficient production of GABA; rather, emerging evidence is also addressing the excessive amounts of glutamate. A new anti-epilepsy medication is being investigated that appears to inhibit glutamate receptors, thereby controlling excitability in the brain and reducing the frequency of seizures (see Focus on research 1.2).

1.2

FOCUS ON RESEARCH

NEW MEDICATION OFFERS HOPE TO PATIENTS WITH FREQUENT, UNCONTROLLABLE SEIZURES

A study carried out at the Johns Hopkins University School of Medicine has investigated a new type of anti-epilepsy medication to reduce seizures. The study, led by professor of neurology Gregory Krauss, has investigated the effects of perampanel, a new class of drugs that appears to inhibit the glutamate receptor called AMPA, therefore decreasing the excitatory responses in the brain and reducing seizures. In the past, research has targeted a variety of drugs to modify glutamate receptors with the aim of controlling a range of diseases; however, results have not offered a lot of hope, with major side effects such as sleepiness and even comas occurring.

This study included 700 people with uncontrolled partial-onset seizures (the most common form in epilepsy). These seizures can involve anything from twitching to confusion to convulsions. At the beginning of the study, the participants were experiencing about 10 seizures a day and were all taking one to three anti-epileptic drugs as part of their treatment plan.

Each participant was assigned by Krauss and his colleagues to add to their treatment plan either a placebo or 2 milligrams, 4 milligrams or 8 milligrams per day of the drug perampanel.

The researchers found that the higher the dose, the better the results. Roughly one-third of participants who were given 8 milligrams of the drug saw the frequency of their seizures fall by more than 50 per cent. Four milligrams of the drug was the lowest effective dose.

While the most common side effect was dizziness, these results do offer hope to people with epilepsy as well as people suffering from some drug addictions and ALS, a form of motor neuron disease in which glutamate is believed to play a role.

Source: Adapted from Johns Hopkins Medicine. (2012, April 18). New medication offers hope to patients with frequent, uncontrollable seizures. *ScienceDaily*.

QUESTIONS

1. Does the drug perampanel act as an agonist or an antagonist? Explain your answer.
2. What was the aim of this research?
3. Identify the IV and DV of the research.
4. What is a placebo? Explain the purpose of using a placebo in this study.
5. Explain the results that were obtained.

Other important neurotransmitters that influence physical and psychological functioning

There are many other important neurotransmitters throughout our nervous system that can influence our physical and psychological functioning. One such neurotransmitter found in many synapses in the central and peripheral nervous systems is **acetylcholine**. In most cases it acts as an excitatory neurotransmitter and normally activates muscles. However, it is inhibitory at the heart and in some other autonomic nervous system functions. Acetylcholine also plays an important role in cognitive processes such as memory and learning, and its role has been linked to Alzheimer's disease (discussed in more detail in Chapter 5).

Two important neurotransmitters that are significant in controlling arousal levels are **epinephrine**

acetylcholine A neurotransmitter that can act in both an excitatory and inhibitory manner; also plays a role in cognitive processes such as memory and learning

epinephrine (adrenalin) A chemical secreted by the medulla in the brain that helps to increase levels of arousal that occur when the sympathetic nervous system is activated

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(adrenalin) and norepinephrine (noradrenalin). Both these chemicals are secreted by the medulla in the brain. Epinephrine is important in increasing levels of arousal that occur when the sympathetic nervous system is activated. It acts to increase blood pressure, heart rate, pulse and respiration rates. Norepinephrine is also secreted by the neurons of the sympathetic nervous system and is important in controlling arousal, wakefulness, hunger, learning and memory. It is also involved in a range of emotional experiences. Lower levels of norepinephrine are associated with depression.

Dopamine is a neurotransmitter that is mostly inhibitory in action and is involved in the transmission of impulses that direct voluntary movement. It is also involved in attention, learning, arousal and some emotional experiences such as pleasure. A lack of dopamine has been associated with Parkinson's disease (discussed in more detail shortly), a condition in which movement is impeded. A lack of dopamine is also thought to contribute to attention deficit hyperactivity disorder (ADHD). Excesses of dopamine have been linked with schizophrenia. One theory is that the excess dopamine triggers a flood of unrelated thoughts, feelings and perceptions, which may account for the voices, hallucinations and delusions experienced by people with schizophrenia. Evidence for this theory comes from studies into the action of drugs that treat schizophrenia. By acting as *antagonists*, these drugs bind to the same receptor site as dopamine, thereby blocking its action (see Figure 1.33).

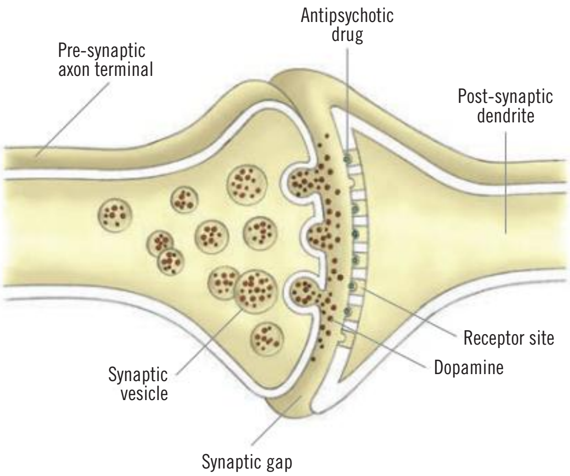

FIGURE 1.33 Antipsychotic drugs to treat schizophrenia bind to the same receptor sites as dopamine does, blocking its action.

Serotonin, a chemical produced in the CNS as well as the intestines, is another major inhibitory neurotransmitter. It is involved in many processes including pain, sleep and mood regulation. Lower levels of serotonin have been associated with mood disorders, anxiety and sleep disorders. Some drugs have been developed to 'boost' the effects of serotonin and improve mood. One well-known example is the antidepressant Prozac (a selective serotonin re-uptake inhibitor), which acts by preventing the re-uptake of serotonin after it has been released, resulting in greater than usual amounts of serotonin being available. The effects are instant, accounting for the immediate improvement in mood. Conversely, because a surge of serotonin is made available, the supplies of this neurotransmitter are depleted rapidly, producing a 'crash' in mood, short-term irritability and depression.

1.8 CHECK YOUR UNDERSTANDING >>

1 Which statement about the effects of GABA and glutamate is incorrect?
   - A Glutamate is the primary excitatory neurotransmitter, whereas GABA is the primary inhibitory neurotransmitter.
   - B A post-synaptic neuron is more likely to fire in response to glutamate and less likely to fire in response to GABA.
   - C Glutamate is involved in high-speed neural transmission, whereas GABA is involved in slowing down neural transmission.
   - D Caffeine can increase GABA functioning, whereas alcohol increases the functioning of glutamate.

2 Which of the following neurotransmitters is involved in cognitive processes such as memory and learning?
   - A Serotonin
   - B Epinephrine
   - C Acetylcholine
   - D Norepinephrine

3 Which neurotransmitter is released by the medulla and involved in arousal?
   - A Both acetylcholine and epinephrine
   - B Epinephrine
   - C Norepinephrine
   - D Both epinephrine and norepinephrine

4 Explain how the role of GABA and glutamate is essential in regulating the flow of messages.

5 Explain why excessive amounts of glutamate can be toxic.

6 What disorder do benzodiazepines aim to treat? Explain their function as an agonist drug, referring to the neurotransmitter involved.

7 Explain the role that GABA and glutamate are believed to play in epileptic seizures.

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1.3 TRY IT YOURSELF >>

RESEARCH INTO NEUROTRANSMITTERS

Using your textbook and other resources, complete a summary table on the main types of neurotransmitters.

NEUROTRANSMITTER	WHERE IT IS FOUND	ROLE IN THE NERVOUS SYSTEM	EFFECT (EXCITATORY/INHIBITORY/BOTH)
GABA			
Glutamate			
Acetylcholine			
Epinephrine			
Norepinephrine			
Dopamine			
Serotonin			

INTERFERENCE TO NEUROTRANSMITTER FUNCTION

A number of diseases of the brain and nervous system are associated with changes in the level or action of neurotransmitters. As a result of this interference to neurotransmitters, the functioning of the nervous system can be affected and this can lead to chronic changes as is the case with neurodegenerative diseases. Such diseases can gradually and progressively kill nerve cells, causing nervous system malfunction and permanent or long-lasting loss of abilities such as balance, movement, talking, breathing, heart function and cognition. While neurodegenerative diseases can have a genetic cause, they can also be caused by a range of other influences such as toxins, chemicals, viruses, tumours, stroke and chronic alcoholism. Since these diseases involve degenerative changes and death of neurons, they will often also cause the interference to the functioning of neurotransmitters and how messages are sent, thus interfering with the complex and interactive nature of the nervous system.

PARKINSON'S DISEASE: MALFUNCTION AT A CELLULAR LEVEL

Parkinson's disease (PD) is a neurodegenerative disorder characterised by chronic and progressive changes in the brain due to the malfunction and deterioration to neurons, which leads to impairment in movement. British physician James Parkinson (1755–1824) was the first to observe and depict the symptoms of the disease, hence the name of the disease. PD is estimated to affect 7 to 10 million people worldwide; however, it can affect people in different ways and the presentation of symptoms can vary. The illness progresses at a very slow rate and lifespan is not necessarily shortened. The average age of diagnosis is 65 years, but younger people can also be diagnosed with PD, with men affected more often than women (Parkinson's Australia, 2015; Parkinson's Disease Foundation Inc., 2015a).

SHUTTERSTOCK.COM/FEATUREFLASH

FIGURE 1.34 Actor Michael J Fox was diagnosed with young-onset Parkinson's disease in 1991, at the age of 30.

norepinephrine (noradrenalin) Important in controlling arousal, wakefulness, hunger, learning and memory; it is also involved in a range of emotional experiences

dopamine A neurotransmitter found in the brain; involved in smooth and coordinated voluntary movements, learning, arousal and emotional experience

serotonin A neurotransmitter found in the CNS; involved in the regulation of pain, mood and sleep

chronic changes Changes that are long-lasting

neurodegenerative disease A disease that gradually and progressively kills nerve cells and results in nervous system dysfunction and permanent loss of ability

TABLE 1.3 The primary, secondary and non-motor symptoms experienced by people with Parkinson's disease

PRIMARY MOTOR SYMPTOMS	SECONDARY MOTOR SYMPTOMS	NON-MOTOR SYMPTOMS
» Unpredictable tremors, or shaking of hands, arms, legs » Rigidity, or stiffness of the muscles » Bradykinesia, or slowness of movement and gradual loss of spontaneous movement » Reduced coordination and balance	» Reduced control over facial muscles resulting in a fixed, inexpressive face » Pain and discomfort in limbs » Constipation and bladder problems » Speech and swallowing problems » General slowing of muscle activity leading to problems with temperature regulation, digestion and sexual function	Psychological symptoms » Feeling embarrassed by physical behaviour and dependence on others » Feeling worried about their uncertain future » Anxiety » Depression » Cognitive side effects including slowness of thinking and memory problems » Dementia (advanced stages) Social problems » Difficulties with communication, limiting the person's ability to socialise » Social isolation due to feeling embarrassed, anxious and depressed

The symptoms of PD develop gradually with difficulties in voluntary movements being the defining symptom. This is characterised by a number of primary motor symptoms including tremors and shaking, **bradykinesia** (slowness of movement and the difficulty initiating voluntary and spontaneous movements), rigidity (muscles stiffness), and reduced coordination and balance. The primary motor symptoms of PD can lead to a range of secondary motor symptoms as well as a range of non-motor symptoms that include psychological symptoms and social problems (see Table 1.3) (Parkinson's Disease Foundation Inc., 2015b).

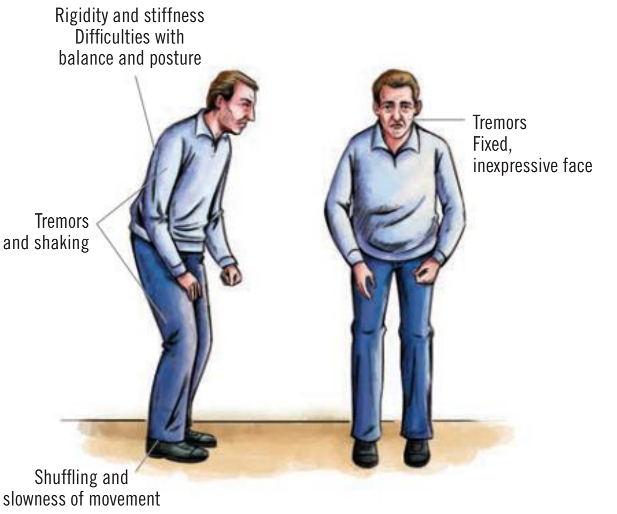

FIGURE 1.35 Parkinson's disease is characterised by reduced control over voluntary movement, which gradually affects a person's ability to move.

Symptoms of Parkinson's disease influenced by cellular changes and dopamine levels

In most cases of PD, the cause is unknown, with a small number of cases being influenced by genetic or hereditary factors. While a cause is still unclear, it is known that the disease begins with malfunction and deterioration to neurons in the **substantia nigra** of the brain (see Figure 1.36). The substantia nigra is composed of nerve cells that produce and release dopamine. As discussed previously, dopamine is a neurotransmitter involved in the transmission of impulses that direct smooth, coordinated voluntary movements. As neurons in this structure deteriorate, their ability to produce and release dopamine is impaired. Damaged dopamine-producing neurons gradually continue to generate less dopamine, and it is only when the damage has continued for some time that the symptoms of PD appear (see Figure 1.37). As well as the substantia nigra, other areas of the brain associated with movement control and the loss of dopamine-producing neurons are also affected by PD. These include other structures of the **basal ganglia**, including structures of the **corpus striatum**

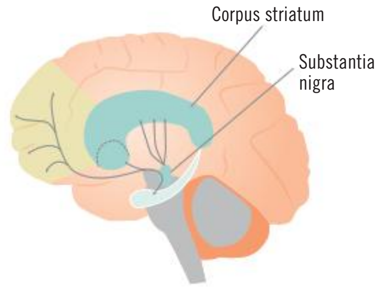

FIGURE 1.36 When neurons in the substantia nigra and corpus striatum are damaged, their ability to produce dopamine is impaired.

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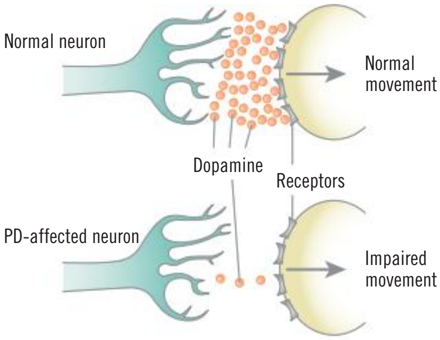

FIGURE 1.37 The difference in the dopamine levels of a normal neuron and a neuron affected by Parkinson's disease

(see Figure 1.36). The corpus striatum is also affected because not only does it produce dopamine, it also receives messages from the substantia nigra in order to produce purposeful muscle activity, both of which can be impaired in the case of PD (Barnes, 2013; Freberg, 2006).

In research over the last decade, scientists are exploring other possible links to PD that could be responsible for the ultimate cause of the deterioration of the dopamine-producing cells. Possible cellular changes are being investigated related to a protein called *alpha-synuclein* that can be found throughout the brain. This protein is assumed to be an early indicator in the development of PD. *Lewy bodies* (abnormal parts of a neuron) are formed when an accumulation of the alpha-synuclein protein occurs causing 'clumps' to form. Dopamine-producing neurons are believed to be exposed to excessive amounts of alpha-synuclein, and it is believed that accumulation of the protein in these cells not only impairs structure components (such as axons and axon terminals) but also the ability to transmit dopamine (Lundblad, Decressac, Mattsson, & Björklund, 2012; Parkinson's Disease Foundation Inc., 2015c). This assumption has been supported by a study by Lundblad et al. (2012) that investigated changes in the release of dopamine at synapses upon exposure to a virus infected by alpha-synuclein. The study used adult rats whose substantia nigra was injected with a virus containing alpha-synuclein. The results demonstrated that 10 days after the injection, neurotransmission of dopamine had been affected. This impairment continued 3 weeks after the injection and also included the first indication of damage to axons and the swelling of axon terminals. Furthermore, the later stages of results (8 to 16 weeks after the injection) indicated extensive damage to axons and axon terminals, as well as a significant reduction in the release and re-uptake of dopamine by 80 to 90 per cent, leading to similar symptoms characteristic of advanced PD (Lundblad et al., 2012; Parkinson's Disease Foundation Inc., 2015c).

1.9 CHECK YOUR UNDERSTANDING >>

1 Which of the following statements about neurodegenerative diseases is incorrect?
   A These diseases can gradually and progressively kill nerve cells.
   B These diseases can cause dysfunction in the nervous system.
   C These diseases involve temporary symptoms.
   D These diseases can have a genetic cause.
2 Which of the following brain structures does not display visible degeneration in Parkinson's disease?
   A Basal ganglia
   B Substantia nigra
   C Corpus striatum
   D Hippocampus
3 Which of the following symptoms are considered to be experienced by people with Parkinson's disease?
   A Reduced control over facial muscles
   B Gradual loss of spontaneous movement
   C Slowness of thinking and memory problems
   D All of the above
4 Describe the primary motor symptoms of Parkinson's disease.
5 Outline the role of dopamine in the development of Parkinson's disease.
6 Explain the cellular changes that occur in Parkinson's disease as a result of the protein alpha-synuclein.
7 Explain the relationship between alpha-synuclein and dopamine in Parkinson's disease.

Treatments targeting neural changes and dopamine loss

Treatment of PD aims to restore the insufficient production of dopamine. The standard and most widely used treatment is a substance called **levodopa (L-dopa)**. This substance is a type of amino acid that is converted to dopamine by neurons in the brain. When dopamine levels are raised, symptoms of PD are reduced. The use of levodopa in the treatment of PD became influential as a result of research

bradykinesia Slowness of movement and gradual loss of spontaneous and voluntary movement

substantia nigra A midbrain structure composed of nerve cells that produce dopamine, associated with movement control

basal ganglia Clusters of nerve cells that regulate motor control

corpus striatum A midbrain structure composed of white and grey matter that contributes to the production of smooth, purposeful muscle movements

levodopa (L-dopa) A drug that the brain converts to dopamine; used to treat Parkinson's disease findings by Swedish pharmacologist Arvid Carlsson. Not only did he demonstrate that a decrease in dopamine leads to impaired movement and motor control, he also investigated the effects of levodopa on the conversion of dopamine in the brain, thereby restoring movements and control. Carlsson studied rabbits that went into a complete physical trance after receiving a drug that removed dopamine from their brain. Carlsson then injected the rabbits with the drug levodopa and the results demonstrated restored movement in the rabbits (Animal Research Info, 2014).

The use of levodopa on its own has been known to produce side effects such as nausea. Therefore, levodopa can be combined with a drug called carbidopa, which prevents this side effect and also ensures that levodopa is not converted into dopamine in the bloodstream before it reaches the brain (Parkinson's Disease Foundation Inc., 2015d). While medications containing levodopa-carbidopa assist in the improvement of many of the symptoms of PD such as tremors and muscle control, they are also associated with many side effects, especially when taken long-term, such as muscle spasms and **dyskinesia** (impulsive involuntary movements). Furthermore, persistent deterioration of neurons in the substantia nigra can result in less dopamine-producing neurons available to be influenced by levodopa-carbidopa.

The other type of drug used in the treatment of Parkinson's disease is a group known as **dopamine agonists**. These medications stimulate the dopamine receptors of the brain, thereby imitating the effect of dopamine. Like levodopa, these types of medications can help to manage and ease symptoms, but the progression of the disease is not reduced. These medications are associated with side effects such as hallucinations, sleep disturbances and sedation, as well as impulse control disorders, because of increases in dopamine. Dopamine agonists can also cause dyskinesia; however, they are less likely than levodopa to do so (Parkinson's Disease Foundation Inc., 2015d).

Because treatments aimed at restoring insufficient production of dopamine have a range of benefits and side effects, researchers are continuing to investigate and compare both levodopa (L-dopa) and dopamine agonists for their effectiveness in treating PD (see Focus on research 1.3).

FOCUS ON RESEARCH 1.3

LEVODOPA BETTER THAN NEWER DRUGS FOR LONG-TERM TREATMENT OF PARKINSON'S, LARGEST EVER TRIAL SHOWS

The largest ever trial of Parkinson's Disease (PD) treatment has been published in *The Lancet*, revealing that the most widely used treatment of levodopa is still the best initial treatment for most patients when compared with a newer class of drugs including dopamine agonists (DA) and monoamine oxidase type B inhibitors (MAOBI).

The trial was interested in comparing the drugs because the standard use of levodopa over the long term can lead to movement problems and dyskinesia, which can be less evident with the use of the new alternatives of DA and MAOBI. However, the use of these alternative drugs can lead to a range of other side effects that have an impact on quality of life, such as nausea, hallucinations and sleep disturbances.

The trial included 1620 people with early PD, who were randomly assigned to either receive levodopa or an alternative drug (DA or MAOBI). The trial involved obtaining self-report data over a period of 7 years. While the difference found between the two drugs in terms of mobility and quality of life was small, it did indicate that the use of levodopa was more beneficial, with patients receiving the levodopa treatment reporting significantly better scores on a variety of scales that measured factors such as body discomfort and experiences in daily living. The trial indicates that when comparing levodopa to DA and MAOBI, on the benefits, side effects, overall quality of life as well as cost, then levodopa is still considered the best initial treatment.

Recently, treatment for PD has focused on these newer drugs for initial treatment; however, treatment for PD worldwide is likely to change as a result of this trial. When compared to past studies, not only is this trial the largest ever performed on PD treatment, other studies have not included long-term follow-up and they have not included self-report data; rather, they have focused on clinicians' assessments of motor symptoms.

Source: Adapted from *The Lancet*. (2014, June 10). Levodopa better than newer drugs for long-term treatment of Parkinson's, largest-ever trial shows. *ScienceDaily*.

QUESTIONS

1. Write a hypothesis for the study.
2. Identify the IV and DV.
3. Define the term 'random allocation'. Was it used for this trial? Explain.
4. The trial obtained self-report data. Explain what self-report data are and describe a strength and a limitation of obtaining this type of data.
5. Is this a longitudinal study? Explain your answer.
6. Based on the results, what conclusion can be made about this trial?
7. Explain two benefits of this trial when compared to previous studies of this type.

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Emerging evidence published in the *Journal of Parkinson's Disease* is also investigating the use of **levodopa-carbidopa intestinal gel (LCIG)** as an alternative to the standard treatment of levodopa. It differs from the levodopa oral medication in that it is injected continuously into the small intestines using a portable infusion pump (see Figure 1.38). This kind of delivery results in constant plasma concentrations of levodopa because it essentially avoids erratic gastric emptying and fluctuating absorption. The evidence of taking LCIG in Parkinson's patients is promising – there are improvements in the side effects associated with dyskinesia and also in controlling symptoms for a longer duration when compared to taking levodopa orally (Slevina et al., 2015).

FIGURE 1.38 Levodopa-carbidopa intestinal gel is pumped into the small intestines via a portable pump that is permanently inserted into the body.

Other research targeting treatment of Parkinson's disease is focusing on the most recent findings on the accumulation of the alpha-synuclein protein (which forms Lewy bodies) in dopamine-producing cells. Research was carried out at the University of Pennsylvania on cultured mouse neurons and mice to investigate if alpha-synuclein could be influenced by antibodies (proteins produced by the immune system) in order to prevent the clumps of alpha-synuclein spreading to other neurons and forming Lewy bodies. The results found that mouse neurons displayed 76 per cent fewer Lewy bodies when they were pre-treated with antibodies before exposure to excessive amounts of alpha-synuclein. Likewise, neurons (already exposed to excessive alpha-synuclein) did not die when treated with antibodies. Furthermore, fewer Lewy bodies were found in mice that were given antibodies 30 minutes before the exposure to excessive alpha-synuclein. Motor coordination was also measured in other mice that were exposed to excessive alpha-synuclein and then treated with antibodies 7 days after, followed by long-term weekly treatment. While these mice did show some improvements in motor coordination, the improvements were inconsistent. And while these results were not carried out on humans, they do provide the possibility that antibodies that target alpha-synuclein (and its spread) can prevent associated cell death that could thereby affect how the deterioration of dopamine-producing neurons occurs. Likewise, because the antibodies had varying impacts on motor function, it could indicate that targeting the treatment of alpha-synuclein may only be effective in the early stages of PD (Parkinson's Disease Foundation Inc., 2015e).

Because of its chronic and progressives changes, the complexity of PD in terms of possible causes and treatments is continuing to be constantly investigated.

OTHER NEUROLOGICAL DISEASES CAUSED BY NEUROTRANSMITTER DYSFUNCTION

A number of other neurodegenerative diseases can have debilitating effects on the brain and nervous system. Many of these diseases have known causes, including a genetic component and degeneration of brain structures and neurons. They can also be considered the result of neurotransmitter dysfunction.

An irreversible, progressive and fatal neurodegenerative disease causing severe cognitive and behavioural decline is **Alzheimer's disease**. Brain scans of Alzheimer's sufferers indicate that the earliest damage occurs in the hippocampus, slowly followed by a loss of neurons and synapses in the cerebral cortex, particularly in the temporal lobe, parietal lobe and frontal lobe. Because of this loss of neurons and synapses, attention, memory, learning and higher

dyskinesia A condition characterised by abnormal involuntary muscle movements

dopamine agonists Drugs that mimic the effect of dopamine by activating dopamine receptors in the brain that would normally be stimulated by dopamine

levodopa-carbidopa intestinal gel (LCIG) An alternative to the standard treatment of levodopa, it is injected into the small intestines via a portable pump

Alzheimer's disease An irreversible and progressive neurodegenerative disease that gradually kills brain cells, causing severe cognitive and behavioural decline that eventually results in death; associated with low levels of acetylcholine cognitive abilities do not function effectively. Tests show that the Alzheimer's brain also produces reduced levels of several neurotransmitters; in particular, there is a low level of acetylcholine. The belief that acetylcholine plays a vital role in memory is supported by evidence that drugs that block the action of acetylcholine have been found to disrupt the formation of memory in healthy subjects.

Huntington's disease, caused by the inheritance of an altered gene, is another disease characterised by degeneration of neurons in the basal ganglia of the brain, in particular in the caudate nucleus and the putamen (see Figure 1.39), as well as the cerebral cortex. This disease leads to involuntary jerky movements as well as other effects such as dementia and depression. Huntington's disease causes degeneration of neurons that contain the neurotransmitter GABA, therefore the disease is also linked to the decrease of this inhibitory neurotransmitter (Breedlove, Watson, & Rosenzweig, 2010).

Motor neuron disease (MND) is another condition in which there is progressive degeneration of motor neurons, leading to weakening of muscles and paralysis. In most cases the cause of MND is unknown; however, genetic factors play a part in vulnerability to the disease. The disease has also been linked with a lack in the regulation of the neurotransmitter glutamate, causing toxicity to the motor neurons. In the most common form of MND called amyotrophic lateral sclerosis (ALS), problems with glutamate receptors and transport systems can lead to excessive glutamate (Foran & Trotti, 2009). Likewise, drugs that have been found to block glutamate receptors may also offer respite to people suffering from ALS (Johns Hopkins Medicine, 2012).

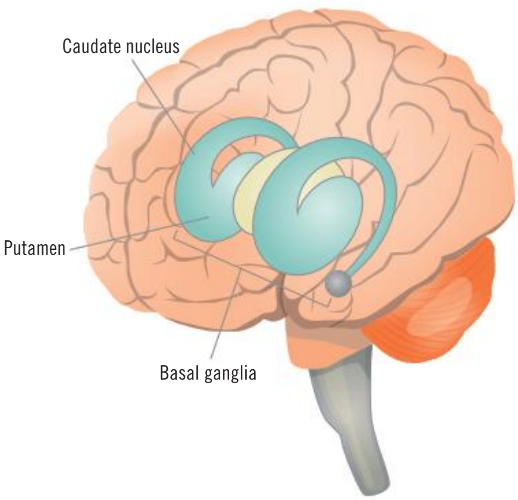

FIGURE 1.39 Huntington's disease is characterised by degeneration of neurons in the caudate nucleus and the putamen in the brain, which are structures within the basal ganglia.

1.10 CHECK YOUR UNDERSTANDING >>

1 Which of the following is not considered a treatment for Parkinson's disease?
   - A Dopamine antagonists
   - B Levodopa
   - C Levodopa-carbidopa intestinal gel (LCIG)
   - D Dopamine agonists

2 Which of the following statements about levodopa is incorrect?
   - A Levodopa is a type of amino acid that acts like a dopamine agonist.
   - B When levodopa enters the brain it is absorbed by the brain's nerve cells and converted into dopamine.
   - C Levodopa does not slow the progress of Parkinson's disease but it does help to reduce tremors, stiffness and slowness.
   - D Long-term treatment with levodopa is associated with muscle spasms and dyskinesia.

3 Dopamine agonists:
   - A stimulate the dopamine receptors of the brain, thereby imitating the effect of dopamine.
   - B inhibit the release of dopamine.
   - C are a type of amino acid that is converted to dopamine by neurons in the brain.
   - D are not associated with any negative side effects.

4 Explain two findings made by Arvid Carlsson on his research into the treatment of Parkinson's disease.

5 Explain one difference and one similarity between the treatments of Parkinson's disease using levodopa when compared with dopamine agonists.

6 Explain the benefits of using levodopa-carbidopa intestinal gel (LCIG) over the standard levodopa.

7 Identify the neurotransmitter(s) that have been identified to be associated with the following diseases and disorders of the brain and nervous system:
   - a Parkinson's disease
   - b schizophrenia
   - c motor neuron disease
   - d depression
   - e seizures
   - f Alzheimer's disease
   - g Huntington's disease
   - h anxiety disorders.

Huntington's disease A genetic disorder characterised by jerky movements and associated with the degeneration of neurons in the brain that contain the neurotransmitter GABA

motor neuron disease A disease of the nervous system associated with the wasting away of motor neurons and linked to a lack in the regulation of the neurotransmitter glutamate

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CHAPTER SUMMARY

Divisions of the nervous system

- The central nervous system (CNS) is composed of the brain and the spinal cord. The brain is the 'engine room' of the nervous system. It receives and processes information from the rest of the body and generates responses to it. The spinal cord, an intricate and delicate cable of nerve fibres stretching from the base of the brain to the lower back, connects the brain to the rest of the body via its connection to the peripheral nervous system (PNS).
- The PNS consists of all of the nerves outside the CNS; in other words, all the nerves that extend throughout the rest of the body. Its main role is to convey information from the body's internal and external environments to the CNS and transmit commands from the CNS to the rest of the body. The PNS comprises the somatic nervous system, which controls voluntary responses, and the autonomic nervous system (ANS). The ANS is further divided into the sympathetic nervous system, which stimulates arousal and activity levels, and the parasympathetic nervous system, which calms and lowers arousal levels.

Conscious and unconscious responses of the nervous system

- The somatic nervous system is responsible for all voluntary responses. It does this through communication with the brain. It sends sensory information via the spinal cord to the brain. The brain determines a response and then sends this message via the spinal cord back to the somatic nervous system and the motor neurons to enable a response.
- Not all responses performed by the somatic nervous system are conscious, voluntary responses involving the brain. Some simple responses called spinal reflexes occur automatically and only involve the spinal cord and the somatic nervous system. They are quick responses that are essential for survival. Spinal reflexes can be monosynaptic, which involves the connection between a sensory neuron and a motor neuron, or polysynaptic, which involves an interneuron making a connection between a sensory neuron and motor neuron.
- While our ANS is mostly self-regulating and not under voluntary control, there are times when we can practise certain techniques that can control the activities of our ANS, especially when we want to remain calm or experience a state of relaxation. These techniques can include meditation, yoga and biofeedback.

The role of neurons in the nervous system

- Neurons are individual nerve cells that are specialised to receive, process and transmit information. They are the basic building blocks of the nervous system.
- Incoming messages are detected by the dendrites protruding from the soma and transmitted along the axon (which is protected by myelin coating) in the form of a neural impulse or action potential, until they reach the axon terminals where the message crosses the synapse to the next neuron.
- There are three main types of neurons in the nervous system. Sensory neurons detect energy from internal and external environments and carry information about it to the CNS. Motor neurons carry commands from the brain to the body's muscles, organs and glands to enable movement. Interneurons carry information directly between sensory and motor neurons and are involved in spinal reflexes.

The role of neurotransmitters in the transmission of information

- Transmission of a message between neurons begins when neurotransmitters carry the message across the synapse to the receptor sites on the dendrite of the post-synaptic neuron. This part of transmission is chemical.
- A particular neurotransmitter must attach to its own specific receptor site on the next neuron if the neural impulse is to continue. The neurotransmitter fits the receptor site in a similar way to a key fitting a lock.
- Neurotransmitters may act in one of two ways when they arrive at the post-synaptic neuron. Some neurotransmitters have an excitatory effect (e.g. glutamate) that speeds up neural transmission by stimulating the post-synaptic neuron, making it more likely for it to fire an action potential. Other neurotransmitters have an inhibitory effect (e.g. GABA) by slowing down neural transmission and making it less likely for the post-synaptic neuron to fire and pass on the neural impulse.

Effects of chronic changes to the nervous system due to interference of neurotransmitter function

- Parkinson's disease is a progressively degenerative neurological disorder that affects the control of body movements. Effects include unpredictable tremors and shaking, rigidity and stiffness of muscles, and bradykinesia.
- Parkinson's disease is caused by deterioration in the substantia nigra and other basal ganglia structure including the corpus striatum. When neurons in these structures are damaged, their ability to produce dopamine is impaired. Current research is also investigating possible cellular changes related to excessive amounts of a protein called alpha-synuclein, which forms Lewy bodies in dopamine-producing neurons that impair their structure components (such as axons and axon terminals) and also their ability to transmit dopamine.

- Treatments for Parkinson's include the amino acid levodopa, which is absorbed by the brain's nerve cells and converted into dopamine; dopamine agonists that stimulate the dopamine receptors and mimic the effect of dopamine; and levodopa-carbidopa intestinal gel, which is injected continuously into the small intestines resulting in constant plasma concentrations. Current research is also investigating the treatment of excessive alpha-synuclein with the use of antibodies.
- Some other neurodegenerative diseases are also linked to neurotransmitter dysfunction, including acetylcholine in Alzheimer's disease, GABA in Huntington's disease and glutamate in motor neuron disease.

APPLY YOUR KNOWLEDGE AND SKILLS

SECTION A: MULTIPLE-CHOICE QUESTIONS

Answer the following questions by writing the correct letter in your workbook. Only one answer is correct for each question.

1 The brain and nervous system:

A are made up of billions of neurons.
B work together in an integrated way.
C are responsible for our behaviour and cognitive processes.
D All of the above

2 The peripheral nervous system is composed of the:

A brain and spinal cord.
B sympathetic and parasympathetic nervous system.
C somatic and autonomic nervous systems.
D parasympathetic and spinal systems.

3 The main function of the spinal cord is to:

A transmit neural impulses to and from the brain.
B control the body's voluntary (skeletal) muscles.
C store and release neurotransmitters and neuromodulators.
D coordinate movements of body parts.

4 Which of the following is not true of the autonomic nervous system?

A It relays messages between the muscles that control our organs and glands and the central nervous system.
B It keeps our body in a state of homeostasis.
C It relays messages between the skeletal muscles in the body and the central nervous system.
D It functions automatically.

5 Crossing the road, Sam gets a fright when he narrowly misses a moving car. Which of the following physiological changes is Sam most likely to experience?

A An increased heart rate and respiration rate
B An increased heart rate and decreased perspiration
C A decreased heart rate and dilated pupils
D A drop in his blood pressure

6 Which branch of Sam's nervous system is dominant in question 5?

A The peripheral nervous system
B The spinal cord
C The parasympathetic division of the autonomic nervous system
D The sympathetic division of the autonomic nervous system

7 The parasympathetic division of the autonomic nervous system:

A is a component of the central nervous system.
B controls the movement of voluntary muscles in the arms and legs.
C dominates our bodily systems during arousal, so that they operate at levels that produce more energy.
D dominates our bodily systems during times of calm, so that they operate at normal levels.

8 Corrine was walking along the beach when she accidently stepped on a jagged seashell. Instantly she withdrew her foot from the shell. Which of the following pathway sequences is correct?

A Interneuron, sensory neuron, motor neuron
B Sensory neuron, motor neuron, interneuron
C Motor neuron, interneuron, sensory neuron
D Sensory neuron, interneuron, motor neuron

9 Jake was doing the ironing when he accidently drew the hot iron over his finger. When he experienced a pain sensation, Jake quickly pulled his finger away from the iron in a reflex action. In this instance:

A a reflex arc occurred in Jake's cranial nerves, causing a sensory neuron to synapse with a motor neuron, via an interneuron, leading to the withdrawal of Jake's hand.
B a reflex arc occurred in Jake's spinal cord when an interneuron caused a sensory neuron to automatically connect with a motor neuron, leading to the withdrawal of Jake's hand from the iron.

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C a reflex arc occurred in Jake's spinal cord when an interneuron caused a motor neuron to automatically activate a sensory neuron, leading to the withdrawal of Jake's hand from the iron.

D the activation of the parasympathetic nervous system caused Jake's hand to automatically withdraw from the iron.

10 The part of a neuron responsible for receiving a message from an adjacent neuron is the:

A axon.

B dendrite.

C axon terminal.

D synapse.

11 The transmission of a neural impulse from neuron to neuron is an all-or-nothing phenomenon. This means:

A nerve cells are continuously activated.

B action potentials occur completely or not at all.

C an electrical current crosses the synapse completely or not at all.

D all the neurons in a particular lobe of the brain fire or none of them fire.

12 One difference between sensory neurons and motor neurons is that:

A sensory neurons are found only in the CNS and motor neurons are found only in the PNS.

B sensory neurons transmit afferent information and motor neurons transmit efferent information.

C sensory neurons only transmit efferent information and motor neurons only transmit afferent information.

D motor neurons receive information about the external environment and sensory neurons take messages to the muscles, organs and glands, which enable them to move.

13 Which statement about the neurotransmitter glutamate is correct?

A Glutamate is an excitatory neurotransmitter that calms down neural activity.

B Glutamate is an excitatory neurotransmitter that blocks activity in the post-synaptic neuron.

C Glutamate is an inhibitory neurotransmitter that causes slow neural transmission.

D Glutamate is an excitatory neurotransmitter that makes it more likely for the post-synaptic neuron to fire an action potential.

14 Parkinson's disease results from damage to neurons that produce:

A levodopa.

B glutamate.

C dopamine.

D GABA.

15 Which of the following is not a symptom of Parkinson's disease?

A Tremors

B Bradykinesia

C Rigidity, or stiffness of the muscles

D Immediate dementia

SECTION B: SHORT-ANSWER QUESTIONS

1 Distinguish between the roles of the central nervous system and the peripheral nervous system.

2 You are about to attend a job interview and you feel very nervous.

a List three physical symptoms you would experience as a result of the activation of your sympathetic nervous system.

b How could you influence your autonomic nervous system so you remain calm?

3 Explain the parts of the central nervous system and the somatic nervous system that are involved when we:

a make a conscious voluntary response.

b make an unconscious automatic response.

4 Explain how the autonomic nervous system can be both self-regulating and under conscious control.

5 Explain how a message is received and transmitted within a neuron. Ensure you refer to the role of the structural components in the process.

6 Explain the difference between an excitatory neurotransmitter and an inhibitory neurotransmitter.

7 Distinguish between the roles of glutamate and GABA. Ensure you refer to their activity on the post-synaptic neuron.

8 Explain the role of GABA in anxiety disorders. How does medication aim to control anxiety symptoms?

9 Explain how the protein alpha-synuclein is believed to be linked to cellular changes that occur in Parkinson's disease.

10 Emma has just been diagnosed with Parkinson's disease.

a Explain four symptoms she may be experiencing.

b Decide on a drug you would prescribe to Emma to help control her symptoms of Parkinson's disease. Explain why you would recommend this drug over others.

SECTION C: EXTENDED-RESPONSE QUESTION

The autonomic nervous system is self-regulating and plays a vital role in increasing or decreasing our levels of physical preparedness and arousal to respond to our environment. For example, when our sympathetic nervous system is activated, heart rate and blood pressure increase; when the parasympathetic nervous system dominates, heart rate and blood pressure return to normal. Although the responses of our autonomic nervous system are not under our conscious control, we can sometimes control some of these responses. It is well recognised that relaxation techniques, when successful, can significantly lower levels of physical arousal.

You are to design an investigation examining the effects of relaxation methods on the control of one measure of the autonomic nervous system.

You are required to write an introduction and method section of a practical investigation report.

In your answer be sure to include:

- an introduction
  - a description of key terms relating to the background of this research
  - identification of independent and dependent variables
  - an aim and testable hypothesis
- the method
  - participants
  - materials
  - procedure.

This question is worth 10 marks.

SECTION D: ASSESSMENT TASK

VISUAL PRESENTATION

This activity will demonstrate students' understanding of the functioning of the nervous system.

AIM

Create and present a visual presentation of the nervous system by demonstrating the functions and examining the complex and interactive relationships between the different components of the nervous system and neurons with reference to examples.

AUDIENCE

VCE students

MATERIALS

Either a large sheet of poster paper and coloured pens or a multimedia software program

METHOD

Your presentation can be in the form of either a poster or a multimedia presentation.

Your presentation should clearly explain the functions of each division and their associated subdivisions, as well as the role of neurons as the basic building blocks of the nervous system.

The following should be included in your presentation:

- central nervous system
- peripheral nervous system
- brain
- spinal cord
- somatic nervous system
- autonomic nervous system
- sympathetic nervous system
- parasympathetic nervous system
- sensory neurons
- motor neurons
- interneurons.

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CHAPTER 02

STRESS

KEY KNOWLEDGE INCLUDES:

- sources of stress (eustress and distress) including daily pressures, life events, acculturative stress, major stress and catastrophes that disrupt whole communities
- models of stress as a biological process, with reference to Selye's General Adaptation Syndrome of alarm reaction (shock/counter shock), resistance and exhaustion, including the 'fight–flight–freeze' response and the role of cortisol
- models of stress as a psychological process, with reference to Richard Lazarus and Susan Folkman's Transactional Model of Stress and Coping (stages of primary and secondary appraisal)
- context-specific effectiveness, coping flexibility and use of particular strategies (exercise and approach and avoidance strategies) for coping with stress.

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STRESS: A PSYCHOBIOLOGICAL PROCESS

The term 'stress' was first introduced in the 1930s by Austrian–Canadian endocrinologist Hans Selye. Originally, Selye researched the effect of stress on rats exposed to a variety of stressors, such as mild electric shocks, extreme temperature or excessive exercise. He noticed that despite differences in the form of the stressor, the rats' physiological response was generally the same. Selye concluded that stress is a non-specific condition in response to a stressor. Later, he studied human responses to stressors, which led him to the same conclusion. As a result of his studies, Selye formulated a description of the body's three-stage physiological response to a stressor, which he called the **general adaptation syndrome (GAS)**. The GAS will be described in detail later in this chapter.

FIGURE 2.1 Hans Selye studied the physiological effect stress had on rats and concluded that stress was a non-specific condition in response to a stressor.

To understand the nature of stress and its effects on our health and wellbeing, psychologists usually adopt a *psychobiological approach*. This approach uses biological methods to examine how the body and mind interact to produce behaviour, emotions and mental processes. The psychobiological approach to stress builds on Selye's idea that there is a stereotypical physiological response to all stressors because it considers the role psychological factors play in the stress response. It suggests that psychological processes involved in the way we appraise or rate these stressors contribute to producing a stress response that is unique to the individual.

STRESS

Stress refers to the automatic psychological and physical arousal (or tension) a person feels in response to a change in their external or internal environment that challenges them or causes them to feel they do not have the personal or social resources to cope. For a person to experience stress, they must be exposed to a stressor. A **stressor** is any person, object or event that challenges or threatens them. Stressors can be internal (for example, a pain or a disturbing thought), or they can arise from the external environment (for example, a loud noise, job loss or a relationship break-up).

Because stressors place demands on us, homeostasis is disturbed and our physical or emotional wellbeing is affected. Often, when people think about stress, they perceive it to be a negative experience. They associate it only with the discomfort and negative impacts of feeling under threat because they think they cannot manage a situation. However, the type of stress and the level at which someone experiences it depends on their evaluation of the stressor. If they consider a situation to represent an exciting or stimulating challenge, their experience of the stress will be positive rather than negative.

Even though we may be exposed to the same stimuli as others, perception of stimuli is an individual, subjective experience influenced by a range of factors, including past experiences, personality, belief systems, culture, educational background and genetic factors. What represents a stressor for one person may not be perceived as a stressor by another person, therefore the type of stress experienced and the intensity of the stress varies between individuals. For example, you may become quite anxious and feel threatened if you are asked to deliver a speech at a school assembly, but your friend may feel quite excited at the prospect of doing this.

Psychologists generally agree that stress can manifest itself in two forms: *eustress* and *distress*. And, regardless of the origin of the stress or whether we respond positively or negatively following exposure to a stressor, stress activates the sympathetic nervous system and the physiological changes it triggers are the same.

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EUSTRESS

Activities such as playing in a tennis match, skydiving, waiting to meet a role model or planning your next birthday party are examples of stressors. When we engage in these activities, our sympathetic nervous system is activated and a cascade of hormones (such as adrenalin and cortisol) is released into our bloodstream. As a result, we automatically experience the physiological changes associated with stress that energise and arouse us so we can perform at an optimal level to achieve our goal. We experience the same physiological changes when we experience distress; however, when we experience eustress our psychological response to them is positive because we feel we can probably cope with the challenging situation. This results in psychological states such as excitement, enthusiasm and optimism. This experience of stress is known as eustress. Eustress is defined as a positive psychological response to a stressor as indicated by the presence of positive psychological states (Simmons & Nelson, 2001).

Eustress is experienced when we perceive a stressful situation as a challenge that we can manage rather than a threat that we cannot manage. Experiencing eustress can be beneficial because it increases our alertness and energises us so we are ready to meet the demands of challenging situations. Eustress may motivate us to perform as well as possible or to change undesirable behaviours. For example, you may feel anxious about your end-of-year exams, but your desire to succeed and the thought of all the enjoyable things you can do when the exams are over may motivate you to study when you would rather be socialising with your friends. So, eustress demonstrates that stress is not always a negative experience. Generally, when we are faced with a challenge we initially feel nervous or uncertain. However, we feel in control of the situation and feel that we are able to manage its demands. Eustress situations are normally enjoyable and not harmful psychologically or physiologically even though they demand that we change or adapt in some way. Once we have reached our goal and the stress-producing activity has finished, our parasympathetic nervous system calms our body and returns it to its normal level of functioning.

FIGURE 2.2 Many enjoyable activities produce eustress.

DISTRESS

When we perceive a stressor to be a threat to our wellbeing that is beyond our coping capabilities, we perceive it as a threat and we experience stress in its negative form. This is known as distress. Distress is a negative psychological response to a stressor, as indicated by the presence of negative psychological states (Simmons & Nelson, 2001). These states include anger, anxiety, fear, or feelings of helplessness and hopelessness. Distress is considered to be a negative form of stress because it impedes our ability to perform and cope at an optimal level. We experience distress when we feel we have no control over a situation and we feel overwhelmed and unable to manage its demands.

Like eustress, distress automatically activates our sympathetic nervous system so we experience the same physiological changes designed to help us perform at an optimal level when attempting to cope with the stressor. However, unlike eustress, distress is characterised by unpleasant, negative psychological states, such as anxiety or fear, that can interfere with our daily activities and threaten our health and wellbeing. In these situations the perception of the stressor as a threat can become magnified, making it

general adaptation syndrome (GAS) According to Hans Selye, the body's typical response pattern in terms of resistance to stress over time, comprising three stages: alarm-reaction, resistance and exhaustion

stress A state of mental or physical tension that occurs when an individual must adjust or adapt to their environment but they do not feel they have the capacity to do so

stressor The object or the event that causes a feeling of stress

eustress A positive psychological response to a stressor, characterised by positive psychological states, that helps the body perform at an optimal level

distress A negative psychological response to a stressor, characterised by negative psychological states, that impedes optimal performance more difficult for the person to cope with. Common physiological symptoms of distress include elevated blood pressure, shallow breathing and a generalised feeling of tension. Behavioural symptoms include changes in appetite (overeating or loss of appetite), excessive alcohol intake and smoking.

Acute stress and chronic stress

Stress can also be categorised as acute or chronic stress. Acute stress, which is the most common form of stress, is the body's immediate response to a perceived stressor. Since our environment is constantly changing, we must constantly change our behaviour to suit these new circumstances. Acute stress is typically caused by the daily demands and pressures encountered in everyday life. Regardless of whether we perceive these stressors to be challenging or threatening, our immediate response is to become highly aroused. So, acute stress can be intense, but because it usually appears and disappears over a short period of time it doesn't have enough time to damage us psychologically or physically. Mild acute stress can even be beneficial because it can motivate and energise us, so it keeps us active and alert. Acute stress can be thrilling and exciting in small doses. However, if we are repeatedly exposed to the same stressor, or repeatedly exposed to many different stressors over an extended period of time, acute stress may develop into chronic stress.

Chronic stress is the body's response to a persistent or long-term stressor. It involves ongoing demands, pressures and worries that we do not feel we have control of and we feel will not end. Unlike acute stress, chronic stress often does not appear to be intense and it is generally experienced as a continual feeling of unease, despair or hopelessness. Often individuals become so used to living with a stressor (or number of stressors) that they do not notice that they are experiencing an ongoing state of higher than normal physiological arousal that characterises chronic stress. Because it lingers for a much longer period of time, chronic stress depletes our body's natural resources and exhausts us, leaving us vulnerable to a host of physical and mental problems.

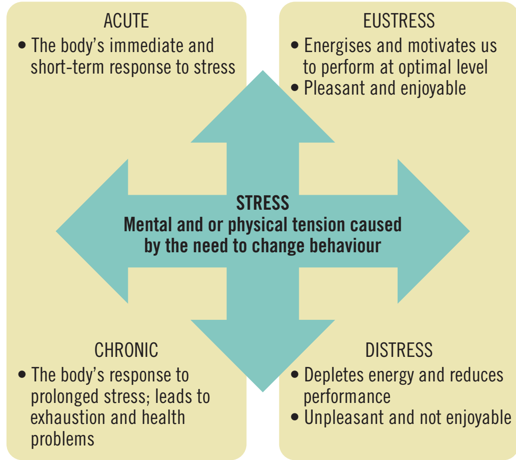

FIGURE 2.3 Stress can be experienced in the form of eustress or distress. It can be acute or chronic.

STRESS AND PERFORMANCE

Whether stress is beneficial or harmful to a person's ability to perform at their optimal level was first investigated by Robert Yerkes and John Dodson in 1908. Yerkes and Dodson developed the inverted-U model (Yerkes-Dodson curve), also known as the Yerkes-Dodson Law, which proposes that people perform best at moderate levels of arousal, and that performance is lower at high or low levels of arousal when there is too little or too much pressure. Yerkes and Dodson demonstrated that stress can be a positive thing because increasing stress and arousal levels helps motivate us and focus attention, but only up to a certain point.

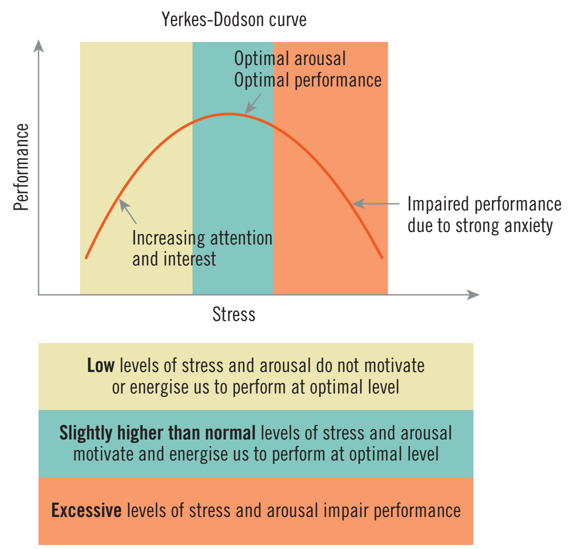

FIGURE 2.4 The Yerkes-Dodson curve of stress and performance: Insufficient or excessive arousal results in insufficient performance.

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Australian Psychological Society's Stress and Wellbeing Survey 2015: Main findings

How stressed are Australians?

Australians' levels of wellbeing have fluctuated over the past 5 years. A slight improvement was recorded in 2014 and 2015, but wellbeing still remains lower than that in 2011 when the APS first surveyed Australians on this important measure.

Main findings

- 35 per cent of Australians report having a significant level of distress in their lives.
- 26 per cent of Australians report above-normal levels of anxiety symptoms.
- 26 per cent of Australians report having moderate to extremely severe levels of depression symptoms.
- Anxiety symptoms were the highest they have been in the 5 years of the survey.
- Financial issues are rated as the top cause of stress over the 5 years, and the number of people turning to gambling to manage stress (now one in five), has grown from 13 per cent in 2011 to 19 per cent in 2015.

The top five causes of stress in Australia over the 5 years are:

- personal finances – 49 per cent
- family issues – 45 per cent
- personal health – 44 per cent
- trying to maintain a healthy lifestyle – 40 per cent
- issues with the health of others close to us – 38 per cent.

The five most popular ways of managing stress in Australia over the 5 years are:

- watching television/movies – 85 per cent
- focusing on the positives – 81 per cent
- spending time with friends and/or family – 81 per cent
- listening to music – 80 per cent
- reading – 75 per cent.

Source: Australian Psychological Society (2015)

FIGURE 2.5 The 2015 Australian Psychological Society's report on the psychological and physical health of Australians states that levels of wellbeing are lower than in 2011, and stress and distress levels are higher than those reported in 2011 and 2012.

2.1 CHECK YOUR UNDERSTANDING >>

1 The non-specific response of the body to any demands placed on it is referred to as:
   A a stressor.
   B stress.
   C eustress.
   D distress.

2 What is the term given to the positive experience of stress that helps the body deal with pressure situations?
   A Prolonged stress
   B Super stress
   C Distress
   D Eustress

3 Which of the following experiences is most likely to produce eustress?
   A Financial worries
   B A death in the family
   C Divorce
   D A promotion to a new job

4 The Yerkes-Dodson curve shows that:
   A when not threatened, organisms seek to reduce arousal and maintain homeostasis.
   B a highly aroused state is required for best performance on a task.
   C a low level of arousal is required for best performance on a task.
   D there is an optimal level of arousal for best performance on a task.

5 Which of the following is an example of a stressor?
   A Learning to relax from a trained professional
   B Sitting an examination
   C Running on a treadmill
   D Participating in a yoga class

6 Explain why eustress is considered to be positive and distress is considered to be negative.

7 Identify two key differences between acute stress and chronic stress.

SOURCES OF STRESS

We experience stress on a daily basis. It is an everyday occurrence that arises from any situation or circumstance that requires us to adjust our behaviour to suit our changing circumstances, therefore stress is considered to be a normal part of life. Stressors can come from a variety of sources; for example, daily pressures, life events, relocating to a new country or experiencing a catastrophic event. They can arise from the *external* environment; for example, sitting your end-of-year exams or being involved in an accident. They can also come from your *internal* physiological or psychological environment; for example, from a burst appendix or always worrying about your appearance because you do not feel as attractive as your friends. Regardless of the origin of the stressor, or whether you perceive it to be challenging or threatening, the automatic physiological response is always the same.

DAILY PRESSURES

Daily pressures, often referred to as 'daily hassles', are stressors that consist of the little annoyances or relatively minor events that occur practically every day, such as missing the bus, arguing with friends and family, trying to meet deadlines at school or work, or losing your house keys. Daily pressures are the opposite of *daily uplifts*, which consist of the minor positive

acute stress A state of brief but intense physiological arousal in response to an immediate perceived stressor that normally has no negative effects on health and wellbeing

chronic stress A state of prolonged physiological arousal in response to a persistent stressor that negatively affects health and wellbeing

Yerkes-Dodson curve A graph that demonstrates the relationship between arousal and performance, showing the optimal level of performance; insufficient or excessive arousal results in insufficient performance

daily pressures Frequently experienced stressors consisting of relatively minor events that require adjustments in behaviour experiences of everyday life that help to counteract the effect of daily hassles, such as receiving a compliment or suddenly finding your lost keys. Daily pressures are often disruptive because they require us to adjust our behaviour to meet our changing circumstances. However, because dealing with these situations is part of our daily routine, we often do not realise that they represent stressors in our lives.

FIGURE 2.6 Every day we experience stress as a result of frustrating and annoying minor events, such as being caught in a traffic jam.

The impact of daily pressures can be manifested in a variety of ways, including headaches, mood swings and lowered self-esteem. Daily pressures can also affect our social functioning by having a negative impact on our social relationships. This negative impact may intensify because daily pressures can accumulate over time and combine to form one large cause of stress. When this happens the effects of stress are amplified and they drain our coping resources. Even a minor hassle can elevate our cortisol level and, if we experience a number of hassles over a prolonged period of time, our physical and mental health will suffer. So, it appears that there is some truth in the saying, 'I'm worried sick'. In a study into the health impact of daily hassles, Courtois, Réveillère, Paüs, Berton and Jouint (2007) compared the influence of significant life events (such as marriage or death of a loved one) compared with daily hassles on adolescent drinking and smoking. Results of their study showed a correlation between adolescent drinking and smoking rates and life events, but that daily hassles had a greater correlation with these behaviours. Further research into the relationship between daily hassles and the mental health of students during the transition from high school to university showed a high positive correlation between stress from daily hassles and the incidence of depressive symptoms (Bouteyre, Maurel, & Bernaud, 2007).

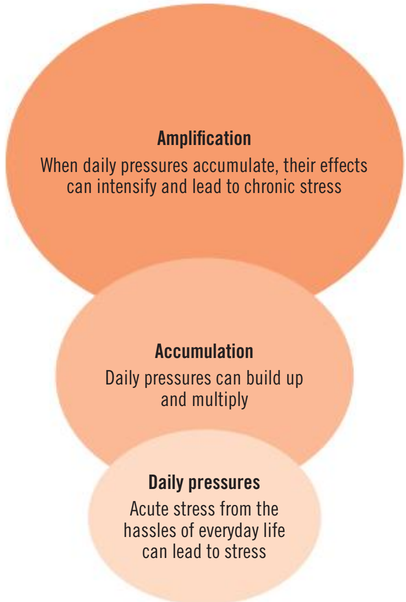

FIGURE 2.7 When we encounter daily pressures, we experience acute stress. This is usually short-term and harmless. If daily pressures accumulate and intensify over a prolonged period of time, we experience chronic stress. Chronic stress has a negative impact on our physical and psychological health.

FOCUS ON RESEARCH 2.1

EARLY LIFE STRESS AFFECTS COGNITIVE FUNCTIONING IN LOW-INCOME CHILDREN

About a fifth of all children in the United States live in poverty. These children are more likely to experience learning and cognitive delays. Researchers have tried to determine causes for this disparity, with recent work identifying the hormone cortisol as a possible reason because of its ability to pass the blood–brain barrier. Cortisol is one of the most influential hormones in the human body, and is often referred to as the 'stress hormone' because it's secreted into the bloodstream at higher levels as part of the body's flight-or-fight response to stress. Now a new study (conducted at the University of Rochester, the University of Minnesota and Mt. Hope Family Center) of children from low-income backgrounds has identified how specific patterns of cortisol activity may relate to the cognitive abilities of children in poverty. The study also outlines how greater instability in family environments and harsh and insensitive caregiving in the context of poverty may predict these different types of cortisol activity in children.

Researchers examined children's cortisol levels over three consecutive years in 201 low-income mother–child pairs. When children were 2 years old, the researchers observed them playing with their mothers and collected

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extensive information about families' experiences, such as how stable the family home was and whether children had been exposed to domestic violence. They collected cortisol through children's saliva when they were 2, 3 and 4 years old. When children were 4 years old, researchers measured their cognitive abilities.

'Overall, we found three cortisol profiles among the children, which were categorised as elevated, moderate and low,' explains Jennifer H. Suor, the study's first author. 'We found that children's cortisol levels remained relatively stable across the 3 years. And we discovered that exposure to specific forms of family adversity when children were 2 years old predicted their cortisol profile, which in turn was linked with notable differences in children's cognitive functioning at age four.'

The study found that about 30 per cent of the children observed maintained relatively higher cortisol levels over the 3 years, 40 per cent of the children maintained lower cortisol levels, and the remainder had moderate levels. Children with both higher and lower levels had experienced family instability. In addition, children with the higher cortisol pattern had experienced harsher and more insensitive interactions with caregivers (e.g. mothers who had difficulty being attuned to their children's needs). The study also found that children with relatively higher and lower cortisol profiles had significantly lower levels of cognitive functioning at age four. Children with a moderate cortisol profile were exposed to relatively less family adversity at age two and had the highest cognitive abilities at age four.

'Low-income children are at increased risk for developing cognitive delays, but the specific environmental and biological factors that influence these outcomes are less understood,' explains Melissa L. Sturge-Apple, assistant professor of psychology at the University of Rochester. 'Our study shows that children's cortisol activity and the experience of specific family adversities may be key processes that predict cognitive development for children from low-income backgrounds. The findings can inform preventive interventions, especially those that can reduce family stress and strengthen parent–child relationships, because these may promote healthy cortisol levels in children and, in turn, may result in positive cognitive outcomes.

'The exact mechanisms through which too much or too little cortisol affects cognitive functioning aren't fully understood. Researchers hypothesise that too much cortisol can have toxic effects on parts of the brain that are important for cognitive functioning, and too little might hinder the body's ability to recruit the biological resources necessary for optimal cognitive functioning.'

Source: Society for Research in Child Development. (2015, June 17). Early life stress affects cognitive functioning in low-income children. *ScienceDaily*.

QUESTIONS

1 Write a possible hypothesis for this study.
2 Identify the following for this study:
   a the population of research interest
   b the independent and dependent variables.
3 Identify two ethical principles the researchers would need to follow and state how they could follow them.
4 Identify the results of the study.
5 What conclusion(s) can be drawn from these results?

LIFE EVENTS

In reference to stress, life events are the opposite of daily pressures. **Life events** refer to major significant but relatively rare events that require a change in behaviour within a relatively short time. Whether or not the life event is perceived as a positive or negative event determines whether the person experiences eustress or distress, how intense this reaction is and how long it persists.

Many life events, such as getting married, going to university, starting a new job or winning the lottery, are usually considered to be positive experiences and the eustress experienced as a direct result of the event is short term. However, if the person feels threatened by an event (for example, the death of a loved one or the breakdown of a significant relationship), then it becomes a source of distress that often persists for a

FIGURE 2.8 Significant life events, such as getting married, can be very stressful even though they are enjoyable and exciting.

life events Stressors that consist of significant but relatively rare events that require substantial adjustments in behaviour within a relatively short time

The Holmes-Rahe life stress inventory

The Social Readjustment Rating Scale

Instructions: Mark down the point value of each of these life events that has happened to you during the previous year. Total these associated points.

LIFE EVENT		MEAN VALUE
1	Death of spouse	100
2	Divorce	73
3	Marital separation from mate	65
4	Detention in jail or other institution	63
5	Death of a close family member	63
6	Major personal injury or illness	53
7	Marriage	50
8	Being fired from work	47
9	Marital reconciliation with mate	45
10	Retirement from work	45
11	Major change in the health or behaviour of a family member	44
12	Pregnancy	40
13	Sexual difficulties	39
14	Gaining a new family member (i.e. birth, adoption, older adult moving in etc.)	39
15	Major business readjustment	39
16	Major change in financial state (i.e. a lot worse off or better off than usual)	38
17	Death of a close friend	37
18	Changing to a different line of work	36
19	Major change in the number of arguments with spouse (i.e. a lot more or a lot less than usual regarding child rearing, personal habits etc.)	35
20	Taking on a mortgage (for home, business etc.)	31
21	Foreclosure on a mortgage or loan	30
22	Major change in responsibilities at work (i.e. promotion, demotion etc.)	29
23	Son or daughter leaving home (marriage, attending college, joined military)	29
24	In-law troubles	29
25	Outstanding personal achievement	28
26	Spouse beginning or ceasing work outside the home	26
27	Beginning or ceasing formal schooling	26
28	Major change in living condition (new home, remodelling, deterioration of neighbourhood or home etc.)	25
29	Revision of personal habits (dress manners, associations, quitting smoking)	24
30	Troubles with the boss	23
31	Major changes in working hours or conditions	20
32	Changes in residence	20
33	Changing to a new school	20
34	Major change in usual type and/or amount of recreation	19
35	Major change in church activity (i.e. a lot more or less than usual)	19
36	Major change in social activities (clubs, movies, visiting etc.)	18
37	Taking on a loan (car etc.)	17
38	Major change in sleeping habits (a lot more or a lot less than usual)	16
39	Major change in number of family get-togethers	15
40	Major change in eating habits (a lot more or less food intake, or very different meal hours or surroundings)	15
41	Vacation	13
42	Major holidays	12
43	Minor violations of the law (traffic tickets, jaywalking, disturbing the peace etc.)	11

Now, add up all the points you have to find your score.

150 points or less means a relatively low amount of life change and a low susceptibility to stress-induced health breakdown.
150–300 points implies about a 50 per cent chance of a major health breakdown in the next 2 years.
300 points or more raises the odds to about 80 per cent, according to the Holmes-Rahe statistical prediction model.

FIGURE 2.9 The Social Readjustment Rating Scale (SRRS) by Holmes and Rahe (1967)

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significant period of time. These types of distressful events are often sudden, unexpected and unwanted, and they disrupt a person's life. The stress that results from a distressful life event may be magnified because it can create new and multiple prolonged strains (for example, a divorce may create financial strains), and prolonged strains may culminate in a further stressful life event (for example, workplace strains may precede losing your job).

In 1967, psychiatrists Thomas Holmes and Richard Rahe wanted to investigate whether or not stress contributes to illness. Holmes and Rahe believed there was a significant correlation between life changes and stress-related illness, and that the significance of a particular event could be determined by the degree of adjustment this event would normally require. To measure the relationship between life changes and wellbeing, they developed the Social Readjustment Rating Scale (SRRS) (see Figure 2.9). The SRRS is a list of 43 positive and negative life events that are ranked in order from the most stressful (death of spouse) to the least stressful (minor violations of the law). They designed the SRRS after noticing their patients experienced a cluster of life-changing events before their admission to hospital. The scale itself consists of a list of life events that were scored based on the amount of readjustment to daily life these events would cause if they were to take place. Each event, called a Life Change Unit (LCU), had a different 'weight' for stress, ranging from 100 (most stressful) to 11 (least stressful). Holmes and Rahe surveyed over 5000 medical patients and asked them to indicate whether they had experienced any of a series of 43 life events in the previous 2 years. The LCU points of the events indicated made up a total LCU score. Results indicated a positive correlation of 0.118 between their life events and their illnesses, which led Homes and Rahe to conclude that life events do cause illness. Holmes and Rahe also found that any changes, positive or negative, can be stressful (Holmes & Rahe, 1967).

More recent research, however, has indicated that people's emotional, cognitive and behavioural response to the same experience can vary markedly, so it is not possible to determine the significance of a particular event in advance of its occurrence. Rather, stress should be seen as a 'transaction' between the person and the environment (Lazarus & Folkman, 1984) that is influenced by the person's perception of the stressor and the resources they have to cope with it.

ACCULTURATIVE STRESS

The culture in which people live plays an important role in shaping their values, beliefs, behaviours and sense of self. For example, people often refer to themselves as being Australian, Indian, Vietnamese or Iranian. When an individual moves from one culture to another, they need to modify many aspects of self-identity to accommodate information about and experiences within the new culture. This process, generally referred to as acculturation, involves a person changing their behaviour to adopt the cultural traits or social patterns of the dominant culture they have moved to.

Immigration is a major life event that can be difficult and stressful for individuals and families. Every year, an increasing number of immigrants and refugees coming to Australia face many challenges when they attempt to adapt to a multitude of changes including a different language, dress code, values, laws and social norms. Relocating to a new country can present a number of challenges such as loss of family and social support, language barriers, loss of professional status and former economic and social status, and parental fear of a loss of cultural heritage in their children. For many of these immigrants, this is a period of culture shock known as acculturative stress, a term commonly used to refer to the unique stressors of immigration (Berry, 2006).

Specifically, acculturative stress refers to the reduction in health status caused by the stress of attempting to adapt to the demands and values of a foreign culture psychologically and socially. In other words, their difficulties arise when they experience problems caused by an ineffective acculturation process. The stress that accompanies acculturation chiefly stems from trying to cope with differences between the host culture and the original culture, such as social customs, politics, norms and values, as well as standards in education and politics. In recent years, research has shown that acculturative stress is an important factor in the mental health of immigrants, and impacts on their physical, psychological and emotional wellbeing. Acculturative

acculturation A process that involves a person changing their behaviour to adopt the cultural traits or social patterns of the dominant culture they have moved to

acculturative stress Stress caused by attempting to psychologically and socially adapt to the demands and values of a foreign culture

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stress can lead to severe and long-lasting psychological and behavioural problems including low self-esteem, anxiety, hostility, depression, alienation, substance abuse, relationship issues, physical illness, feelings of helplessness and identity confusion (Sher & Vilens, 2010; Thomas, 1995). Research also suggests that the effects of acculturative stress is greater for certain populations, such as women and children, and individuals with disabilities or limited financial resources. Despite their need for mental health services, these groups also face significant obstacles to receiving quality mental health care including financial difficulties, the lack of culturally and linguistically appropriate services, and mistrust of mental health providers (Sher & Vilens, 2010).

Several variables are associated with the degree of acculturative stress a person may experience – factors such as the conditions they lived in before immigrating, overcoming cultural and language barriers, encountering discrimination, and the motivation for immigrating, such as trying to cope with the trauma experienced in their native country (Sher & Vilens, 2010). The separation of families, which has been linked to distress among immigrant children, may also involve temporarily disrupting families if one adult immigrates before the rest of the family (Suárez-Orozco & Suárez-Orozco, 2001).

The degree to which a person attempts to *assimilate* by adjusting their behaviours to fit their new culture, and whether the new culture is accepting of them, impacts on the level of stress they experience. A person who actively attempts to integrate will have less stress, as will a person who is welcomed into the new society even if they have not tried very hard to assimilate. A person who deliberately remains separate from the new culture or who is marginalised when they try to assimilate will experience higher levels of stress. New immigrants may experience discrimination, stereotyping and prejudice because of racism and anti-immigrant attitudes. Intergenerational conflict caused by differing degrees of assimilation between parents and children can also intensify acculturative stress. In families where parents do not speak English, children may need to translate and facilitate communication on behalf of their parents, resulting in a power shift from the adults to the children.

FIGURE 2.10 Adapting to a foreign culture can be stressful and cause acculturative stress.

2.2 CHECK YOUR UNDERSTANDING >>

1 Our physiological response to a stressor:
   A is lower for an internal stressor than an external stressor.
   B is the same for internal and external stressors.
   C is higher for an internal stressor than an external stressor.
   D varies according to personal attributes.

2 Acculturation can best be described as the process by which:
   A members of a cultural group adopt the behaviours, values and beliefs of a different society.
   B cultures become more alike as they share behaviours, values and beliefs.
   C individuals or groups from different cultures come to accept each other's behaviours, values and beliefs.
   D relocating to another culture causes stress.

3 Acculturative stress refers to:
   A the accumulation of daily pressures felt by immigrants.
   B stress caused by attempting to adapt to the values and behaviours of a foreign culture.
   C stress related to the personal attributes of an immigrant.
   D stress caused by moving away from the familiarity of your homeland.

4 Josh was recently fired from his part-time job as a cleaner. As a source of stress for Josh, this event probably represents:
   A a daily pressure.
   B acculturative stress.
   C a life event
   D eustress.

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5 When comparing daily pressures with life events as a source of stress, research suggests that:
   A life events are a greater source of stress than daily pressures.
   B daily pressures are a greater source of stress than life events.
   C daily pressures and life events contribute equally to a person's stress.
   D daily pressures are too minor to impact on stress levels.
6 Explain how, as a source of stress, daily pressures are different from life events.
7 What is the relationship between level of assimilation and level of acculturative stress?

MAJOR STRESS FROM CATASTROPHES THAT DISRUPT WHOLE COMMUNITIES

A person can experience major stress after any catastrophic experience or event. A **catastrophe** is a sudden, unpredictable, uncontrollable, intense event that is out of the control of an individual and causes intense and prolonged suffering. Catastrophes disrupt peoples' lives and threaten them. Catastrophes are unexpected, they have not been prepared for and there is nothing a person could do to prevent them from happening. The individuals affected by a catastrophe suffer major stress and this usually has significant and long-lasting effects.

Catastrophes can be an experience unique to the individual (for example, being attacked or crashing their car) or they can be shared with others (for example, a tsunami or a war) when an event becomes a massive collective stressor that wreaks havoc for people at a personal and community level. Regardless of the individual or group nature of the catastrophe, when people experience a catastrophe they often experience major stress and become so psychologically traumatised they enter a state of lasting shock that overwhelms their ability to cope.

Catastrophes can be natural, or environmental, such as a flood, cyclone, earthquake, bushfire, tsunami, volcanic eruption or landslide. They can also be man-made, such as war, genocide, a factory explosion or an industrial accident involving chemical spills or discharge of radiation. Research suggests that the psychological effects of man-made catastrophes appear to be longer lasting than those of natural catastrophes. Natural disaster may be seen as inevitable or fate, so there is no-one to blame. By definition, man-made disasters could have been prevented. Therefore, someone can be blamed, and they are often more difficult to process than natural disasters. For example, Baum et al. (1992) compared 23 flood victims with 27 people living near a leaking, hazardous toxic waste dump and 27 control persons. Although only 9 months after the event, those persons exposed to the hazardous material as a result of human endeavours were more depressed, anxious, alienated and aroused than those in the other two groups. Such effects have been found for technological failures as well (Davidson, Fleming, & Baum, 1986).

FIGURE 2.11 Earthquakes are an example of a natural catastrophe that can traumatise individuals and whole communities.

No matter what the cause, catastrophes that disrupt whole communities represent a significant collective stressor for those affected because they destroy or disrupt the systems that underpin peoples' everyday lives. Following the initial stress of the catastrophic event, survivors often experience a range of ongoing secondary stressors that can compound their initial stress and lead to mental disorders. For example, relocation as a result of homelessness, loss of employment, ongoing pain from physical injury, financial loss, legal procedures and lack of access to services all affect survivors' mental health. Persistent and significant mental health difficulties are more likely to occur when a natural disaster results in large-scale injuries or mortality, mass devastation and property damage, interruption in the provision of social services, and continued economic turmoil within the community (Shultz, Marcelin, Madanes, Espinel, & Neiria, 2011).

Investigations into the effects of natural disasters and catastrophes indicate that those affected experienced a significant increase in stress level; however, given the right resources and responses

catastrophe A sudden, unpredictable, uncontrollable, intense event that causes large-scale damage and suffering for a group to needs, most people return to a reasonably stable level of mental health. A small minority, though, will experience long-term and persistent psychological distress (Bonanno, Brewin, Kaniasty, & La Greca, 2010). Psychosocial difficulties linked to a specific traumatic event or the aftermath of different catastrophes include post-traumatic stress disorder (PTSD), depression, anxiety, suicidal ideation, substance abuse, sleep disturbances, various psychosomatic ailments, domestic violence and divorce, cognitive impairment and diminished task performance (Bonanno et al., 2010; Freedy, Shaw, Jarrell, & Masters, 1992; Kemp, Helton, Richardson, Blampied, & Grimshaw, 2011; Morrissey & Resser, 2007). Interestingly, research also suggests that trauma following a catastrophe also has the potential to increase positive psychological growth, which reduces anxiety and produces an enhanced quality of life in the future (Kraemer, Wittmann, Jenwein, & Schnyder, 2009; Sattler, Kaiser, & Hittner, 2000; Tang, 2006). Positive adjustment and outcomes following a disaster are thought to be the product of an active coping style and support seeking behaviours, which counteract the impact of negative affect and arousal (Tang, 2006). Positive responses following a disaster include a sense of greater resilience and spirit, a more balanced and greater appreciation for life, stronger family and community bonds, and an enhanced sense of self-efficacy (Sattler et al., 2000; Tang, 2006).

THE EFFECT OF MAJOR STRESS ON AN INDIVIDUAL: POST-TRAUMATIC STRESS DISORDER (PTSD)

Traumatic events and catastrophes can lead to a range of post-traumatic mental health problems. A frequent effect of disaster experience is **post-traumatic stress disorder (PTSD)**, a mental disorder that leaves a person feeling vulnerable to unknown future events after exposure to a frightening and traumatic event. PTSD is usually defined as a pattern of symptoms following exposure to a stressful life event that sets off clinically significant distress or impairment of human functioning. The long-lasting effects may include re-experiencing the event in vivid flashbacks or nightmares; avoidance of places, people or activities that remind the person of the event; feeling numb or detached from others; having negative thoughts about oneself and the world; feeling irritable or angry; sleeping difficulties; and long-lasting periods of increased autonomic arousal.

PTSD can be caused by a variety of events, including natural and man-made disasters, sexual or physical assault, experience in a war zone, or a serious accident. Research suggests that approximately 1 million Australians experience PTSD in any one year, and 12 per cent of Australians will experience PTSD during their lifetime (Beyond Blue, 2015a).

Signs of PTSD can happen at any age. Individuals may develop PTSD symptoms after being directly

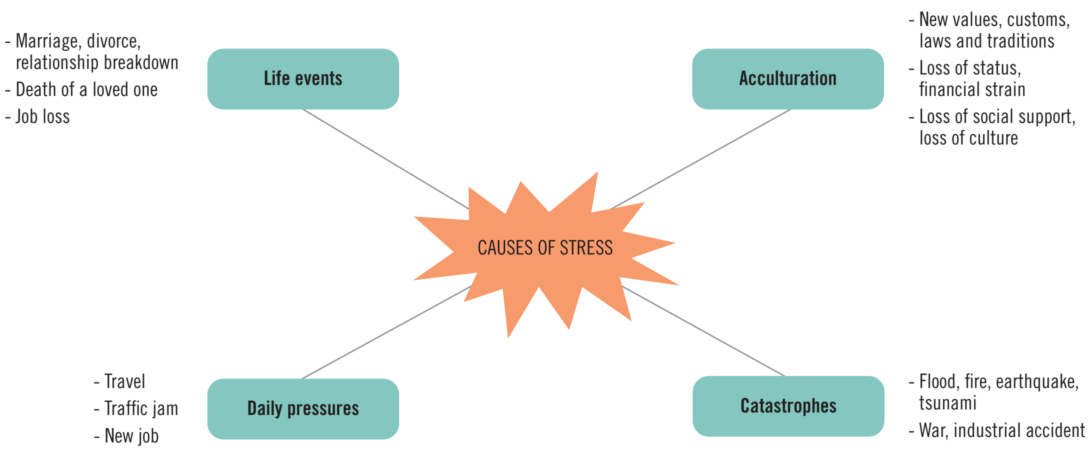

FIGURE 2.12 Stress can be caused by a number of internal and external stressors, and it can manifest itself psychologically and physically. The pressures of daily life, events that significantly alter a person's life, moving to another culture and experiencing a catastrophe all result in stress.

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involved in a traumatic event that threatened their life or as a result of witnessing someone else's trauma. Symptoms may vary in frequency and intensity over time but, initially, the individual would have reacted to the event with intense fear, helplessness or horror. To be diagnosed as a PTSD case, the person should persistently re-experience the traumatic event through flashbacks or vivid nightmares, actively avoid any reminders of the event, experience negative changes in thought and emotions, and experience behavioural changes, such as constantly feeling highly aroused and on alert (Victoria. Better Health Channel, 2015a). Symptoms must be present for at least 1 month and cause clinically significant distress or impairment in functioning.

Symptoms of PTSD can emerge even decades after the traumatic experience (Landau & Litwin, 2000). In one research study, Holocaust survivors at the age of 75 and older were compared with control persons of a similar age and sociocultural background. The assessment of vulnerability included physical as well as mental health and PTSD. The findings suggest that extremely traumatic events have long-lasting effects on the victims. Men who survived demonstrated a higher prevalence of PTSD, whereas women reported greater health-related difficulties and poorer health (Wagner, Wolfe, Rotnitsky, Proctor, & Ericson, 2000).

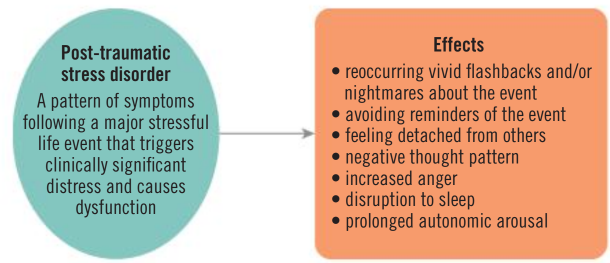

FIGURE 2.13 Symptoms of post-traumatic stress disorder (PTSD) include physical, cognitive, behavioural and emotional changes.

FIGURE 2.14 It is not uncommon for Australian soldiers to experience post-traumatic stress disorder when they return from a war zone.

2.3 CHECK YOUR UNDERSTANDING >>

1 Which statement is incorrect? Research indicates that:
   A most people recover from the effects of natural disasters.
   B most people find it more difficult to psychologically recover from the effects of man-made disasters than from natural disasters.
   C trauma that follows a catastrophic experience can lead to an increased ability to cope with future stressors.
   D trauma that follows a catastrophic experience decreases a person's ability to cope with future stressors.

2 Which of the following would be considered to be a symptom of post-traumatic stress disorder (PTSD)?
   A Increased arousal
   B Avoidance and numbing of emotions
   C Re-experiencing the traumatising event in vivid flashbacks
   D All of the above

3 Which of the following statements about post-traumatic stress disorder (PTSD) is not true?
   A PTSD can occur at any time following a traumatic event.
   B PTSD can occur at any age.
   C Only those who were directly affected by the traumatic event can develop PTSD.
   D PTSD is not diagnosed until after 4 weeks following the traumatic event.

4 Explain the difference between a major life event and a catastrophe.

5 Explain why it is easier for people to recover from the stress caused by a natural disaster than a man-made disaster.

6 Describe three symptoms that must be present for a person to be diagnosed with post-traumatic stress disorder.

STRESS RESPONSES

Stress responses consist of a set of physical and psychological responses that are automatically set in motion when the sympathetic nervous system is activated following the perception of a threat. Stress responses enable us to harness all necessary physiological and psychological resources to help combat the stressor. Thus, they help the body and mind to function at their optimal levels when attempting to

post-traumatic stress disorder (PTSD) A pattern of symptoms following exposure to a stressful life event that sets off clinically significant distress or impairment of human functioning

stress responses A set of physical and psychological responses that are automatically triggered as a result of sympathetic nervous system activation following the perception of a threat

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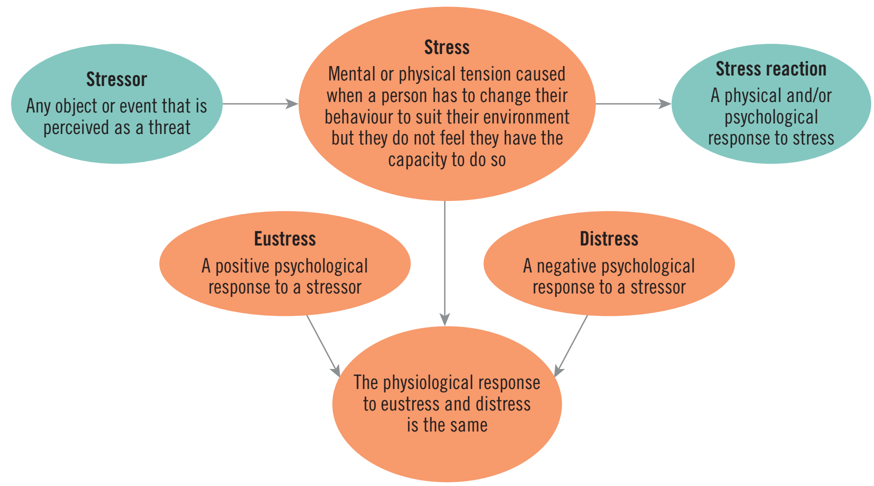

FIGURE 2.15 The relationship between a stressor, stress and a stress reaction

cope with threat. Consequently, they help us adapt to our changed circumstance and this aids our chance of survival. Figure 2.15 shows the relationship between stressors, stress and stress reactions.

STRESS AS A BIOLOGICAL PROCESS

When we perceive a stressor to be a threat, whether real or imagined, our sympathetic nervous system, a branch of our autonomic nervous system (ANS), is automatically activated. As we learnt in Chapter 1, when activated, the sympathetic nervous system sets off a chain of physiological changes that automatically increases our arousal level and energises us so that out body is prepared for action. For example, a flood of hormones (such as adrenalin, noradrenalin and cortisol) is released into the bloodstream that initiates the physical changes needed for our body to deal with the threat. Our heart beats faster, our muscles tense and our pupils dilate. At the same time, the body functions not needed to deal with an immediate threat – such as the digestive and immune systems – slow down and repair and growth of body tissues slows. Now, all our energy can be directed to areas of our body needed to respond to the threat. Traditionally, this automatic physiological response to a sudden threat was described as the fight–flight response because our body was prepared to confront (fight) the stressor if we believe we could outfight it or escape to safety (flight).

The concept of a fight-or-flight response in the context of a perceived threat was introduced by Walter Bradford Cannon in the 1920s. Cannon theorised that animals react to threats with a general activation of the sympathetic nervous system, which prepares them for fighting or fleeing. However, in particularly threatening situations, we may be terrified and feel overwhelmed by the threat. Research has shown that if we believe there is no hope of defeating the stressor or escaping to safety, the *parasympathetic nervous system* is activated. We become physically relaxed to the point of immobility so we tend to 'freeze', or experience tonic immobility. Because freeze responses are now believed to be a fundamental part of our stress response, psychologists now describe our response options to a threat as consisting of three responses, which they refer to as the fight–flight–freeze response (Barlow, 2002).

FIGHT–FLIGHT–FREEZE RESPONSE

To understand the fight–flight–freeze response, we have to understand how the two branches of the ANS work in harmony to deal with threats and then recover from them.

Fight or flight: A mobilising response to threat

As we saw in Chapter 1, the ANS is a major division of the peripheral nervous system (PNS). The ANS is a network of nerve fibres that extends throughout the body. It connects the brain with various organs, glands and muscle groups and coordinates the activities of its two branches, the sympathetic and parasympathetic nervous systems. When we perceive a threat, our sympathetic nervous system is activated and we automatically evaluate whether or not we can do something to survive the threat. If we decide we

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can, we adopt the fight technique to strike back. For example, if you are confronted by a thief on a lonely street, you look at them and evaluate your chances of disarming them. If you decide that you can, you adopt the fight technique to deal with this stressful and dangerous situation. If you believe that fighting will only cause you harm but you think you can escape, you adopt the flight technique and run away to safety.

Regardless of your decision, the perception of a threat activates your sympathetic nervous system. When activated, the sympathetic nervous system triggers the fight–flight response and the level of your internal activity changes. Now your bodily resources have been mobilised to produce more energy and elevate your arousal level. You have an increase in strength and stamina, you are more alert and your reaction times are quicker. Because your body is now prepared for emergency action, you can protect yourself by either fighting or running away to safety.

The fight–flight response is considered to be an adaptive response because the body is automatically prepared – both physically and psychologically – for fight or flight. Once you perceive the threat to be gone, the fight–flight response is switched off. Your parasympathetic nervous system activates the relaxation response, the counterpart of the fight–flight response, which calms your body by reversing the effects of the sympathetic nervous system, returning it to its normal level of functioning.

Freeze: An immobilising response to trauma

In normal non-threatening circumstances our parasympathetic nervous system, whose primary function is to conserve energy, functions properly to maintain a state of homeostasis. For example, when our parasympathetic nervous system is active we digest food effectively, our heart beats at a normal rate, our lungs take in a normal amount of oxygen, and our limbs and muscles have sufficient blood flow and energy to enable movement. However, when we are involved in life-threatening situations, such as serious accidents or violent crime, we may feel so overwhelmed and terrified by the event that we become traumatised. We feel helpless and incapable of making any response because we feel that the threat cannot be managed by the mobilisation strategies of fight or flight (Scaer, 2001). When this happens, we adopt the freeze response as our last attempt to survive. During the freeze response the sympathetic nervous system is suppressed and the parasympathetic nervous system is automatically activated. This stops us from attempting a fight or flight response that we feel has no chance of success. The freeze response is our most extreme defence strategy. It immobilises us by conserving our energy and directing it only to organs in the body's core we need for basic survival until the danger has passed (Scaer, 2001). This is why people in a freeze state lose all power to move or communicate. In this state, it is not uncommon for people to vomit, defecate, or faint and lose consciousness. Some individuals become dissociative, and enter a psychological state where they feel mentally detached from their bodies or that time was standing still. In a freeze state, endorphins that activate the body's opiate receptors are released, causing an analgesic or numbing effect. As a result, the person doesn't feel or fear intense pain caused by the event, and sometimes they have no memory of it afterwards (Siegel, 2010).

Like the fight–flight response, the freeze response is also thought to be an adaptive response that enhances our survival chances. For example, if we faint and temporarily lose consciousness in the face of danger, we are unaware of the high levels of pain we may be experiencing. Later we may have no memory of the trauma, so we avoid future potential distress associated with the event. In nature, animals often freeze or collapse when fighting or fleeing from a predator isn't an option. Collapse simulates death, so an attacker that eats only live prey may lose interest. In addition, blood pressure drops rapidly in a freeze state, which could also reduce blood loss from wounds (Siegel, 2010). Although freezing in the context of an attack may appear to make an animal more vulnerable, research suggests that freezing may be the best option if the animal perceives little immediate chance of escaping

fight–flight response The automatic reaction of the sympathetic nervous system to stress that causes physiological change that prepares it to either confront (fight) a threat or escape to safety (flight)

tonic immobility Physical relaxation to the point of immobility

fight–flight–freeze response The body's response options to a threat consisting of either confronting it (fight), escaping from it (flight) or becoming immobilised (freeze) in its presence

relaxation response The counterpart of the fight–flight response, which calms your body by reversing the effects of the sympathetic nervous system, returning it to its normal level of functioning

freeze response A response to a threat whereby we feel so helpless to deal with it that we become immobilised in its presence due to activation of the parasympathetic nervous system overriding the sympathetic nervous system or winning a fight. For example, if a mouse scurrying through grass suddenly sees a cat ahead, out of fear it may suddenly freeze so it does not attract attention. Thus, appearing to be dead until the cat has gone is beneficial to the mouse's survival. Freezing may also be useful when additional attacks could be provoked by movement.

The freeze response may help us survive temporarily; however, after the threat has gone, if we become stuck in freeze mode as a result of parasympathetic imbalance, we will be unable to return to homeostasis, and thus be at risk of developing a range of problems. These problems include digestive and immune problems, poor blood and oxygen circulation, sleep disturbances, fatigue, and suppression of hormones, heart rate and blood pressure. As a result, our compromised health state may lead to or contribute to the development of chronic stress.

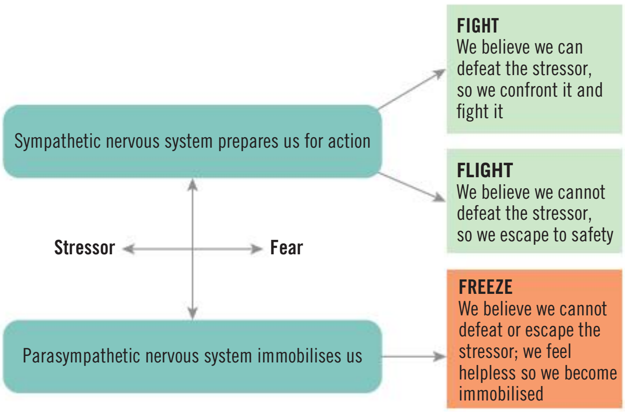

FIGURE 2.16 The fight–flight–freeze response. We have three response options to a stressor: fight it, flee from it or freeze in its presence.

FOCUS ON RESEARCH 2.2

BRAIN IMAGING SHOWS HOW MEN AND WOMEN COPE DIFFERENTLY UNDER STRESS

Men and women differ in their neural responses to psychological stress. The study reveals that different parts of the brain activate with different spatial and temporal profiles for men and women under stress.

The stress response, or the 'fight-or-flight' response, is associated with the main stress hormone system that produces cortisol in the human body – the hypothalamic-pituitary-adrenal (HPA) axis. These findings suggest that stress responses may be fundamentally different in each gender, sometimes characterised as 'fight-or-flight' in men and 'tend-and-befriend' in women. Evolutionarily, males may have had to confront a stressor either by overcoming or fleeing it, while women may have instead responded by nurturing offspring and affiliating with social groups that maximise the survival of the species in times of adversity.

In the study, 32 healthy subjects – 16 females and 16 males – received fMRI (functional magnetic resonance imaging) scans before, during and after they underwent a challenging arithmetic task (serial subtraction of 13 from a 4-digit number), under pressure. To increase the level of stress, the researchers frequently prompted participants for a faster performance and asked them to restart the task if they responded incorrectly. As a low stress control condition, participants were asked to count backwards without pressure.

The researchers measured heart rate, cortisol levels (a stress hormone), subjects' perceived stress levels throughout the experiments, and regional cerebral blood flow (CBF), which provides a marker of regional brain function. In men, it was found that stress was associated with increased CBF in the right prefrontal cortex and CBF reduction in the left orbitofrontal cortex. In women, the limbic system – a part of the brain primarily involved in emotion – was activated when they were under stress.

Both men and women's brain activation lasted beyond the stress task, but the lasting response in the female brain was stronger. The neural response among the men was associated with higher levels of cortisol, whereas women did not have as much association between brain activation to stress and cortisol changes.

'Women have twice the rate of depression and anxiety disorders compared to men,' notes Dr Wang, the lead author of the study. 'Knowing that women respond to stress by increasing activity in brain regions involved with emotion, and that these changes last longer than in men, may help us begin to explain the gender differences in the incidence of mood disorders.'

Source: University of Pennsylvania School of Medicine. (2007, November 20). Brain imaging shows how men and women cope differently under stress. *ScienceDaily*.

QUESTIONS

1 Create a possible hypothesis for this study.
2 Identify the independent variable and state how it was operationalised.
3 Identify the dependent variable and state how it was operationalised.
4 State the results of this study.
5 What conclusion(s) can be drawn from these results?

2.4 CHECK YOUR UNDERSTANDING >>

1 The division of our nervous system that triggers the stress response is the:
  A autonomic nervous system.
  B parasympathetic nervous system.
  C sympathetic nervous system.
  D somatic nervous system.

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2 The fight–flight response:
   A increases digestion.
   B decreases glucose production.
   C causes bronchial constriction.
   D causes the pupils to constrict.
3 When Carla was visiting her uncle's free-range poultry farm, she was frightened when a large rooster ran towards her. Immediately, she ran to the safety of the farmhouse as fast as she could. As she ran, she noticed her heart rate had increased rapidly and that her mouth felt dry. Carla's immediate responses to the rooster indicated that her __________ nervous system had been activated.
   A parasympathetic
   B sympathetic
   C peripheral
   D autonomic
4 The fight–flight response:
   A only involves the central nervous system.
   B is under the control of the central nervous system.
   C is a state of physiological arousal triggered by the activation of the sympathetic nervous system.
   D is a state of physiological arousal triggered by the activation of the parasympathetic nervous system.
5 Describe the circumstances under which we would freeze when confronted by a threat.
6 Explain the difference between stress, a stressor and a stress reaction.
7 Define the fight–flight–freeze response and explain how it is linked to the autonomic nervous system.

SELYE'S GENERAL ADAPTATION SYNDROME (GAS)

As we noted at the beginning of this chapter, Hans Selye considered stress to be a non-specific physiological response caused by any demands placed on the body by either unpleasant or pleasant conditions. As a result of his studies, Selye developed a model of stress which he called the general adaptation syndrome (GAS).

The GAS is the body's typical response pattern in terms of resistance to stress over time. Selye proposed that a bodily mechanism called 'adaptation' was required to accept both eustress and distress. He noticed organisms respond to stress with a similar sequence of reactions to any illness or traumatic event. Based on this, he concluded that humans react to any stress (real, symbolic or imagined) by putting into motion a set of physiological responses that attempts to alleviate the impact of the stressor.

According to Selye, the GAS consists of three stages: an *alarm-reaction* stage, a stage of *resistance* and a stage of *exhaustion* (Selye, 1976).

ALARM-REACTION STAGE

The alarm-reaction stage comprises two sub-stages: shock and countershock. When we first perceive a threat, we go into a state of shock, our resistance level falls below normal and our body acts as though it is injured. Body temperature and blood pressure drop and our muscles temporarily lose tone. These physical effects of shock reduce the individual's ability to deal with the stressor, and they feel momentarily helpless. For example, a VCE student may feel threatened as their critical exam period looms closer and they may enter the shock stage, and may feel they cannot cope with the demand. If this happens, they may stop studying, have trouble concentrating and underperform.

After the shock stage, the body rebounds and enters the stage of countershock. Countershock is characterised by the activation of the sympathetic nervous system and a higher-than-normal arousal level that increases the body's resistance to the stressor. Now the body's resources are mobilised so it can cope with the stressor. A flood of hormones (for example, cortisol, adrenaline and noradrenaline) is released into the bloodstream. This speeds up some bodily processes while others are slowed down, thereby allowing energy to be used where it is most needed (see Chapter 1 for the physical effects of sympathetic nervous system activation). For example, heart rate and respiration increase so that glucose and oxygen can be delivered to the muscles at a faster rate. Countershock also results in the fight–flight response. In the example of a student in a critical exam period, when countershock kicks in our student may feel that they have received energy and now have the necessary resources to stay awake and alert, and be able to function above their normal level.

During countershock, the body's resistance to stress is above normal, though this is not always a positive thing, and can cause some problems. The release of

general adaptation syndrome (GAS) According to Hans Selye, the body's typical response pattern in terms of resistance to stress over time, comprising three stages: alarm-reaction, resistance and exhaustion

alarm-reaction stage The first stage of the GAS, where resistance to stress first drops below normal, then increases above normal

shock The first stage of alarm-reaction in the GAS, where resistance to stress drops below normal and the body acts as though it is injured; blood pressure and body temperature decrease

countershock The second stage of alarm-reaction in the GAS, where resistance to stress rises above normal levels because of the activation of the sympathetic nervous system cortisol into the bloodstream can cause damage to the heart and other vital organs, and can make our immune system susceptible to illness. However, once the threat is removed, the body returns to normal.

STAGE OF RESISTANCE

Following the alarm-reaction stage, if the stressor remains, the body enters the stage of resistance as it attempts to stabilise its internal systems and fight the stressor. When we first move into the stage of resistance, the symptoms of the alarm-reaction stage subside. Although the body is better able to cope with the initial stressor, because physiological arousal remains higher than normal (but lower than during the alarm-reaction stage), continued high cortisol levels compromise our immune system and our ability to resist additional stressors is significantly lowered (the role of cortisol is discussed in more detail later in the chapter). This is because the body puts all its resources into fighting the current stressor, but may not have any resources to fight additional stressors. That is why, if we are exposed to additional stressors (such as infection) during the stage of resistance, we may not be able to cope with them and signs of illness may appear.

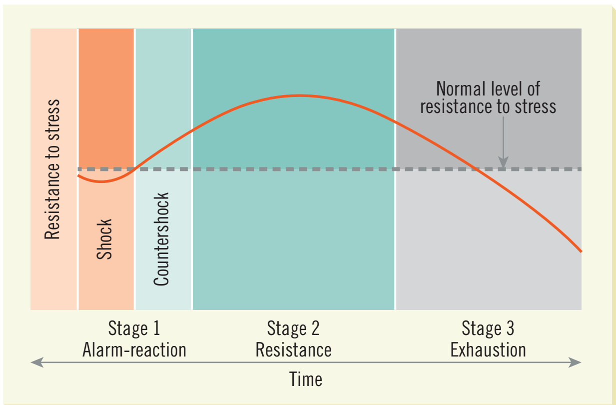
During the resistance stage, the student in the critical exam period will continue with the energetic approach to study they achieved in the countershock stage of alarm-reaction; however, after a period of time their bodily resources can become depleted.

STAGE OF EXHAUSTION

If, during the stage of resistance, we defeat the stressor, our parasympathetic nervous system takes control, reversing the effects of the sympathetic nervous system and returning our body to its normal level of functioning. If we are unable to defeat the original stressor during the first two stages, we reach a stage of exhaustion, in which our body's resources are drained and stress hormones that triggered the fight–flight response are depleted. This leaves us vulnerable to additional stressors such as infection and disease, and we may succumb to physical or mental illness. As the VCE student undertaking exams enters this stage, they may become sick and physically worn out. Signs that they are exhausted include feeling fatigued, anxious or depressed, high blood pressure and have difficulty maintaining normal sleeping and eating routines.

When Selye examined animals in the later stages of the GAS, he found that their adrenal glands were enlarged and discoloured. He also found that there was intense shrinkage of the spleen and lymph nodes and many animals also suffered from bleeding ulcers deep in their stomach. Stress can have similar effects in humans. Stress can also disrupt our body's immune system, which mobilises defences, such as white blood cells, against invading microbes and other disease agents (Ader & Cohen, 1993). When our immune system does not function normally, we are more susceptible to long-term illness or disease. Because the immune system is regulated in part by the brain, stress and upsetting emotions can affect the immune system in ways that increase this susceptibility (Miller, 1998). For example, during major exam times, divorce, bereavement or job loss, our immune system can be compromised by our attempts to cope with stress and we fall ill.

Selye's general adaptation syndrome



Stage 1: Alarm-reaction
When a threat is perceived, the body enters a state of 'shock'. Our resistance level to stress momentarily falls below normal. Then the body rebounds and enters the stage of 'countershock'. Activation of the sympathetic nervous system results in physiological changes that prepare the body for action (fight or flight) by producing a higher-than-normal arousal level that increases the body's resistance to the stressor.

Stage 2: Resistance
If the threat remains, the body enters the stage of resistance. Arousal is higher than normal (but lower than Stage 1) as the body attempts to stabilise its internal systems and cope with the threat. This higher arousal weakens the immune system and signs of illness appear because we are unable to cope with additional stressors.

Stage 3: Exhaustion
If the original threat continues, the body's resources are drained and stress hormones are depleted. Our immune system is depleted and the body moves into the stage of exhaustion and we become ill.

FIGURE 2.17 Hans Selye (1956) proposed that there are three stages in the body's reaction to stress, which he called the general adaptation syndrome.

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During the initial alarm-reaction stage to stress, resistance falls below normal (shock). It then rises again as bodily resources are mobilised (countershock), and it remains high during the stage of resistance. If the stress is prolonged, eventually resistance falls as the stage of exhaustion is reached and the person can experience a range of negative physical effects. For example, continued release of adrenalin into the bloodstream causes the heart to beat at a faster than normal rate, which can cause damage to the heart, leading to heart palpitations and heart disease. Abnormal levels of internal activity that result from prolonged sympathetic nervous system activation can also lead to ulcers and stroke. Skin irritations (including rashes and acne) and fatigue are also physiological effects of long-term stress.

Strengths and limitations of the GAS

The GAS successfully contributed to the popularisation of the concept of stress as it related to physical and mental health in the 1940s and 1950s. However, as an explanation of how the body reacts to stress, the GAS is not without its modern-day critics. Critics argue that the GAS placed significant emphasis on the non-specific nature of the stress response and, therefore, placed the adrenal cortex at the 'centre of the stress universe' (Fink, 2000). However, now we know that different stressors often trigger different patterns of hormone secretion from various organs, demonstrating that a uniform stress response to a non-specific stressor is an oversimplification of the complex way in which the body deals with stressors. Additionally, the differentiation between how one person may respond to a particular stressor in comparison to someone else, due to unique environmental and biological factors, is not adequately explained by Selye's theory. The personal meanings and symbolisms of individual threats would need to be incorporated into why certain issues are more stressful for some individuals than others and how they manage threat or stressors.

2.5 CHECK YOUR UNDERSTANDING >>

1 Our behavioural responses to stressors are managed by our:
   A autonomic nervous system.
   B parasympathetic nervous system.
   C central nervous system.
   D sympathetic nervous system.

2 The correct order of Hans Selye's general adaptation syndrome is:
   A alarm-reaction, resistance, exhaustion
   B resistance, alarm-reaction, exhaustion
   C alarm-reaction, shock, exhaustion
   D resistance, shock, countershock

3 Resistance is at its highest during the __________ stage of the general adaptation syndrome.
   A alarm-reaction
   B resistance
   C exhaustion
   D fight–flight

4 According to Hans Selye's general adaptation syndrome, which of the following would a person experience when they first perceived a threat?
   A Increased temperature
   B Increased blood pressure
   C Decreased respiratory rate
   D Decreased pulse rate

5 Selye's general adaptation syndrome suggests that:
   A stress is primarily the result of physical stimulation.
   B stress is primarily a result of attitude.
   C prolonged stress can result in physical illnesses.
   D type A personalities can be cured.

6 Identify two physiological responses you may experience if you experienced the freeze stage of the fight–flight–freeze response. Explain how these responses might aid your survival in a life-threatening situation.

7 According to the general adaptation syndrome, why does prolonged stress cause physical illness?

CORTISOL'S ROLE IN THE STRESS RESPONSE

Cortisol is an important steroid hormone produced by the adrenal glands (located on top of each kidney) and it is directly secreted into the bloodstream for quick transportation throughout the body. Cortisol is essential to the maintenance of homeostasis. It is involved in a range of biological functions including proper glucose metabolism, regulation of blood pressure, insulin release for blood sugar maintenance, immune function and anti-inflammatory reactions, and central nervous system activation. Cortisol levels normally fluctuate throughout the day and night in a regular pattern and, although cortisol secretion varies among individuals, normally cortisol levels

stage of resistance The second stage of the GAS, where the resistance to stress remains above normal levels; cortisol is released to help repair the damage caused by stress on the body

stage of exhaustion The final stage of the GAS, where the body's resources are depleted and its resistance to stress falls below normal

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are higher in the morning, decrease during the day and are low at night. Cortisol is normally released in response to events or circumstance, such as waking up in the morning, exercise and the experience of stress. Cortisol is often called the 'stress hormone' because both eustress and distress trigger its release into the bloodstream.

A short-term increase in cortisol levels affects the body in a number of positive ways. For example, cortisol prepares the body for a fight–flight response by flooding it with glucose so we have an immediate burst of energy to large muscles. It also mobilises energy by selecting the right type and amount of carbohydrate, fat or protein needed by the body to meet the physiological demands placed on it. In terms of our survival, it is vital that the adrenal glands secrete more cortisol during the fight–flight response so that the adaptive changes necessary to energise the body and prepare it for action occur. However, it is important that, following the stressful event, the sympathetic nervous system ceases its domination and our internal functioning returns to the control of the parasympathetic nervous system. When this happens, we experience the calming effects of the relaxation response, which reverses the effects of the sympathetic nervous system and returns the body to its normal level of internal activity. Thus, cortisol levels return to normal and homeostasis is maintained.

If this reversal does not happen, the person remains in a prolonged or intense stress state, which results in too much cortisol remaining in their bloodstream. This causes a biochemical and hormonal imbalance that can have a number of negative effects. These effects include impaired cognitive performance, suppressed thyroid function, blood sugar imbalances, decreased bone density and muscle tissue, higher blood pressure, lowered immunity and inflammatory responses in the body, slowed wound healing and increased weight gain due to accumulation of abdominal fat. These effects can also introduce a new stressor to an individual, in the form of a health problem. If the adrenal glands become chronically fatigued because of prolonged activation, inadequate levels of cortisol will be secreted and this can also lead to health problems such as fatigue, sleep disturbances, emotional hypersensitivity, anxiety or mild depression. Either way, prolonged abnormal levels of cortisol in the bloodstream cause health problems that exacerbate a person's level of stress.

FIGURE 2.18 The effects of excess levels of cortisol on the body

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2.6 CHECK YOUR UNDERSTANDING >>

1 During which stage of the general adaptation syndrome is cortisol released?
   A Alarm-reaction
   B Resistance
   C Exhaustion
   D During each stage

2 Which of the following statements about cortisol is true?
   A In normal circumstances, cortisol levels are highest in the evening when we are physically tired.
   B Cortisol is not triggered by eustress.
   C Too much cortisol in your bloodstream can damage your muscles.
   D Cortisol release is triggered by the activation of the parasympathetic nervous system.

3 During times of stress, cortisol:
   A helps the body to repair any damaged muscle tissue.
   B is secreted at a slower rate because the fight–flight–freeze response slows kidney function.
   C helps to direct energy to the immune system so the body can withstand disease or injury.
   D is diverted to the skeletal muscles.

4 Define the relaxation response and identify its two functions.

5 What is cortisol?

6 Explain how too much cortisol in your bloodstream can impact on your health.

2.3 FOCUS ON RESEARCH

HOW STRESS CAN LEAD TO INEQUALITY

A study carried out by scientists at Switzerland's Ecole Polytechnique Fédérale de Lausanne shows how stress could actually be both a consequence and a cause of social and economic inequality, affecting our confidence to compete with others and make financial decisions. The research also shows how cortisol levels in the bloodstream may contribute to this inequality.

Stress and confidence

To test the effect of stress on confidence, more than 200 people were recruited to take two online tests: one to assess their IQ, and one to measure their *trait anxiety* (how prone a person is to see the world as threatening and worrisome). A week later, about half of the study's participants underwent a standard psychological procedure designed to cause acute social stress, such as going through a mock job interview and performing mental arithmetic tasks before an expressionless audience. The other half of the participants did not undergo the stress-inducing procedure. All participants were then given two options in a game where they could win money: they could either take their chances in a lottery, or they could use their IQ score to compete with that of another, unknown participant's; the one with the higher IQ score would be the winner.

In the non-stressed group, approximately 60 per cent of participants chose the IQ score competition over the lottery, showing overall high confidence in the participants, regardless of their trait anxiety scores. But in the group that experienced stress before the money game, the competitive confidence of participants varied depending on their trait anxiety scores. In people with very low anxiety, stress actually increased their competitive confidence compared to their unstressed counterparts; in highly anxious individuals, it dropped.

The findings suggest that stress affects a person's competitive confidence by raising or suppressing an individual's confidence depending on their predisposition to anxiety. When stressed, people with low trait anxiety experience a boost in competing confidence. People with high trait anxiety experience less competing confidence when stressed.

Stress and cortisol

The researchers also found that the effects of stress on confidence were influenced by the hormone cortisol, which is normally released from the adrenal glands in response to stress. The team examined saliva samples from stressed participants for the presence of cortisol. In people with low anxiety, those that showed higher confidence also showed a higher cortisol response to stress. But in highly anxious people, high cortisol levels were associated with lower confidence, which suggests that the behavioural effects of stress are linked to a biological mechanism.

The findings of this experiment can be seen as a simulation of confidence in social competition and the way it relates to socioeconomic inequality. Studies have shown that, in areas with wide socioeconomic inequality (e.g. a wide rich–poor gap), people on the low end of the social ladder often experience high levels of stress as a consequence. 'People often interpret self-confidence as competence,' says Carmen Sandi, leader of the research team. 'So if the stress of, say, a job interview, makes a person over-confident, they will be more likely to be hired – even though they might not be more competent than other candidates. This would be the case for people with low anxiety.'

The results suggest that far from being only a product of competitive inequality, stress must now also be regarded as a direct cause of it. In other words, stress can become a major obstacle in overcoming socioeconomic inequality by trapping highly anxious individuals in a self-perpetuating loop of low competitive confidence.

Source: Adapted from Ecole Polytechnique Fédérale de Lausanne. (2015, February 18). How stress can lead to inequality. *ScienceDaily*.

QUESTIONS

1 What was the aim of this study?
2 Identify the IV and DV.
3 Using dot points, outline the method.
4 What were the results of the study?
5 What conclusion(s) can be drawn from the study?

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STRESS AS A PSYCHOLOGICAL PROCESS

Psychologically, stress has a range of cognitive, emotional and behavioural effects. When we are stressed, especially if the stress is intense and prolonged, cognitive functions such as perception, thinking, attention, memory and learning are negatively affected. Instead of thinking logically and rationally, we may become confused and indecisive. Our sense of being under threat by the stressor and our lack of confidence in our ability to manage the stressor may be magnified to the point where we become dysfunctional and unable to complete our normal daily activities. We may find it difficult to focus our thoughts and solve problems. Our emotions may become unbalanced and difficult to control and we may experience an increase in negative moods such as frustration, grief, anxiety, apathy, anger and aggression. Some people may also experience panic attacks and feelings of hopelessness and helplessness. Stress may also bring about a range of negative behavioural changes, such as disrupted sleeping patterns, avoiding people or situations by withdrawing from social activities, and an increase in maladaptive behaviours such as drug and alcohol abuse, or eating too much or too little.

FIGURE 2.19 People who are stressed for prolonged periods often feel overwhelmed by their circumstances. They find it difficult to think logically and rationally and manage their emotional responses.

PSYCHOSOMATIC ILLNESS

Negative emotions that result from stress can build up and make a current illness worse or result in a **psychosomatic illness**, which is a real physiological illness that results from psychological factors, such as stress. Psychosomatic illnesses occur because during situations of prolonged stress the activity of the immune system is depressed. When this happens, viruses, bacteria and other disease-causing agents can easily attack the body. For example, a lowered immune level may allow a dormant herpes virus to erupt or cancer cells to multiply. Figure 2.20 summarises possible effects of stress on the body.

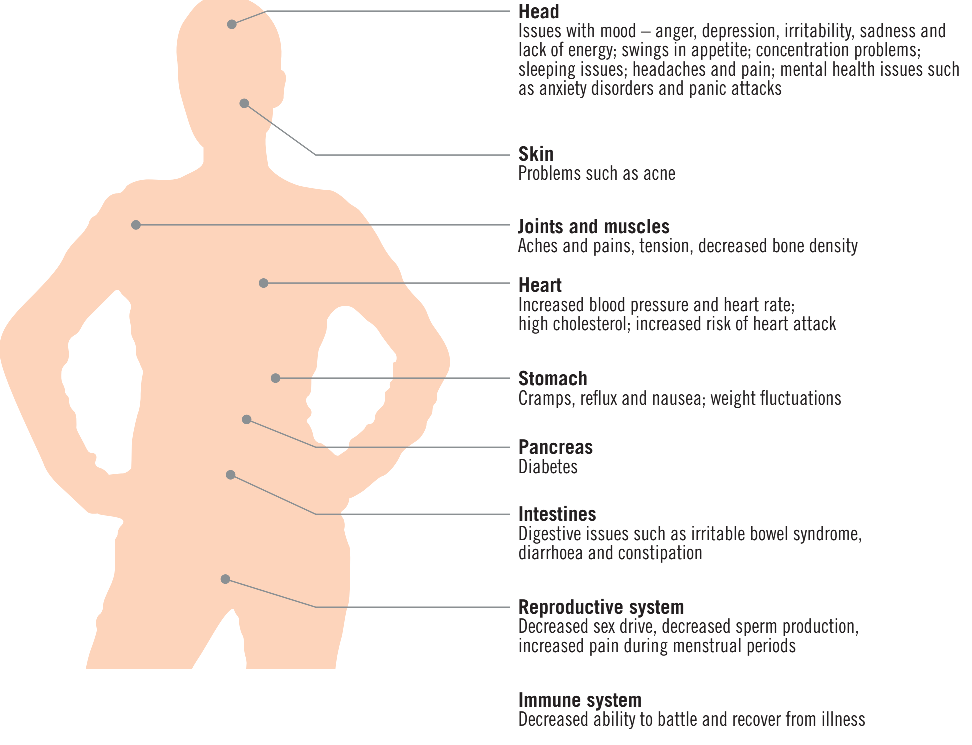

FIGURE 2.20 The effects of stress on the body

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Table 2.1 outlines some of the warning signs of someone having a physiological or psychological response to stress.

TABLE 2.1 Warning signs of stress

EMOTIONAL SIGNS	» Anxiety » Apathy » Irritability » Mental fatigue » Excessive worry about illness
BEHAVIOURAL SIGNS	» Avoidance of responsibilities and relationships » Extreme or self-destructive behaviour » Self-neglect » Poor judgement
PHYSICAL SIGNS	» Exhaustion » Frequent illness » Overuse of medicines » Physical ailments and complaints

Source: Doctor & Doctor, 1994

LAZARUS AND FOLKMAN'S TRANSACTIONAL MODEL OF STRESS AND COPING

In 1984, Richard Lazarus and Susan Folkman introduced a model that explained the mental process, or cognitive appraisal, which influences our response to stressors. This model, referred to as the **transactional model of stress and coping**, proposes that stress is a subjective experience that varies between individuals depending on how they interpret the stressor and perceive their own ability to cope with it. The transactional model focuses on how a person interacts with their external environment and stress is viewed as the result of how a person appraises (evaluates) a situation and their abilities to cope with it. According to this model, stress is experienced when there is an imbalance between the demands of a situation and the person's evaluation of their ability to cope with these demands. Stress is experienced if the demands on an individual exceed their perception of their coping resources, even if that stressor is not life-threatening or it poses only a perceived (not an actual) threat. Unlike Selye's biological explanation of the stress response, Lazarus and Folkman suggest that stress responses are directed by our cognitive appraisal of the stressor as either a challenge or a threat and also by our assessment of the personal and social resources we have to cope with the stressor. In other words, our stress response depends on emotions and psychological factors unique to the individual.

In this model, Lazarus and Folkman suggest that the psychological stress response is a two-way process that comprises a transaction between an individual and their environment. It involves the production of stressors by the environment and the subjective response, or cognitive appraisal, an individual makes about their ability to cope with these stressors. The process of cognitive appraisal consists of two sequentially linked stages: primary and secondary appraisal.

PRIMARY APPRAISAL: HOW SIGNIFICANT AND THREATENING IS THE EVENT?

In the initial stage of **primary appraisal** the person evaluates the severity of the stressor's impact on their situation and the potential threat it poses. They may judge the stressor to be insignificant and of little relevance. Or, they may judge it to be benign (positive). Alternatively, they may judge the stressor to be significant and relevant in terms of the harm it has already done to them and the potential threat or the challenge it poses for the future. For example, someone who is 20 years old and has limited social and financial support may appraise an unexpected pregnancy as a threat, while someone who is 40 years old with adequate financial and social support might appraise their unexpected pregnancy as an exciting challenge. A stressor that is perceived as important is more likely to cause a stress reaction than a stressor that is viewed as relatively trivial. The process of primary appraisal then leads to a process of secondary appraisal.

psychosomatic illness Physiological symptoms that arise as a result of psychological stressors or factors

transactional model of stress and coping A model that proposes that stressful experiences are a transaction between a person and their environment; if demands exceed resources, stress is the likely result

primary appraisal In the transactional model of stress and coping, when we decide if a situation is threatening or positive, relevant or irrelevant to our situation

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SECONDARY APPRAISAL: HOW CAN I COPE WITH THE EVENT?

During **secondary appraisal** we assess what internal and external resources are available to us in terms of coping with the situation so we can create a more positive environment and we determine the best method of managing it. For example, do we have the personal skills (such as knowledge, skills, energy and motivation) required to cope with the demands of the stressor; do we have the necessary external resources (such as money, time or social supports); what are our options and what is the possibility of controlling the situation? If we believe we lack the resources to cope, we will make a negative secondary appraisal and experience stress. Alternatively, if we believe we have the necessary coping resources, we will make a positive secondary appraisal. We will not feel overwhelmed and we may *reappraise* the stressor as being less significant and less threatening. For example, some people may experience stress if they were asked to deliver a speech at a school assembly. Initially, they may feel threatened and lack confidence in their public speaking ability. However, if they remember that they enjoy performing in front of an audience, they may reappraise the situation and decide public speaking is a manageable challenge. Therefore, how we appraise public speaking relative to our perceived resources will affect how we react to it.

Lazarus and Folkman's model is useful because it distinguishes between eustress and distress, and it acknowledges that stress is a subjective experience. By recognising that different individuals have different responses to stress, it helps us understand the role personal interpretation and appraisal play in the stress response. It also highlights that people can change their appraisal of a stressor and their response to it, therefore the individual plays an active role in their stress response. Unlike Selye's biological model of stress, the transactional model considers the role a range of psychological factors such as personality, motivation, confidence and sense of self play in the stress response. However, because it does not consider the automatic physical responses the body has to a stressor, it has been criticised as being too simplistic. Also, because of its subjective nature and the variability of individual responses, Lazarus and Folkman's model is also difficult to test through experimental research. Some critics also point out that it is difficult to separate primary and secondary appraisal, and they suggest that secondary appraisal actually happens simultaneously with primary appraisal.

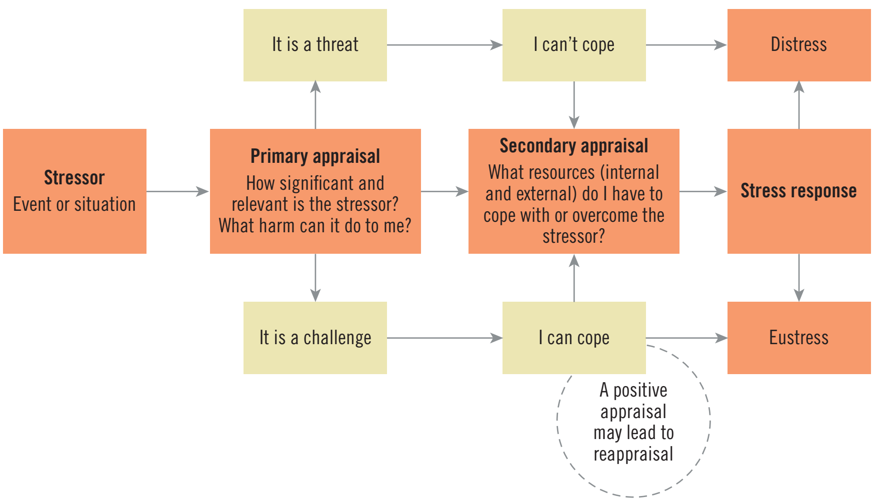

FIGURE 2.21 How we appraise a situation or event influences the type of stress we experience, how much stress we experience and how effectively we respond to a stressor. If, during primary appraisal, we appraise the stressor as a threat, we experience distress. If we appraise it as a challenge, we experience eustress. If we appraise it as neither, we experience no stress at all.

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2.1 TRY IT YOURSELF >>

APPRAISING YOUR STRESSORS

Lazarus and Folkman's transactional model of stress and coping states that stress is about how we appraise the situation.

- List 10 things that have created stress for you in the last week.
- Investigate how each stressor was appraised and how it could have been appraised differently, if necessary.

QUESTIONS

1 What sort of resources could have enabled you to interpret the stressor as a challenge rather than a strain?

2 Is it likely that you will appraise the same situation in the same way in the future? Why or why not?

2.7 CHECK YOUR UNDERSTANDING >>

1 According to the transactional model of stress and coping, the two processes that individuals undergo during a stress response are:

A shock and countershock.

B alarm and resistance.

C primary and secondary appraisal.

D eustress and distress.

2 Which of the following is an example of secondary appraisal according to Lazarus and Folkman's transactional model of stress and coping?

A Evaluating the stressor as either a threat or a challenge

B Evaluating the stressor as either significant and relevant or insignificant and irrelevant

C Evaluating the demands of the stressor

D Evaluating the resources available for managing the stressor

3 Lazarus and Folkman suggested that deciding whether a situation is stressful occurs during:

A sympathetic nervous system activation.

B primary appraisal.

C secondary appraisal.

D reappraisal.

4 According to Lazarus and Folkman, primary and secondary appraisal are different because:

A primary appraisal involves deciding whether the stressor is relevant or irrelevant; secondary appraisal involves deciding whether the stressor represents a threat or challenge.

B primary appraisal evaluates how effective the person's coping resources will be; secondary appraisal evaluates whether the stressor represents a threat or challenge.

C secondary appraisal evaluates how effective the person's coping resources will be; primary appraisal evaluates whether the stressor represents a threat or challenge.

D primary appraisal is a conscious process; secondary appraisal is an unconscious process.

5 As a model to explain the stress response, how does Lazarus and Folkman's transactional model of stress and coping differ from Selye's general adaptation syndrome model?

6 According to Lazarus and Folkman, what part does appraisal play in the stress response?

7 Identify two strengths of the transactional model of stress and coping.

STRESS MANAGEMENT TECHNIQUES: LEARNING TO COPE

No-one is immune to stress; it is an integral part of our lives. Obviously the simplest way of coping with stress is to modify or remove its source, but this is often impossible, which is why learning to manage stress is so important.

CONTEXT-SPECIFIC EFFECTIVENESS AND COPING STRATEGIES

Contextual factors, or the set of circumstances or facts that surround a particular event, influence whether or not we perceive a stimulus as a stressor and the intensity of the stress experienced. For example, if a person is coping with a divorce, how they are adapting depends on the specific aspect of the divorce that is being referred to. Context and an individual characteristic (for example, personality) both influence a person's perception of a stressor and their coping ability. For example, the perception of stressors varies between athletes competing in different sports. Some studies have shown that rugby athletes seem to be particularly worried about sustaining injuries (Nicholls, Holt, Polman, & Bloomfield, 2006), whereas golfers are concerned about changing weather conditions (Nicholls, Holt, Polman, & James, 2005).

Change and the stress associated with adapting to it are a part of our everyday experience and, although it is impossible to eliminate stress in your life, you can learn to manage it. In order to survive, we are continually required to adapt our behaviours so we can manage the demands of our changing environment and maintain a good level of health and wellbeing. In other words, we are required to cope.

secondary appraisal In the transactional model of stress and coping, when we assess what resources are available to us to help combat or cope with the stressor

contextual factors The set of circumstances or facts that surround a particular event and influence whether or not we perceive a stimulus as a stressor and the intensity of the stress experienced

Coping is a process involving constantly changing thoughts and behaviours so we can manage the demands (internal and/or external) of stressors we appraise as taxing or exceeding our resources (Lazarus & Folkman, 1984). While our body has an innate stress response in terms of the fight–flight–freeze response, our coping response must be learnt. If we are going to effectively cope with stress and maintain good health and wellbeing, we must develop a set of coping skills. Coping skills consist of behaviours or techniques that help us solve problems or meet demands. Generally, coping does not consist of a single response, but a series of responses that are repeated in order to handle the remaining, continuing or changed nature of a stressor (Snyder, 2001). Coping is a complex process that varies according to the demands of the stressor, the individual's appraisal of the situation, and the personal and social resources available.

Research into stress and its effects demonstrates that coping is a crucial determinant of psychological wellbeing. Just as there is more than one way to peel an orange, there is more than one way to cope with stress, and how effectively we cope largely depends on the types of coping strategies we choose. A coping strategy consists of the behavioural and psychological responses a person makes to a stressor that are intended to manage the stressor and reduce the physical and psychological stress related to it. So, if we are to cope with stress, we need to develop coping skills so that we can formulate and enact an effective coping strategy.

Coping strategies are considered to be constructive and adaptive if they help to minimise the effects of the stressor so that we can function effectively even though the stressor remains. The effectiveness of the strategy depends on the type of stressor, the particular individual and the circumstances or context related to the stressful situation. Effective strategies do something to alleviate stressful circumstances or regulate the emotional consequences of the stressor. If a coping strategy does not reduce the effects of the stressor, it is ineffective. If we continue to apply it, it is also considered to be destructive and maladaptive because it does not help us deal with the stressor and it often intensifies its effects. However, to be effective, the strategy needs to be consistent with the event's actual level of controllability, and the degree of impact the event has on the individual's wellbeing. Thus, to deal with the broad variety of stressors encountered in modern life, no single style of coping strategy is adaptive across all stressful situations. In contrast, being flexible in using these strategies contributes to resilience (Bun Lam & McBride-Chang, 2007).

COPING WITH STRESS: FLEXIBILITY IS THE KEY

The degree to which a coping strategy or combination of strategies is or are successful in alleviating stress is known as coping effectiveness. Effective coping is achieved when the situation has been appraised accurately and appropriate coping strategies are used. When an appropriate coping style is used, positive emotion can occur even when depression and distress are frequent (Folkman & Moskowitz, 2004). A failure, however, to effectively cope with stress may lead to psychological problems.

To cope effectively, a person must demonstrate that they have coping flexibility. Coping flexibility refers to an individual's ability to stop an ineffective coping strategy (or evaluate their coping process) and implement an alternative effective coping strategy (or adapt their coping process). Coping flexibility is a strong predictor of psychological health. Coping flexibility is a measure of a person's adaptive ability. It determines the extent to which a person can cope with changes in their circumstances and how creative they can be in using available resources to manage their stress.

Coping flexibility includes three components: cognitive flexibility, situation-strategy fit and goal attainment (Cheng, 2001). *Cognitive flexibility* refers to the degree to which an individual's cognitive appraisals of controllability vary across situations and it involves their evaluation of what they could or should think or do when faced with a stressor. *Strategy-situation fit* refers to the degree to which the coping strategy used fits the nature of the situation. *Goal attainment* refers to the degree to which an individual's goals are achieved by the coping strategies used.

Stress research suggests that people who have learnt a variety of different coping skills generally handle demands and solve problems more easily and effectively than those who have not. They are less likely to experience distress and more likely to be confident in their coping ability. Coping flexibility has been shown to have a number of health benefits. These include higher levels of positive adjustment and lower levels of symptoms of burnout, decreases in the severity of anxiety symptoms and increases in quality of life (Cheng, 2003; Cheng &

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Cheung, 2005; Gan, Shang, & Zhang, 2007). Coping flexibility is also associated with a decreased likelihood of experiencing increases in depressive symptoms following the occurrence of stressful life events. On the other hand, lower levels of coping flexibility have been found to predict increases in depressive symptoms over time (Fresco, Williams, & Nugent, 2006).

2.8 CHECK YOUR UNDERSTANDING >>

1 Which of the following factors would improve coping?
   A Social support
   B Optimism
   C Perceived control
   D All of the above
2 A person's efforts to control, reduce or learn to tolerate the threats that lead to stress are known as:
   A coping.
   B avoidance strategies.
   C approach strategies.
   D coping effectiveness.
3 Coping effectiveness refers to:
   A the degree to which a coping strategy or a combination of strategies is successful in alleviating stress.
   B the responses a person makes to a stressor that are intended to manage it or reduce the stress related to it.
   C the ability to identify and replace an ineffective coping strategy with an alternative.
   D the set of circumstances associated with a particular event that influence whether or not the event is perceived as a stressor.
4 How do psychologists define coping?
5 Explain why one coping strategy may be effective in dealing with one stressor but not with a different stressor.
6 Explain why some coping strategies could be considered maladaptive.

PHYSICAL EXERCISE

Much of the immediate discomfort of stress is caused by fight–flight responses. When we are stressed, the body is ready to act, often with tight muscles and a pounding heart. If action is prevented, we remain 'uptight'. Physical exercise, therefore, is a sensible and natural way to restore our body and mind to a calmer, more relaxed state. Physical exercise does not remove or reduce a stressor, but health professionals encourage regular physical exercise as a coping strategy because it prepares your body and mind to cope with stress. Physical exercise provides an outlet and release for the physical stress response by releasing the build-up of muscular tension that occurs when we are stressed. Physical exercise is any planned, structured or repetitive bodily movement produced by skeletal muscles that requires energy expenditure and aims to improve or maintain physical fitness (WHO, 2015).

Physical benefits

Regular exercise has a positive impact on a number of aspects of physical functioning, such as hormone levels, circulation and muscle tone. It improves your physical condition and increases your energy levels, strengthens your immune system and lowers your risks for disease. It also helps you recover from injury and is effective in reducing physical damage caused by stress-based arousal (Forcier et al., 2006). Exercise helps to maintain a healthy resting heart rate and respiratory rate, blood pressure level and core temperature threshold for sweating. When we are stressed, levels of hormones such as cortisol and norepinephrine are released into the blood stream to help arouse and energise us so we are physically prepared to face the stressor. If these levels remain high, they can have potentially damaging effects on our body. When energy normally directed to our immune system is diverted to areas of the body needed to cope with the immediate threat, our immune system becomes compromised. Physical exercise helps our body to deplete the levels of these stress hormones, thereby boosting the body's immune level. In addition, physical exercise relaxes tense muscles and tissue, so they help to reduce stress-related aches and pains such as neck and back pain and headaches.

Psychological benefits

As a stress management technique, physical exercise has also been shown to have a number of psychological benefits. For example, it promotes a positive mood because the repetition of body movements involved

coping A process involving constantly changing thoughts and behaviours so we can manage the demands (internal or external) of stressors we appraise as taxing or exceeding our resources

coping skills Learnt behaviours or techniques that help us solve problems or meet the demands of a stressor

coping strategy The behavioural and psychological responses a person makes to a stressor that are intended to manage the stressor and reduce the physical and psychological stress related to it

coping effectiveness The degree to which a coping strategy or combination of strategies is successful in alleviating stress

coping flexibility The ability to stop an ineffective coping strategy (or evaluate the coping process) and implement an alternative effective coping strategy (or adapt the coping process)

physical exercise Any planned, structured or repetitive bodily movement produced by skeletal muscles that requires energy expenditure and aims to improve or maintain physical fitness

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BENEFITS OF PHYSICAL EXERCISE

PHYSICAL

- Depletes the body of excess stress hormones (e.g. cortisol) and strengthens the immune system
- Reduces risk of illness and disease and assists with recovery from injury
- Helps maintain a healthy heart rate, respiratory rate, blood pressure level and core temperature for sweating
- Relaxes tense muscles and tissue, so helps to reduce aches and pains
- Promotes the release of serotonin and endorphins

PSYCHOLOGICAL

Cognitive

- Reduces mental fatigue
- Improves alertness and concentration
- Reduces stress-related anxiety

Emotional

- Promotes a positive mood because of increased levels of serotonin and endorphins

SOCIAL

- If done in the company of others, increases social contact, which can reduce feelings of loneliness and provide social support

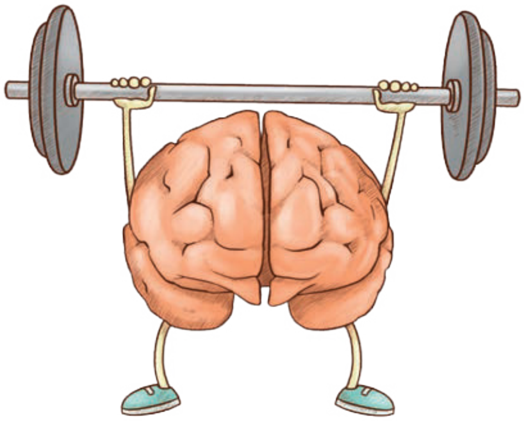

FIGURE 2.22 Regular physical exercise helps to maintain good physical and mental health.

in exercises such as running, swimming and walking allows a person to focus on a single activity. If a person is focused on their breathing, they are temporarily distracted from thinking about their problems. This has a calming effect, which is why people often feel relaxed and experience a more positive mood after they have exercised.

Physical exercise also promotes the release of mood-lifting chemicals, such as serotonin and endorphins, which help us cope with the psychological and social pressures associated with stress more effectively. Endorphins, often referred to as the 'happy hormones', are a group of neurotransmitters that help to combat the negative effects of stress by producing a positive mood state by promoting feelings of euphoria. Endorphins make us feel better because they provide natural pain relief, help regulate appetite, impact on the release of different sex hormones, improve sleeping ability and enhance our immune response. Endorphins are released approximately 30 minutes after you begin exercising. Because endorphins have a positive effect on our functioning, health professionals encourage people to exercise at least three times a week.

Exercise also has cognitive benefits. It improves alertness and concentration, it reduces mental fatigue and it is also believed to help people cope with stress-related anxiety and depression. Individuals who suffer from depression often have low serotonin levels, a neurotransmitter involved with controlling appetite, sleep patterns, memory and mood. Because exercise elevates levels of serotonin in the brain, their mood is more positive. They are more optimistic, they have an improved sense of control and self-esteem, and they feel they are better able to deal with their stressors (Sadock & Sadock, 2003). If done with other people, physical exercise can also provide social support and reduce feelings of loneliness that may be associated with stress. Physical exercise does not remove or reduce the stressor, but it is considered to be a positive coping strategy because it helps your body and mind cope with the stressor in a more effective manner.

EFFECTS OF EXCESSIVE (OR COMPULSIVE) EXERCISE

While health professionals encourage regular physical exercise as a coping strategy for stress, they caution against over-exercising because of its negative physical and psychological effects. Excessive (or compulsive) exercising occurs when an individual repeatedly exercises beyond the requirements of what is considered safe. The risks of over-exercising can be severe. For example, a compulsive exerciser may not be aware of dehydration or the serious effects of natural elements such as heat or cold. Excessive exercising can also lead to insomnia. Physical side effects include muscular atrophy and skeletal injuries such as shin splits, bone fractures, arthritis or damage to cartilage and ligaments. Too much exercise can lead to the release of excessive free radicals, which have been

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linked to cellular mutations and cancer. Females may cease menstruation, a condition called amenorrhea.

Over-exercising can also have a number of negative psychological and social side effects. For example, depression, fatigue and anxiety are common side effects of compulsive exercising. A person may also notice a deterioration in their personal relationships. Social isolation is common among those exercising compulsively because all available time is scheduled for physical activity, usually alone. They may become frustrated at not being able to exercise, which may also affect their social life and work or school performance. If an already stressed individual over-exercises, the negative side effects of their behaviour may add to their original stress level rather than alleviate it.

Psychologists who study stress refer to two basic models of coping with stress to describe the cognitive and emotional activity we engage in, which either make us more susceptible or less susceptible to a stressor. These strategies are described as *approach* or *avoidance strategies*.

2.9 CHECK YOUR UNDERSTANDING >>

1 Physical exercise is considered to be a positive way of coping with stress because:
   - A it helps to minimise the stressor.
   - B it increases physical and psychological energy needed to cope with the stressor.
   - C it reduces the amount of endorphins and seratonin in the bloodstream.
   - D it reverses the fight–flight response.

2 Serotonin:
   - A is a mood-enhancing hormone that helps to calm a stressed person.
   - B helps repair damage to muscles that may occur when attempting to cope with a stressor.
   - C helps to arouse and energise the body so it is prepared to deal with a stressor.
   - D can compromise the immune system if levels are too high in the bloodstream.

3 Endorphins:
   - A are released into the bloodstream when the sympathetic nervous system is activated.
   - B improve our cognitive and emotional ability to deal with a stressor.
   - C help to reduce the severity of the stressor.
   - D have no impact on our stress response.

4 What do health professionals mean by 'physical exercise'?

5 Explain the link between physical exercise and endorphins.

6 Why do health professionals recommend physical exercise as a way of coping with stress?

APPROACH STRATEGIES

Approach strategies target the stressor or the response to the stressor in practical ways. They consist of behavioural or psychological responses designed to change (remove or diminish) the nature of the stressor or how one thinks about it. Approach strategies help us adapt to the changes and demands a stressor introduces so that living with it becomes tolerable. Approach strategies are considered to be active strategies because they involve an awareness of the stressor, followed by attempts to reduce the negative outcome of the stressful situation. They require a person to directly confront the stressor, make a realistic appraisal of it, evaluate alternative courses of action, recognise and change any unhealthy emotional responses they may have to it, and do something to try to prevent any adverse effects it may have on them physically or psychologically. Examples include seeking support from others, making plans to deal with the stressor, seeking information about the stressor and goal setting (Littleton, Horsey, John, & Nelson, 2007).

Approach strategies are considered to be the most effective way of coping with stress. By attempting to cope with a stressor, the individual gains a sense of control over their situation which leads to a feeling that they can manage it. Approach strategies also allow people to practise problem-solving, which may be of use when confronted with future stressors (Min, Farkas, Minnes, & Singer, 2007). Approach strategies can be either problem-focused or emotion-focused.

Problem-focused strategies

Problem-focused strategies directly target the stressor and they aim at reducing the stressor. These strategies include seeking information about the stressor and reappraising its significance, making a plan of action, learning new skills to deal with the stressor, and concentrating on the next step to manage or resolve

serotonin A neurotransmitter found in the CNS; involved in the regulation of pain, mood and sleep

endorphins A group of neurotransmitters that help to combat the negative effects of stress by producing a positive mood state and promoting feelings of euphoria

excessive (compulsive) exercising Repeatedly exercising beyond the requirements of what is considered safe

approach strategies Practical stress management strategies that consist of behavioural or psychological responses designed to change (remove or diminish) the nature of the stressor or how one thinks about it

problem-focused strategies Approach strategies that directly target the stressor and aim to reduce it

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the stressor. Problem-focused approaches will not work in situations where the stressor is beyond the individual's control. For example, when someone dies, problem-focused strategies may not be effective in reducing the sense of loss or stress experienced by the bereaved person. They work best when the person can control the source of stress. For example, you may feel stressed by the thought of your final exams. If you implement a regular study program, you may become more confident in your abilities and this may reduce your stress.

Emotion-focused strategies

Emotion-focused strategies are aimed at managing the emotional distress by changing the unpleasant emotions associated with the stressor, such as embarrassment, fear, anxiety, depression, excitement and frustration. These strategies help us feel better but they don't solve the source of our distress. They are generally used when we feel a situation is uncontrollable, so we cannot change the stressor (Littleton et al., 2007). Some research suggests that emotion-focused coping may be particularly effective when the stressor is outside the person's control and cannot be altered, and in the immediate aftermath of the stressor (Reynolds et al., 2000). However, although emotion-focused strategies may be our only realistic option when faced with some stressors, because they fail to deal with the stressor itself and because they do not provide a long-term solution, they are often less effective than problem-focused strategies in relation to health outcomes (Penley, Tomaka, & Wiebe, 2002).

Positive emotion-focused strategies include disengaging from emotions related to the stressor, seeking emotional support from others, meditation, expressing emotions creatively and venting emotions. Negative strategies include denial, oversleeping, substance abuse, overeating, shifting blame to others or just giving up dealing with the situation altogether.

AVOIDANCE STRATEGIES

Avoidance strategies involve choosing your response to a stressor based on trying to either cognitively or behaviourally avoid or escape painful or threatening thoughts, feelings, memories or sensations associated with the stressor. They are used when we feel we have little or no control over our situation and we feel we cannot manage it. Typical examples of avoidance strategies include withdrawing from others, denying the stressor exists, disengaging from one's thoughts and feelings about the stressor, and self-destructive behaviour (Littleton et al., 2007). These strategies can involve doing something (for example, someone who excessively washes their hands to try to avoid possible contamination from germs) or not doing something (for example, when someone avoids a person because they don't want to have an awkward conversation), but they do not involve the person directly confronting the stressor.

Avoidance coping strategies are also typically ineffective because they don't encourage people to seek social support or engage in problem-solving activities (Min et al., 2007). Research consistently shows that less adaptive avoidant coping responses

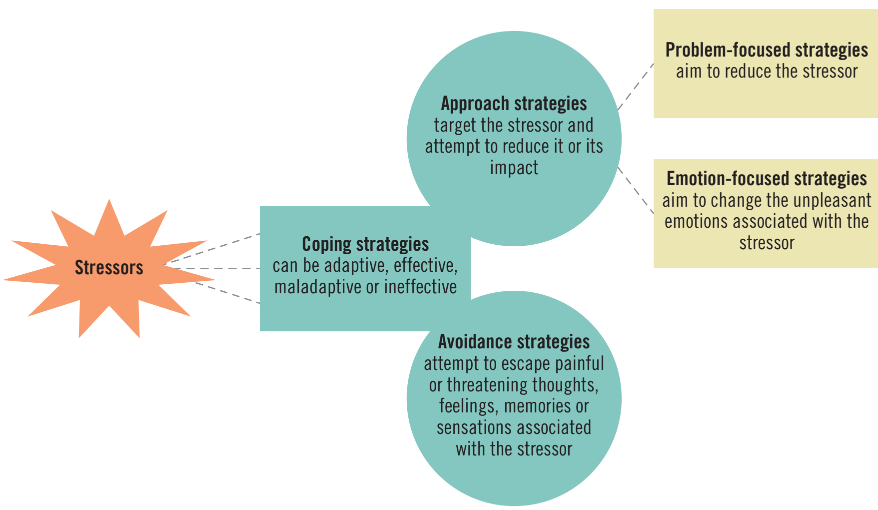

FIGURE 2.23 Coping strategies involve the behavioural and psychological responses a person makes to a stressor that are intended to manage it and reduce the physical and psychological stress related to it. These strategies can be adaptive, effective, maladaptive or ineffective.

contribute to poorer health outcomes (Futa, Nash, Hansen, & Garbin, 2003) and suggests that avoidance coping is the strongest predictor of adverse future wellbeing (Gibbons, Dempster, & Moutray, 2011). The manner in which individuals react to or cope with stressful situations influences the long-term impact of those stressors, and differences in coping are important contributors to psychological adjustment (Min et al., 2007).

Avoidance coping is also considered to be a maladaptive coping mechanism because it does not attempt to defeat the stressor. It can be counterproductive because it may lead to activities (for example, excessive alcohol consumption or binge eating) or mental states (for example, withdrawal) that keep the person from confronting their stressor or successfully adapting to future stressful events. While avoidance strategies may decrease psychological stress in the short term, they generally add to long-term stress because the underlying problem remains unsolved. Instead of alleviating a person's stress, avoidance strategies generally maintain or increase the stress. They do not provide a person with any sense of control over their stressful situation and research suggests that they often lead to a further lack of self-confidence and self-esteem when dealing with future stressors. For example, if coping strategies adopted during childhood, such as withdrawal and a tendency to dissociate, are used in adulthood, they can impair a person's ability to develop more adaptive social, cognitive and emotional coping mechanisms needed for the successful handling of stressful situations in adult life (Briere, 2002).

Whether we choose one type of strategy over another will be determined partly by our personality and also by the type of stressful event and our appraisal of it. However, using approach strategies, while reducing the use of avoidance coping, may lead to a decline in stress (Kao & Craigie, 2013).

2.10 CHECK YOUR UNDERSTANDING >>

1 Which of the following is an example of a problem-focused coping strategy?
   - A Getting drunk to alleviate your stress
   - B Seeking practical or informational support to alleviate your stress
   - C Praying for help to alleviate your stress
   - D Seeking emotional support to alleviate your stress

2 Which of the following is an example of an emotion-focused coping strategy?
   - A Getting drunk to alleviate your stress
   - B Praying for help to alleviate your stress
   - C Denying that the stressor exists
   - D Avoiding friends and family

3 Abdul decides not to walk the same way to school to avoid some students who have bullied him in the past. Which coping strategy is Abdul using?
   - A Emotion-focused strategy
   - B Problem-focused strategy
   - C Avoidance strategy
   - D Approach strategy

4 Explain the difference between an approach coping strategy and an avoidance coping strategy as a means of coping with stress.

5 Explain two reasons why avoidance strategies are considered to be less effective strategies for coping with stress than approach strategies.

emotion-focused strategies Approach strategies aimed at managing the emotional distress caused by a stressor by changing the unpleasant emotions associated with it

avoidance strategies Stress management strategies that involve choosing your response to a stressor based on trying to either cognitively or behaviourally avoid or escape painful or threatening thoughts, feelings, memories or sensations associated with the stressor

CHAPTER SUMMARY

Stress as a psychobiological process

- Stress is a state of mental or physical tension that occurs when an individual must adjust or adapt to their environment but they do not feel they have the capacity to do so. Psychologists consider stress to be a psychobiological process because it involves an interaction of predictable bodily reactions to a stressor with psychological factors that are unique to the individual.
- Although the physical results of stress are always the same, psychological factors determine whether we experience eustress (a positive psychological response to a stressor) or distress (a negative psychological response to a stressor). Stress can also be acute (short-term and harmless) or chronic (prolonged and harmful).

Sources of stress

- Stress can come from a variety of sources. For the individual these include daily pressures or the minor but disruptive events that annoy us on a daily basis; life events that require significant change in our behaviour; and acculturation, or the stresses associated with migrating to a foreign country. Major stress can also be experienced by whole communities when a catastrophe occurs. Individuals who experience major stress often develop post-traumatic stress disorder (PTSD).

The biological model of stress

- The stress response occurs as a result of our sympathetic nervous system automatically activating when we perceive a threat. This triggers the fight–flight response, which is characterised by a chain of physiological changes that increase our arousal level and energise us so that our body is prepared for action.
- The biological model is based on Hans Selye's 1956 theory of the stress response, which he called the general adaptation syndrome (GAS), the body's three-stage physiological response to a stressor. The stages of the GAS are (1) alarm-reaction stage, (2) resistance and (3) exhaustion. Selye proposed that our stress response was a physical response that helped us automatically adapt to a changing environment by preparing our body to either fight a stressor or escape to safety. This is known as the fight–flight response.
- Later researchers also added a third stress response option: the freeze response. This occurs in situations where we feel helpless because we feel we can neither fight or escape the threat, so we become temporarily immobilised or 'frozen'.

The psychological model of stress

- Lazarus and Folkman suggested that stress is a subjective experience that varies between individuals depending on how they interpret the stressor and perceive their own ability to cope with it. Their theory states that the psychological stress response has two parts: primary appraisal (where we evaluate the severity and significance of the threat) and secondary appraisal (where we evaluate the resources available to cope with the threat). The result of these appraisals determines the type and severity of stress we experience.

Stress management techniques

- As a result of life's experiences, we encounter stress. If we cannot remove a stressor from our life, we can learn to cope with it. Coping strategies include physical exercise and approach or avoidance strategies.
- To be effective, a coping strategy must be suited to the specific stressful conditions. This means that no single strategy will work in all stressful situations. Therefore, we need to be flexible in our choice of coping strategy.
- Regular physical exercise is a positive coping strategy because it has a positive impact on a number of aspects of our physical and psychological functioning. Physical exercise does not remove or reduce the stressor but it helps your body and mind cope with the potentially debilitating effects of stress in a more effective manner.
- Approach strategies attempt to directly deal with the stressor so they are action-driven. They aim to remove or reduce the stressor (problem-focused strategies) or reduce the negative emotions associated with it (emotion-focused strategies). Approach strategies are considered to be healthy and adaptive ways of managing stress.
- Avoidance strategies do not attempt to confront the stressor. They are driven by a desire to escape from the negative emotions associated with the stressor. Avoidance strategies are considered to be unhealthy, maladaptive ways of managing stress.

APPLY YOUR KNOWLEDGE AND SKILLS

SECTION A: MULTIPLE-CHOICE QUESTIONS

Answer the following questions by writing the correct letter in your workbook. Only one answer is correct for each question.

1 Which of the following statements is true?

A The stress response is considered to be a non-specific psychological response.

B Different types of stressors produce the same response.

C Different people may respond to the same stressor differently.

D All of the above

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2 According to Hans Selye, distress is:
- **A** positive or negative.
- **B** the result of internal stressors.
- **C** the result of external stressors.
- **D** unpleasant and objectionable.

3 Acute stress is the most common form of stress. Which of the following situations can cause acute stress?
- **A** Inadvertently sending your car into a skid
- **B** Skiing downhill on a difficult slope
- **C** Making a presentation before a roomful of people
- **D** Any of the above

4 The feelings of tension and anxiety that occur when an individual's ethnic identity is not easily accepted or is challenged by a dominant culture is an example of:
- **A** a daily pressure.
- **B** a life event.
- **C** acculturation.
- **D** acculturative stress.

5 The hormone that is released into the bloodstream to help repair the damage done to the body from stress is known as:
- **A** adrenaline.
- **B** cortisol.
- **C** noradrenaline.
- **D** serotonin.

6 The second stage of the general adaptation syndrome is resistance. In this stage, people:
- **A** prepare to fight the stressor.
- **B** prepare to move on to the next stage.
- **C** become aware of the presence of the stressor.
- **D** run away from the stressor in alarm.

7 According to the Yerkes-Dodson Law, higher levels of arousal:
- **A** are best when performing simple tasks.
- **B** always disrupt performance of a task.
- **C** are best for performing all tasks, whether simple or complex.
- **D** are best when performing complex tasks.

8 According to the transactional model of stress and coping, the two processes that individuals undergo when attempting to cope with stress are:
- **A** alarm and resistance.
- **B** stress and stressors.
- **C** resistance and exhaustion.
- **D** primary and secondary appraisal.

9 One evening, Russell, who was very tired, was curled up in his beanbag watching late-night television. He suddenly noticed a large spider crawling across the television screen. Immediately, Russell jumped to his feet and ran out of the room. What response was activated when Russell saw the spider?
- **A** The sympathetic nervous system response
- **B** The parasympathetic nervous system response
- **C** The autonomic nervous system response
- **D** The fight–flight response

10 During which stage of Selye's GAS is the sympathetic nervous system activated?
- **A** Primary appraisal
- **B** Alarm-reaction
- **C** Resistance
- **D** Secondary appraisal

11 According to the general adaptation syndrome (GAS), in the first stage the body produces physiological changes that accompany the fight–flight response in an attempt to resist the stressor. If the stressor is not removed at this point:
- **A** the body will enter the 'shock' phase.
- **B** the body's arousal will return to normal.
- **C** the body will maintain the fight–flight response.
- **D** adrenaline will continue to be released into the bloodstream and cortisol will stop being released.

12 The physiological arousal response in which the body prepares to combat a real or perceived threat is called:
- **A** the sympathetic nervous system.
- **B** the fight–flight response.
- **C** the alarm-reaction stage of the general adaptation syndrome.
- **D** stress.

13 Which of the following is an example of primary appraisal according to the Lazarus and Folkman's transactional model of stress and coping?
- **A** Determining the extent to which additional resources are needed to cope.
- **B** Evaluating the potential impact of the stressor.
- **C** Judging the usefulness of coping resources that are available.
- **D** Any exchange between the individual and their environment.

14 Psychologists describe coping as:
- **A** a non-specific response to a stressor.
- **B** the behavioural and psychological responses a person makes to a stressor that are intended to manage the stressor and reduce the physical and psychological stress related to it.
- **C** a process that requires a person to constantly change their thoughts and behaviour so they can manage stressors they feel they don't have the resources to deal with.
- **D** a response to a stressor based on trying to either cognitively or behaviourally avoid or escape painful or threatening thoughts, feelings, memories or sensations associated with the stressor

→

15 Will's perception of his retrenchment as being a major, significant stressor is, according to the transactional model of stress and coping:

A a primary appraisal.
B a secondary appraisal.
C the alarm-reaction stage.
D the resistance stage.

SECTION B: SHORT-ANSWER QUESTIONS

1 Explain one reason why Selye's general adaptation syndrome and Lazarus and Folkman's transactional model of stress and coping differ as explanations of the stress response.

2 What is a psychosomatic illness?

3 Explain the difference between eustress and distress.

4 Identify two factors that may contribute to acculturative stress.

5 According to Selye's general adaptation syndrome, why might a VCE student fall ill just before their final exams?

6 Explain why cortisol is released into the bloodstream when we experience stress.

7 According to psychologists, how can the immobilising effects of the freeze response to stress assist our survival?

8 Identify two limitations of Lazarus and Folkman's transactional model of stress and coping.

9 Why are approach strategies considered to be an adaptive response to stress and avoidance strategies considered to be a maladaptive response to stress?

10 If your brother is distressed because he unexpectedly lost his job, describe an approach strategy that could be effective in helping him to cope with his stress.

SECTION C: EXTENDED-RESPONSE QUESTION

A doctor of psychology and his colleagues wanted to investigate whether the coping strategies used by people who make decisions for relatives in an intensive care unit (ICU) contributes to them developing post-traumatic stress disorder (PTSD). The doctor and his team studied three coping styles for family decision-makers:

- *problem-focused* – doing something such as seeking information, making a plan and getting help or advice
- *emotion-focused* – looking for support or comfort from others, making jokes to lighten the situation or trying to see the situation in a new way
- *avoidance* – not thinking or doing anything about the situation; for example, substance abuse or simply denying the reality of the situation.

Adults who had relatives admitted to the ICU unit of a large urban hospital agreed to participate in the research. Participants were surveyed about their coping skills 3 to 5 days after their family member entered the ICU, and then 30 days later to see if their coping strategies had changed. Sixty days later, they were tested for PTSD. The results for the 80 people surveyed were as follows:

- 32 per cent of problem-focused decision-makers had clinically significant PTSD symptoms
- 28 per cent of emotion-focused decision-makers had clinically significant PTSD symptoms
- 47 per cent of decision makers who used avoidance strategies had clinically significant PTSD symptoms.

You are required to write a discussion section of a research report for this experiment that follows the usual conventions. This section should include:

- the aim of the investigation
- a description of the results and a statement about whether a conclusion can be drawn (and why)
- the independent variable and the dependent variable
- at least two possible extraneous variables that may have affected the results, what effect they may have had and ways to control them in the future.

This question is worth 10 marks.

SECTION D: ASSESSMENT TASK

Design a flow chart that outlines Hans Selye's general adaptation syndrome (GAS) as an explanation of how the body responds to stress. Your flow chart should demonstrate your understanding of the following concepts:

- the stages of the GAS
- the role of perception
- the role of the sympathetic nervous system
- the fight–flight response
- the role of stress hormones
- the role of multiple stressors
- the relationship between stress and illness
- strengths and limitations of the GAS.

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CHAPTER 03

NEURAL BASIS OF LEARNING AND MEMORY

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KEY KNOWLEDGE INCLUDES:

- neural plasticity and changes to connections between neurons (including long-term potentiation and long-term depression) as the fundamental mechanisms of memory formation that leads to learning
- the role of neurotransmitters and neurohormones in the neural basis of memory and learning (including the role of glutamate in synaptic plasticity and the role of adrenaline in the consolidation of emotionally arousing experiences).

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WHAT IS LEARNING?

How do we learn? What happens in the brain during learning? How does learning affect behaviour? What is the neural link between learning and memory? To help you answer these questions, this chapter explores the biological basis of learning and memory.

Although we are born with some innate abilities that enhance our chances of survival (for example, sucking and grasping), most human behaviour is learnt. In other words, most of our behaviours (and changes in behaviour) are the result of experience, which is stored in our memory system. Learning and memory are closely related concepts. If information is not learnt, it cannot be remembered. And, if information cannot be remembered, learning does not occur. Imagine what would happen if you suddenly lost all the information and skills you had ever learnt. What would you be able to do? You would be unable to read or write. You couldn't feed yourself, find your way home, drive a car, play the guitar, or 'party'. Needless to say, you would be totally incapacitated.

Psychologists define **learning** as a relatively permanent change in behaviour (or behaviour potential) due to experience. When we say that what you learn – and the change in behaviour that results from the learning – is relatively permanent, we mean the change is stable and usually resistant to change. Temporary changes in behaviour caused by motivation, fatigue, disease, injury or drugs are therefore not considered to be the result of learning.

Learning begins at birth and continues throughout our lifetime. It enables us to function on a daily basis and adapt to changes that are constantly occurring in the world around us. Learning is dependent on **memory**, which is an active information processing system that receives, organises, stores and recovers information when we need it. Memory begins as we take in information from our senses from both the internal and external environment. Our nervous system converts this sensory information into impulses of electrochemical energy and transmits it to our brain where it is processed, interpreted and stored for future use. In Chapter 5 we will investigate how our memory system operates to encode, store and retrieve information and the different memory systems thought to be involved in different aspects of memory.

Researchers have been investigating the changes that occur in our brain as a result of learning and how we form memories. However, given the complex nature of our nervous system, particularly the brain, there are many mysteries still surrounding the mechanisms involved in learning and memory, and more research is needed to fully understand the biological basis of these processes. But let's have a look at some of the mechanisms of memory and learning that research has so far uncovered.

THE BIOLOGICAL EXPLANATION OF MEMORY

One of the greatest challenges of science today is to understand how the brain functions. To understand this, neuroscientists study the structure and function of the nervous system, particularly the central nervous system (CNS), which consists of the brain and spinal cord. The brain receives and processes sensory stimuli and interprets it – and it also decides how we will respond to stimuli. These decisions or motor messages are relayed to the body via the spinal cord, which links the brain to the peripheral nervous system (PNS). The PNS then carries the instructions for actions to the muscles, organs and glands involved in performing the behaviour. The multitude of brain and nervous system functions determine who we are and how we will respond to stimuli.

The nervous system, and therefore the brain, is a living organ that grows and changes continuously in response to in-built genetic programs and to its interactions with the environment.

As we noted in Chapter 1, the nervous system is a hierarchical structure composed of billions of interconnected neurons. These neurons link to one another in tight clusters and long chains to form a neural network that receives, processes, integrates and transmits immense amounts of information around the body. Each neuron in the brain is linked to as many as 15 000 other neurons, and millions of neurons must

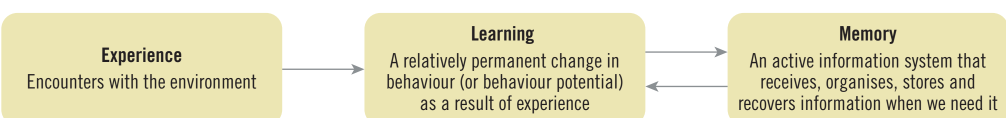

FIGURE 3.1 Learning is dependent on memory.

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send messages at the same time to produce even the most fleeting thought (Carter, 1998).

The mass of neurons we call the human brain enables us to make decisions, solve problems, fall in love or read a book – it also enables us to learn. Thus, everything you do, think, or feel can be traced back to these tiny cells. To understand the physiological mechanisms involved in learning and memory, scientists have studied the physical changes that occur in the brains of animals such as rats, cats, frogs, chimpanzees and snails (as well as human subjects) during learning, as well as the changes in behaviour produced by these brain changes. However, the study of the human brain (both intact and damaged) can be problematic. This is due to the brain's complexity, the vast number of neurons that make up its neural networks and ethical issues that arise when conducting research into human brain structure and function.

Neuroscientists interested in the physical mechanisms of learning and memory have found that basic organisms such as the aplysia (sea slugs) are easier to study than more complex animals; for example, humans. Because the neural circuits of organisms such as the aplysia are simplistic, any behavioural changes they experience as a result of learning can be analysed neuron by neuron. This approach to the study of the brain is called the simple-systems approach.

Kandel: In search of the memory trace

In 2000, Columbia University's Professor Eric Richard Kandel won the Nobel Prize for his previous work on the physiological basis of memory formation in neurons. To discover the molecular mechanisms involved, Kandel had studied learnt reflexes in a simple organism, the aplysia – or sea slug (see Figure 3.2). Aplysia were chosen because they have a very simple nervous system with a small number of extraordinarily large and distinctively pigmented nerve cells. This made it easy to observe any physiological changes, particularly synaptic changes, occurring during learning. Kandel observed the aplysia's neural connections before and after learning, noting any anatomical or chemical changes, particularly those relating to changes in the level of neurotransmitters released at the synapse.

In one study, Kandel taught the aplysia to withdraw its gill and water siphon in response to touch. Kandel began by repeatedly gently touching the aplysia's siphon. Ordinarily, sea slugs withdraw their gill and siphon at the slightest stimulation, but Kandel found

FIGURE 3.2 An aplysia: the aplysia's simple nervous system allows psychologists to observe synaptic changes that occur during memory formation.

that they soon habituate to being gently touched. Once habituation is established, withdrawal in response to touch stops. After the aplysia habituated to touch, Kandel followed the touch with a mild electric shock. Although the shock was harmless, it was strong enough to cause the reflex withdrawal of the gill and siphon. After several trials, the touch alone caused the gill and siphon to be withdrawn (Castelluci & Kandel, 1976). (This is an example of classical conditioning, which we will investigate in Chapter 4.)

Kandel concluded that reflex learning had occurred because the aplysia had formed a memory of the association between touch and pain, causing the aplysia to release more of its neurotransmitters into its synapses. Based on these findings, Kandel theorised that memory formation depends on neuronal activity, specifically related to the release of neurotransmitters at specific synapses. Increases in the level of neurotransmitters strengthen the synaptic connections between neurons, resulting in more efficient synaptic transmission and more efficient neural circuits (this is called long-term potentiation (LTP), a concept that is investigated later in the chapter). Therefore, durable changes in synaptic transmission may be the neural building blocks of memory (Kandel & Schwartz, 1982).

Some drugs that block neurotransmitters have been shown to disrupt information storage (Squire, 1987). For example, alcohol impairs memory formation by disrupting the activity of the neurotransmitter serotonin (Weingartner, Rudorfer, Buchsbaum, & Linnoila, 1983). This is why, after a night of heavy drinking, the next morning a person may have trouble remembering events of the previous evening.

learning A relatively permanent change in behaviour (or behaviour potential) due to experience

memory An active information-processing system that receives, stores, organises and recovers information

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3.1 CHECK YOUR UNDERSTANDING >>

1 Human memory is best defined as:
   A an active cognitive process that involves organisation, storage and recovery of information.
   B a cognitive process of storage and retrieval of information about stimuli and events when the original stimulus is no longer present.
   C a cognitive process of being able to bring to consciousness all information that has been experienced before.
   D the mental capacity to store and later recognise things that were previously experienced.
2 The human nervous system consists of which two main branches?
   A The central and autonomic nervous systems
   B The central and peripheral nervous systems
   C The sympathetic and parasympathetic nervous systems
   D The autonomic and somatic nervous systems
3 Learning is best defined as:
   A a change in behaviour that occurs when we are exposed to stimuli.
   B changes that occur in the body when we are exposed to stress and need to escape.
   C a relatively permanent change in behaviour due to experience.
   D an active information processing system that receives, organises and stores information for later use.
4 The decrease in behavioural responding when a stimulus is repeatedly presented to an organism is known as what?
   A Associative learning
   B Habituation
   C Desensitisation
   D Tolerance
5 Outline the role of the central and peripheral nervous systems.
6 Why were aplysia used in Kandel's study?
7 Explain what Kandel's research tells us about what occurs at the synaptic connections between neurons when learning takes place and memories are formed.

SYNAPSE FORMATION: SYNAPTOGENESIS AND ITS LINK TO LEARNING

The brain is a complex organ made up of a number of structures and each structure has a specialised function. In order for the brain to process the variety of information it receives so it can form an integrated view of the world, the neural pathways that link the brain's different parts must constantly transmit information around the brain. To efficiently do this, these neural pathways need to be established and maintained. During learning, neurons develop new connections and form new synapses (connections), or existing synapses are strengthened. Information is then able to pass from one neuron to the next. Once this information transfer happens repeatedly, the information is being learnt.

Not all brain neurons have synaptic connections with other neurons when we are born – the synapses between many neurons must form as our brain continues to develop. This process is known as synaptogenesis. After conception and during gestation, once neurons have migrated to their appropriate positions within the body, axons (thin fibres that carry information away from the neuron's cell body) and dendrites (neuron fibres that receive incoming messages) begin to grow from them. Synaptogenesis then occurs: the axons and dendrites project out and link with a target cell, or form a synapse (see Chapter 1, Figure 1.26).

Synaptogenesis occurs throughout a healthy person's lifespan, but it occurs most rapidly during early brain development, beginning at about 2 months before birth until approximately 2 years after birth. Synaptogenesis allows us to form many new synaptic connections between neurons to establish the neural pathways that allow different brain areas and structures to communicate. Those pathways that are most often stimulated and strengthened (because they are used most often) become a permanent part of the brain. Other pathways or neurons that do not form synapses will be 'pruned' away and lost.

EFFECTS OF EXPERIENCE ON NEURAL DEVELOPMENT

Genetically, a cell may be programmed to find its target cell and establish a synapse. Even so, many potential synaptic connections are lost, and up to 50 per cent of neurons die during the time of synaptogenesis in most regions of the developing nervous system (Oppenheim, 1991).

It is clear then, that genetics alone do not determine neural development – the external environment also plays a part. The main principle that governs the effects of experience on neural development is the principle of 'use it or lose it'. Canadian psychologist Donald Hebb (1949) was one of the first to propose that use of a function increases neural structure, whereas disuse decreases it. This principle suggests that neurons that are not activated by experience do not survive (Hockfield & Kalb, 1993; Kalil, 1989), and those that are activated and fire together, wire together, and in so doing, form a synapse.

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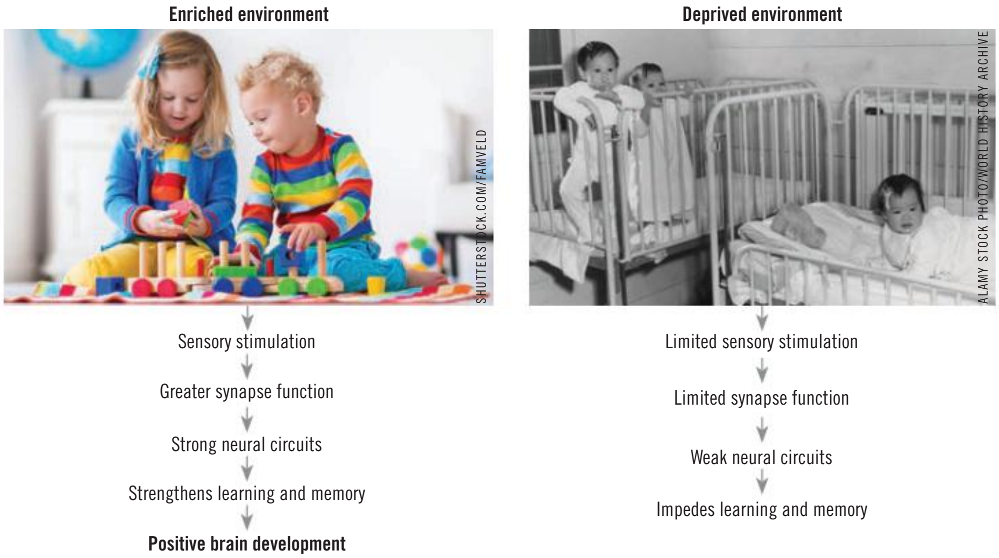

FIGURE 3.3 Our brain changes in response to experience.

Some of the earlier studies that have demonstrated the influence of experience on neural development include those on visual deprivation. For example, animals reared in the dark were found to have fewer synapses (Cragg, 1975) and fewer dendrites (Valverde, 1971) in their primary visual cortices (the area of the brain that receives and initially processes visual stimuli) than animals reared in their natural light-filled environment. The animals reared in the dark were also unable to judge depth correctly (Walk & Walters, 1973) and they had deficits in their pattern vision as adults (Tees, 1968).

Other studies into the influence of early exposure to enriched environments (environments offering a variety of sensory and intellectual stimulation) on animal neural development support the belief that the external environment plays a crucial role in neural development. These studies consistently suggest that enriched experience results in greater synapse formation. In one study, rats that were raised with other rats in enriched environments (complex cages) that stimulated their senses were found to have thicker cortices with more dendritic development (Greenough & Volkmar, 1973) and more synapses per neuron (Turner & Greenough, 1983) than rats raised by themselves in simple cages (see Figure 3.4) where sensory stimulation was lacking. In fact, there was 23 per cent more branching of the dendrites in the cells of the cerebellum (a brain structure involved in the memory of learnt skills and actions) of the enriched rats when compared to the rats in simple cages. Similarly, rats raised in an enriched environment showed increased branching of dendrites in the primary visual area of the cerebral cortex (Greenough & Juraska, 1979; Volkmar & Greenough, 1972). These studies suggest that learning through experience can play a big part in how our synapses form.

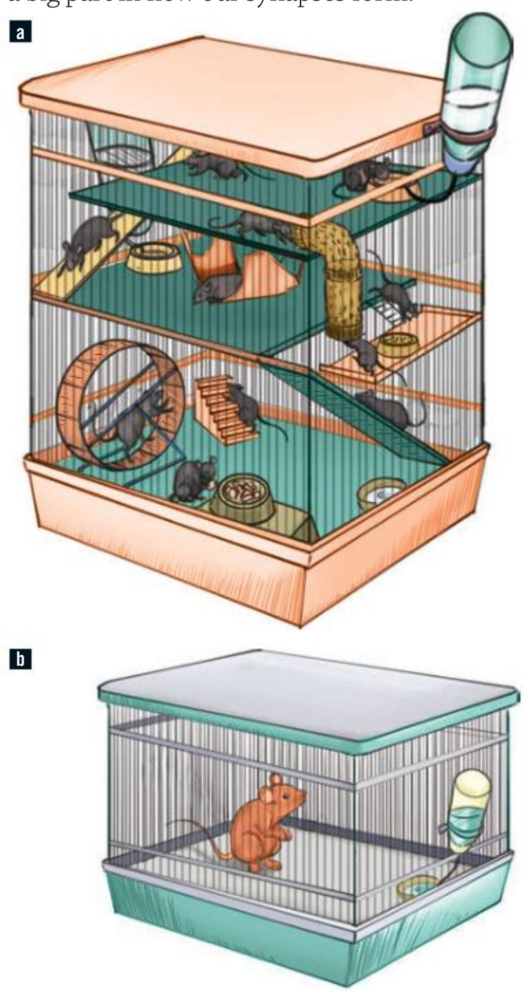

FIGURE 3.4 Rats raised in an enriched environment (a) show greater synapse formation and thicker cortices (with more dendrite development) than rats raised in simple cages (b).

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3.2 CHECK YOUR UNDERSTANDING >>

1 Synaptogenesis:
   A is the process of synaptic formation, or when the neurons connect.
   B is the growth of bushier dendrites in order to create fewer receptor sites.
   C occurs only in early life.
   D is the process of strengthening existing neural pathways by reducing the transmission of chemicals.

2 According to Hebb, which is the likeliest site where the neural changes underlying learning and memory first take place?
   A The nucleus
   B The synapse
   C The axon hillock
   D The nodes of Ranvier

3 Animals reared in enriched environments have been shown to have greater numbers of synapses on what part of the neuron?
   A The axon
   B The dendritic spines
   C The pre-synaptic terminals
   D The cell body

4 What effect has raising a rat in an enriched environment had on their brains?

5 Describe the process of synaptogenesis.

6 When does synaptogenesis occur?

7 Describe one way the neural development of an animal raised in an enriched environment would differ from an animal raised in a deprived environment.

NEURAL PLASTICITY

If something is plastic, it means that it can be moulded and changed. For example, a lump of plasticine can be transformed into whatever shape we want; it does not have a fixed shape. In terms of the human brain's capacity to learn, research studies indicate that the human brain can also be moulded and changed throughout the lifespan. These studies indicate that the brain we started with as babies changes over time as a result of experience and learning. Because of advances in modern technology, the application of a range of neuroimaging techniques has provided neuroscientists with the ability to demonstrate that the brain has the ability to change its structure and relocate functions to different areas and neuronal networks when damaged or to adapt to changing conditions. This ability to modify neural circuitry to meet the demands of experiences is referred to as brain or neural '**plasticity**'. Neuroplasticity is the umbrella term, commonly used to describe the malleability of the brain and nervous system, allowing the brain to be reorganised or 'rewired' in response to experiences over a lifetime.

The brain appears to change when we learn and in turn form memories, and exposure to stimuli will encourage this process.

Neural plasticity can occur by one of three mechanisms:

- by modifying the strength or efficacy (effectiveness) of synaptic transmission of existing synaptic connections
- by producing growth of new synaptic connections or the pruning away of existing ones
- by modulating the excitability properties of individual neurons (Malenka, 2002).

Neural impulses are not simply transmitted along hardwired pathways in the brain. Instead neural impulses code our thoughts, actions and experiences by constantly reorganising the structure and function of pathways, which enables the brain to respond effectively to the changing demands around us.

Some of you may have played or still play a musical instrument such as the guitar. Learning any musical instrument requires effort, particularly when starting out. The learning experience for most instruments requires you to engage many different parts of the brain, including cognitive, sensory and motor areas. When you begin guitar lessons, you may find it difficult to operate both hands at once, because one hand is strumming the strings and the other is fingering the notes. If you practise and keep at it, pretty soon the neural pathways used to produce the behaviour will begin to fire repeatedly. The more often the neurons in the circuitry fire, the stronger the connection between the neurons will become.

If you continue to practise the guitar regularly, eventually you may become more proficient. If you have learnt to read music, for example, the neural circuits involved in this behaviour will have developed 'bushier' dendrites and the neurons will have extended their axons, creating connections with more neurons and a better organised neural network. Over time, if we were to use neuroimaging technology to scan your brain, we would probably find that some areas of your brain will have changed in size or structure; for example, the areas of the brain involved in the motor coordination used in the strumming and fingering of the notes.

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3.1 TRY IT YOURSELF >>

NEURAL PLASTICITY

Draw a diagram and annotate it to show the three mechanisms whereby neural plasticity can occur. Your diagram should include the components of a neuron and identify how a neural pathway can be created or improved, or pruned, during plasticity.

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FIGURE 3.5 Neural plasticity enables individuals to learn new skills throughout their lifetime.

PHASES OF NEURAL DEVELOPMENT IN LEARNING

Donald Hebb (1949) hypothesised that the way cells assemble is the critical building block for learning. He theorised that when two neurons are jointly activated, they become more closely linked. Hebb's theory was debated for many years and, although not all details are supported, most researchers now agree that when learning takes place a physical change occurs in the synapse between neurons (Hawkins & Bower, 1989). These changes result in the laying down of new neural circuits, or neural pathways, through which information can travel around the brain.

One of the most important properties of neural circuits is that they can change; that is, they can learn. We know that the capacity to learn is crucial to survival, because it supports an organism's adaptability to their ever-changing environment. But how does learning actually occur in the brain? The answer to this is complex, but if we are to process information and learn from it (that is, remember it), the first thing that must happen in our brain is that the neurons must be able to communicate.

There is an assumption that all behaviour is associated with some underlying physiological activity, and that learning and memory have a neurological basis. Researchers continue to investigate how the nervous system changes in response to prolonged experience. A phenomenon that is often used to explore synaptic plasticity or changes at the level of the neuron is termed long-term potentiation (LTP).

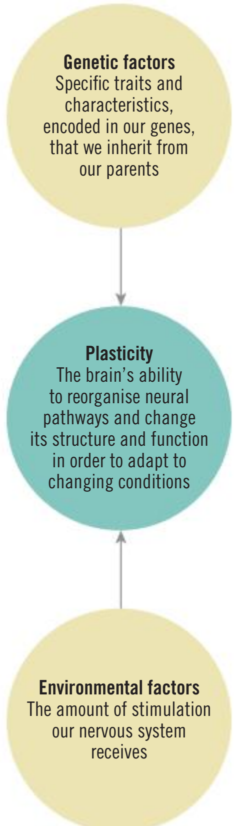

FIGURE 3.6 Factors that affect plasticity

3.1 FOCUS ON RESEARCH

'WHICH WAY, GUVNA?'

Studies into the effects of learning on brain structure have included those by Maguire et al. (2000). They conducted research into the effects of spatial experience on brain structure using London taxi drivers.

London taxi drivers were ideally suited to this study because they use spatial navigation as an integral part of their job. London taxi drivers must undergo rigorous training, and it takes approximately 2 years to learn how to navigate the vast city.

→

plasticity The brain's ability to reorganise its neural pathways when damaged or to adapt to changing conditions

The aim of the experiment was to compare the brains of London taxi drivers to participants who did not drive taxis, to see whether there were any structural differences between the brains. The experimental group consisted of 16 male London taxi drivers who were all right-handed, with a mean age of 44 years. All drivers were healthy according to medical, neurological and psychiatric tests. The control group consisted of 50 right-handed males with a mean age of 44 years who were all healthy according to the same tests performed on the taxi drivers.

The brains of all participants were scanned using structural MRI (on the same machine), and the scans were then compared. The results showed that an area of the rear part (posterior) of the hippocampus in the brains of the taxi drivers was significantly larger in comparison to those of the control participants. The control group was found to have a larger area in the front part (anterior) of the hippocampus than the experimental group. Taxi drivers with more driving experience showed greater volume in the hippocampus than drivers with less experience (Maguire et al., 2000).

It appears, therefore, that the hippocampus may play a role in storing spatial information about navigation and location. As more spatial information is learnt, the hippocampus expands to take this in. The more spatial information or learning that takes place, the larger the volume of the hippocampus appears to become. This has led researchers to conclude that there is a capacity for the human brain to change in structure (increase plasticity) in response to environmental demands.

QUESTIONS

1 What was the aim of the experiment?

2 Who were the participants?

3 What were the results?

4 What are three limitations or extraneous variables for this experiment?

3.3 CHECK YOUR UNDERSTANDING >>

1 What is the term used to describe the brain's ability to change and adapt as conditions change?
- A Synapse
- B Genetics
- C Neurosis
- D Plasticity

2 To meet the changing demands of the world around us, the circuitry of the brain can change in which of the following ways?
- A It can change the strength and efficiency of the messages being sent between neurons.
- B It can reduce neural pathways by pruning unnecessary connections or neurons.
- C It can produce growth of new synaptic connections.
- D All of the above

3 Neural pathways in the brain:
- A can change; that is, they can learn.
- B are fixed and are hardwired to produce behaviour once the pathway has been stimulated.
- C are genetically predetermined and are not influenced by the environment.
- D cannot change as they are inflexible once established.

4 Define 'neuroplasticity'.

5 Outline the three mechanisms by which neural plasticity can occur.

6 What is the purpose of brain plasticity?

7 Why might the growth of new synapses and the pruning of unused synaptic connections be beneficial to an organism when creating neural pathways for learning?

WHEN NEURONS COMMUNICATE

Learning involves the introduction of experience or new information, which produces changes in neurons and neural networks. Through learning, new synapses grow and existing synapses form closer links. To investigate long-term potentiation, let's briefly review the process involved when two neurons communicate.

As we know, neurons must communicate over the synapse (synaptic gap) because neurons are not joined to one another. So how does a message travel across the synapse from one neuron to another?

The nerve impulse *within* a neuron is primarily electrical. That's why behaviour is affected when the brain is electrically stimulated. In contrast, communication between neurons is chemical, so messages are sent between neurons chemically. The sending neuron is known as the **pre-synaptic neuron** (before the synapse) and the receiving neuron is known as the **post-synaptic neuron** (after the synapse). When an electrical charge in the form of a nerve impulse, or **action potential**, sweeps down the axon, neurotransmitters are released into the synapse. As we learnt in Chapter 1, neurotransmitters are chemicals released at the axon terminal of the pre-synaptic neuron. They carry the chemical messages across the synapse to the dendrite (receptor site) on the post-synaptic neuron (see Chapter 1, Figure 1.25). Neurotransmitters therefore enable communication between neurons and enable messages to travel from sensory receptor sites to the brain.

Neurotransmitters may act in one of two ways when they arrive at the post-synaptic neuron. Neurotransmitters may excite the post-synaptic neuron (that is, make it more likely to fire an action

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potential) or inhibit it (that is, make it less likely to fire an action potential). At any instance, a single neuron may receive hundreds or thousands of messages from adjacent neurons. However, whether the result of synaptic transmission will be excitatory or inhibitory depends on the type of neurotransmitter released by the pre-synaptic neuron and the electrically charged receptors (ion channel receptors) on the post-synaptic neuron they interact with.

3.4 CHECK YOUR UNDERSTANDING >>

1 The neuron sending a message to another neuron is called the:
   - A pre-synaptic neuron.
   - B post-synaptic neuron.
   - C transmitter neuron.
   - D motor neuron.

2 The neuron receiving a message from another neuron is called the:
   - A pre-synaptic neuron.
   - B post-synaptic neuron.
   - C transmitter neuron.
   - D motor neuron.

3 The transmission of information from one neuron to another is done via chemicals called __________, which are released by the axon terminal into the synapse.
   - A neuroplastics
   - B vesicles
   - C electrons
   - D neurotransmitters

4 An action potential is:
   - A when a pre-synaptic neuron sends a nerve impulse from another neuron to another at the synapse.
   - B the amount of energy incorporated in one neuron.
   - C the chemical transported across the synapse.
   - D the electrical impulse travelling down the axon of a neuron.

5 Identify the difference between a pre-synaptic and a post-synaptic neuron.

6 Explain the difference in energy used to transmit a neural message within a neuron and then between neurons.

7 Outline the role of neurotransmitters on a post-synaptic neuron.

THE PROCESS OF LONG-TERM POTENTIATION (LTP)

WHAT IS LONG-TERM POTENTIATION (LTP)?

For many years neuroscientists have understood that the number of neurons in the adult brain do not increase significantly with age or with use; that is, we don't acquire an abundance of new neurons when we learn and form memories. So, if there is no large-scale change to the number of neurons in the brain, something else must happen when we learn and form memories. Current research into how learning changes the brain suggest that neurons change during and after learning and, because they change in certain conditions, they have some plasticity.

When two neurons form a synapse, the pre-synaptic neuron sends a message via neurotransmitters that cross the synaptic gap to the receptor sites on the post-synaptic neuron. When this occurs, long-term potentiation can result in a persistent enhancement (or long-lasting strengthening) of synaptic transmission between neurons, making both neurons more likely to fire in the future when stimulated by a smaller amount of energy. **Long-term potentiation (LTP)** is a form of neural plasticity that is dependent on activity between two neurons. This means that it is experience-dependent; it will not occur if there is insufficient stimulation. LTP leads to a long-lasting increase in neural excitability at the synapse along specific neural pathways as a result of changes in the efficacy (effectiveness) of synaptic transmission.

WHERE IN THE BRAIN DOES LTP TAKE PLACE?

A number of brain structures are involved in the various processes that contribute to memory. For example, the hippocampus in the temporal lobes is important for memory consolidation, and it is the site most commonly used to research LTP. Findings from these investigations suggest that the hippocampus plays a major role in some forms of memory and in spatial learning in humans and a number of animals. In one investigation into LTP, researchers who removed the hippocampus of different species of birds that store food for winter found that the birds still stored their food, but they were unable to remember where they stored it. In addition, bird species that rely on storing food generally have larger hippocampi than species that do not have to rely on this spatial ability or memory.

pre-synaptic neuron The neuron that sends the impulse

post-synaptic neuron The neuron that receives the impulse

action potential An electrical charge that sweeps down the axon of a neuron, prompting the release of neurotransmitters

long-term potentiation (LTP) A form of neural plasticity that leads to an increase in the efficacy of synaptic transmission

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The LTP hypothesis was introduced by Hebb (1949) when he proposed that if two neurons are active at the same time, the efficiency of the synapse will be strengthened. Even though Hebb proposed the concept of LTP, the first full description of LTP did not emerge until 1973 when Bliss and Lomo used rabbits to demonstrate that high-frequency stimulation of the pathways to the hippocampus caused a sustained increase in the efficiency of the synaptic transmission in a part of the hippocampus known as the dentate gyrus. This research finding, as well as later research into LTP, supports the Hebbian theory of the nature of this form of neural plasticity. As a result, it is now widely thought that certain forms of learning and memory are reliant on these synaptic changes occurring through LTP and long-term depression (LTD). Long-term depression, which is discussed later in this chapter, is the opposite of LTP in that it decreases the efficacy of a synapse.

3.5 CHECK YOUR UNDERSTANDING >>

1 Hebb proposed the concept that:
   - A if two neurons are inactive, the synaptic strength between them will be increased.
   - B if two neurons are placed in close proximity to each other, they will form a connection.
   - C if neurons are removed from the hippocampus, learning cannot take place.
   - D if two neurons are active at the same time, the synaptic connection will be strengthened and the cells will operate more efficiently.

2 Bliss and Lomo (1973) discovered long-term potentiation in what brain structure?
   - A The hippocampus
   - B The frontal cortex
   - C The thalamus
   - D The cerebellum

3 Long-term potentiation is best described as:
   - A a form of neural plasticity that leads to long-lasting increases in the effectiveness of synaptic transmission.
   - B a form of neural plasticity that leads to short-term increases in the effectiveness of synaptic transmission.
   - C the amount of flexibility or potential for a neuron to change.
   - D the total decrease in the efficacy of a neuron to fire after stimulation.

4 It is widely agreed that for learning and memory processes to occur, synaptic changes need to occur, such as:
   - A long-term potentiation.
   - B pruning.
   - C long-term depression.
   - D All of the above

5 What is long-term potentiation?

6 Describe what Hebb first proposed about the role of long-term potentiation in neural plasticity.

7 Describe the possible effect of removing the hippocampus on an organism's behaviour.

THE ROLE OF THE PRE-SYNAPTIC NEURON IN LTP

Neural transmission, and therefore LTP, involves activity on both the pre-synaptic and the post-synaptic neuron. The activity of the pre-synaptic neuron will lead to the release of neurotransmitters, and the post-synaptic neuron's subsequent response will be determined by a number of factors, including the actions of the neurotransmitters released across the synapse. Let's look in more detail at the role of the pre-synaptic neuron in LTP.

Most neurons typically maintain an internal environment within the cell that is negatively charged (made up of negatively charged ions), in comparison to the external environment, which is positively charged. This state is referred to as a neuron's resting potential. When a neuron is stimulated electrically, this causes changes to occur in the membrane of the cell, which results in the sodium (Na^+) channels (gates or pathways that allow ions to travel into or out of the cell) on the pre-synaptic neuron to open, allowing Na^+ ions to enter the cell. This causes the cell to become depolarised, which changes the internal environment of the cell to become positively charged, and an action potential or impulse will be sent down the cell. This influx of Na^+ ions causes the calcium (Ca^{2+}) channels to open and then Ca^{2+} flows into the pre-synaptic neuron. This chain of events causes vesicles (which are used to carry neurotransmitters within the pre-synaptic cell) to release glutamate and for these glutamate neurotransmitters to travel across the synapse.

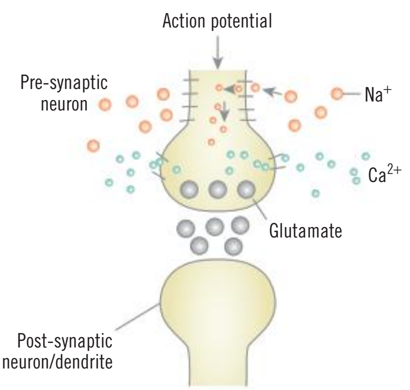

FIGURE 3.7 Na^+ ions enter the cell through the Na^+ channels. This causes the depolarisation of the cell and the opening of the Ca^{2+} channels, allowing Ca^{2+} to enter. Glutamate is then released from the pre-synaptic cell.

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As we saw in Chapter 1, glutamate (also called glutamic acid) is the most common excitatory neurotransmitter in the central nervous system. There are a number of different types of glutamate receptors, and glutamate plays a particularly important role in learning and memory. Two important glutamatergic receptors involved in LTP are the AMPA and the NMDA receptors found on the dendrites of the post-synaptic neuron. Glutamatergic receptors are those that 'bind' to glutamate like a lock to a key, and this binding activates them. AMPA (α-amino-3-hydroxyl-5-methyl-4-isoxazole-propionate) and NMDA (*N*-methyl-D-aspartate) are receptors found on the post-synaptic neuron that bind to glutamate.

THE ROLE OF THE POST-SYNAPTIC NEURON IN LTP

When released by the pre-synaptic neuron, glutamate crosses the synapse and binds to the AMPA receptors. This allows Na^+ ions to pass through into the post-synaptic cell and depolarise the post-synaptic neuron (making the environment in the cell positively charged). This event is significant, because if the cell is not depolarised, the next chain of events will not occur.

The NMDA receptor is not as easily opened. This channel will only open once the Na^+ ions have entered the cell through the AMPA receptor, so NMDA receptor activity depends on the action of the other glutamatergic receptor (AMPA). The NMDA channel is blocked by Mg^{2+} (magnesium ions), but once the Na^+ enters the cell, the Mg^{2+} will be forced out of the channel as the positive ions that are entering the cell will repel the positive Mg^{2+} ions blocking the channel. A strong positive charge will then form around the NMDA channel. Once the Mg^{2+} ions are expelled, the NMDA channel will open up and more Na^+ as well as Ca^{2+} ions (calcium ions) will flow through this channel into the post-synaptic cell. This further depolarises the post-synaptic cell.

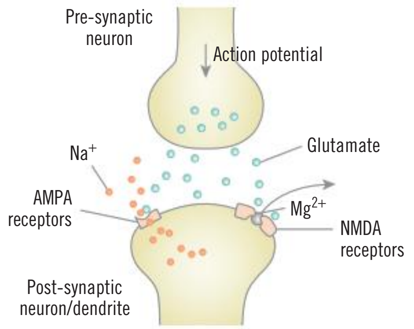

FIGURE 3.8 Glutamate binds with the AMPA receptors allowing Na^+ ions to enter the post-synaptic neuron and depolarising the cell. The Na^+ will force the Mg^{2+} ion blocking the NMDA receptor out.

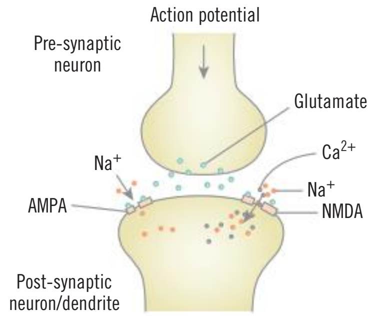

FIGURE 3.9 When the NMDA is free of the Mg^{2+} blocker, other Na^+ and Ca^{2+} ions enter the post-synaptic neuron.

If the cell is not depolarised by the Na^+ ions entering through the AMPA receptor, LTP will not occur. This explains why, in LTP, many pulses from the pre-synaptic neuron in quick succession are necessary in order to have enough Na^+ in the post-synaptic cell to activate the NMDA receptor channel. Therefore, there are two important criteria that must be met for LTP to occur. NMDA receptors must be activated, and the membrane of the post-synaptic neuron must be partially depolarised. The Ca^{2+} channels are, therefore, neurotransmitter and voltage dependent (requiring sufficient strength to open).

The Ca^{2+} that enters the post-synaptic neuron will bind to kinase (an enzyme) in the cell, which leads to the kinase causing phosphates to bind to other parts of the cell. This action is called phosphorylating, and it adds phosphate to the AMPA channels. This increases the AMPA channels ability to open to Na^+, allowing more Na^+ into the cell. AMPA channels will also emerge

resting potential The typical internal environment (negatively charged) of a neuron in comparison to external environment (positively charged)

channels Gates or pathways that allow ions to enter and leave the neuron

vesicles Small sacs within the pre-synaptic neuron that contain neurotransmitters

glutamate The primary excitatory neurotransmitter in the brain responsible for the fast transmission of neural messages and involved in cognitive functions

AMPA (α-amino-3-hydroxyl-5-methyl-4-isoxazole-propionate) receptors Specific receptors found on the dendrites of post-synaptic neurons that bind glutamate

NMDA (*N*-methyl-D-aspartate) receptors Specific receptors found on the dendrites of post-synaptic neurons that bind glutamate

depolarise To change the resting potential of a neuron so that the internal environment becomes more positively charged

kinase An enzyme found in the post-synaptic neuron that catalyses the transfer of phosphates to the AMPA channel from inside the cell and rise to the surface of the dendrite, enabling more potential receptor sites with the incoming neurotransmitters (glutamate) and also results in AMPA channels becoming more efficient at allowing Na^+ ions into the channel. This causes the cell to become even more sensitive to glutamate because there are more receptor sites to bind it.

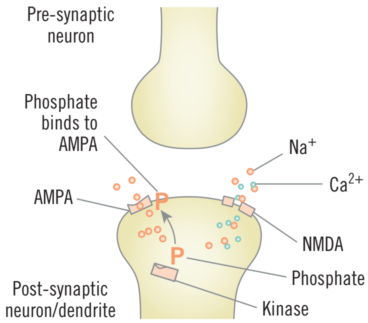

FIGURE 3.10 The action of the Ca^{2+} binding to the kinase, leads to a phosphate group being produced and this increases the ability of the AMPA channels to open to Na^+ allowing more Na^+ into the cell.

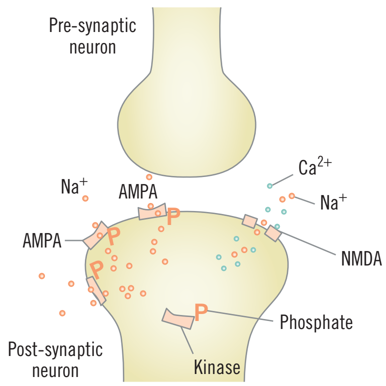

FIGURE 3.11 AMPA channels will be more likely to emerge from the cell and to rise to the surface creating more receptor sites because of the action of the phosphorylation.

Long-term potentiation will therefore result in a higher excitation in the post-synaptic neuron. Before this process occurs, it would take a large or intense signal and a large release of glutamate to activate many receptors in the post-synaptic neuron. However, after this process has occurred, an action potential can be achieved with a much smaller signal and a smaller amount of glutamate is needed to activate the post-synaptic neuron.

SUSTAINING LTP

Although the process of neural transmission explains the mechanism for the formation of LTP, it does not explain how LTP is sustained. Long-term potentiation, as the name would suggest, once established (learnt or remembered), may last for a very long time. For this to occur, changes in the nervous system are required, and these changes may be semi-permanent. Research has found that NMDA receptors are important in establishing LTP; however, they are not a part of maintaining the neural process. When NMDA blockers are used, which are drugs capable of inhibiting or blocking the NMDA receptor activity, after LTP has been established, then this has little to no effect on the transmission of the messages being sent between the neurons. If the AMPA receptors are blocked, however, this will have an effect in the sustained LTP, reducing the transmission between neurons.

When a neuron in the dentate gyrus (a part of the hippocampus) is examined after LTP, the number of receptor sites present on the post-synaptic membranes increases significantly, as more AMPA receptors are present (Bliss & Lomo, 1973). This may be one reason to explain the increased level of excitability in these neurons. As the post-synaptic neuron undergoes structural changes in terms of receptors, other parts of the neuron change too. Just as we need new materials to renovate a house or change the structure of a building, so too the changes that occur during learning and memory require new material. This material is created through protein synthesis and there is evidence to suggest that, during LTP, protein synthesis occurs in the dendrites of the post-synaptic neuron.

During LTP, changes also occur in the pre-synaptic neuron. These changes include more glutamate being produced and released, further exciting the neurons. So, to simplify the concept of LTP somewhat: When glutamate is released by the pre-synaptic neuron, this causes excitation of the post-synaptic neuron. It does this through binding with AMPA and NMDA receptors. New proteins are synthesised, allowing more receptors to emerge. As a result, both the pre-synaptic neuron and the post-synaptic neuron become more efficient at transmitting neural messages.

So how could this intricate process act to form new memories? Long-term potentiation, like learning, is not just dependent on increased stimulation from one particular neuron, but on a repeated stimulus from several sources. It is thought that when a particular stimulus is repeatedly presented, so is a particular circuit of neurons stimulated and therefore the circuitry becomes more efficient at transmitting

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messages. With repetition, the activation of that circuit results in learning. The brain is an enormously intricate and complicated organ. Rather than a one-to-one line of stimulating neurons, it involves a complex web of interacting neurons. The way in which the neurons interact appear to have global effects, meaning that behaviour is the result of a great many neurons; not single circuits.

More permanent changes, which are thought to result in long-term memory, require the synthesis of new proteins in the neurons. In humans, the enzyme CREB (cyclic-AMP response element-binding protein) seems to be involved in the steps that allow this new protein expression. When calcium flows in through NMDA channels, one of the molecules it activates is CREB. CREB acts as a transcription factor, which means that it activates the expression of other genes. This gene expression can lead to the production of more ion channel receptors, as well as structural proteins, which make the synaptic connection between two repeatedly communicating neurons more permanent.

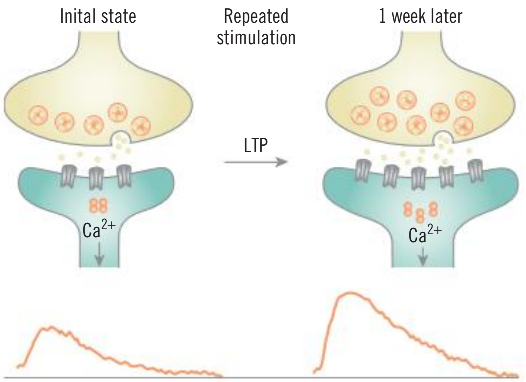

FIGURE 3.12 The number of receptor sites on the post-synaptic site increases, the number of neurotransmitters being released by the pre-synaptic neuron increases, and the resulting action potential is stronger when LTP takes place.

EVIDENCE TO SUPPORT LTP

There have been many studies that have shown that NMDA glutamate receptors are crucial for memory formation, as modelled by LTP. For example, when drugs are introduced that block the NMDA receptor sites and prevent glutamate binding to them, LTP does not occur (Carlson, 1998).

Most of the research into LTP (and its counterpart, long-term depression) has been conducted on neurons in the hippocampus, a part of the brain that is known to be involved in consolidation of some types of memory. When the hippocampus is removed, individuals will lose the ability to store new factual information. In other words, they lose the ability to learn and remember new information. LTP can be artificially induced by researchers by sending a high-frequency electrical stimulation along a neural pathway, and theory suggests that when we learn and form memories, stimulation of the neurons (in particular those found in the hippocampus) produce the same neural circuitry when a memory is formed (Martinez & Derrick, 1996).

3.6 CHECK YOUR UNDERSTANDING >>

1 Information is first received by a nerve cell at the:
   A axon.
   B nucleus.
   C dendrites.
   D axon terminals.
2 When a neuron is electrically stimulated, the ion channels that are first opened allowing positively charged ions into the cell causing depolarisation are:
   A sodium channels.
   B potassium channels.
   C calcium channels.
   D magnesium channels.
3 What is the role of glutamate in LTP?
   A To decrease the excitability of the post-synaptic neuron
   B To increase the excitability of the pre-synaptic neuron
   C To decrease the excitability of the pre-synaptic neuron
   D To increase the excitability of the post-synaptic neuron
4 The NMDA receptor will:
   A remain closed to ions until the magnesium ion is removed from the channel.
   B remain closed to ions until the calcium ion is removed from the channel.
   C open when glutamate binds to the site.
   D open for ions to travel into the cell once there is sufficient sodium on the outside of the cell.
5 Describe the activity on the pre-synaptic neuron during LTP.
6 Describe the activity on the post-synaptic neuron during LTP.
7 How does the process of LTP result in learning and the formation of memories?

transcription factor A protein involved in the expression of genes (which are turned 'on' or 'off')

ISBN 9780170365628

THE PROCESS OF LONG-TERM DEPRESSION (LTD)

Long-term depression (LTD) occurs when the efficacy of the synaptic transmission between two neurons is reduced, a process that is complementary to long-term potentiation (LTP). LTP results in more sensitive post-synaptic cells and more neurotransmitters being produced and sent from the pre-synaptic neuron. However, LTD will occur if the message being sent from the pre-synaptic neuron is weak (because less glutamate is released), resulting in less Ca^{2+} entering the post-synaptic neuron. Lower concentrations of Ca^{2+} make it more likely that the Ca^{2+} will bind to the phosphatase in the cell rather than the kinase. Both kinase and phosphatase are enzymes found in cells, but where kinase can work to release phosphate allowing it to bind to other parts of the cell, the phosphatase prevents the phosphate binding. This will mean that instead of the AMPA channels becoming more abundant on the surface of the dendrite, they remain within the cell. Overall, the result will be a reduced action potential, as the post-synaptic neuron becomes less responsive to glutamate.

The process of LTD may be involved in forgetting, particularly when it occurs in the hippocampus. This is because, rather than improving the ability of neurons to communicate, LTD reduces the transmission of information between neurons. While it may seem to go against logic, LTD may be just as important in learning and memory as LTP, because it may help to weaken and prune back unused synapses – or those that are not stimulated. By removing unused or unnecessary synapses, the brain becomes more efficient and therefore so do the learning and memory processes. The resources to keep the cells healthy are distributed among fewer neurons, and energy is also more effectively used in the neural pathways that are left. Whether LTP and LTD are actual synaptic processes underlying learning and memory, as most neuroscientists believe, has not been definitively resolved. It is clear, however, that these processes are involved in some way when information is learnt and memories are formed (Bliss & Cooke, 2011).

Potentially, LTP and LTD may have an important role to play when devising treatment for some disorders and diseases in the central nervous systems of humans and other animals. For example, in diseases and disorders where the synaptic strength has been changed because of sensory deprivation during childhood, brain damage or disease, there is potential to develop technology to improve or normalise synaptic strength, perhaps improving the lives of people in these situations (Bliss & Cooke, 2011).

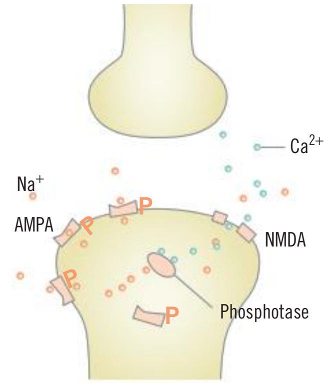

FIGURE 3.13 Phosphatase present in the dendrite binds Ca^{2+} ions more readily than to the kinase when there are lower concentrations of Ca^{2+}. This will reduce the Na^+ entering the cell, leading to LTD.

TABLE 3.1 Comparing long-term potentiation and long-term depression

LONG-TERM POTENTIATION (LTP)	LONG-TERM DEPRESSION (LTD)
» Synapses are strengthened when AMPA receptors in the post-synaptic neuron are increased (number and efficiency), allowing more calcium to enter the cell, increasing the neuron's excitatory response » Increased glutamate is produced and released by the pre-synaptic neuron » Involved in memory and learning as neurons become more efficient at transmitting information	» Synapses are weakened when AMPA receptors in the post-synaptic neuron are decreased, reducing the amount of calcium entering the cell, weakening the neuron's response » Decreased glutamate is produced and released by the pre-synaptic neuron » Involved in memory and learning as neurons become less efficient at transmitting messages and synaptic pruning may take place

3.2 TRY IT YOURSELF >>

LTP AND LTD

Draw a flow chart or use a multimedia program to show the process of long-term potentiation and long-term depression. Use diagrams to show the process within the pre-synaptic and the post-synaptic neurons.

3.7 CHECK YOUR UNDERSTANDING >>

1 The main difference between LTP and LTD is that:

A the efficiency of the cells is increased in LTP and decreased in LTD.

B the efficiency of the cells in decreased in LTP and increased in LTD.

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C LTP is a slower process than LTD.
D LTP results in synaptic pruning and LTD results in more synaptic connections.

2 During LTD, the post-synaptic neuron will become less responsive to which neurotransmitter?
A Glutamate
B Dopamine
C Adrenaline
D Serotonin

3 The process of LTD involves an overall reduction in the efficacy of synaptic transmission between neurons due to which of the following?
A An increase in the number of glutamatergic receptors and an influx of calcium into the post-synaptic neuron
B An increase in calcium ions entering the post-synaptic neuron, resulting in the emergence of more AMPA receptors
C A decrease in the amount of calcium in the post-synaptic neuron, resulting in the AMPA channels remaining within the cell, instead of rising to the surface of the dendrite
D The NMDA receptors binding with more glutamate, exciting the post-synaptic neuron

4 What is an advantage of the process of LTD to learning and memory?

5 Explain the process of LTD in your own words. You may draw a diagram to assist your explanation.

6 Compare the roles of LTD and LTP in learning and memory.

7 Compare the roles of kinase and phosphatase in the responsiveness of the post-synaptic neuron.

NEUROTRANSMITTERS AND NEUROHORMONES: THEIR ROLE IN MEMORY AND LEARNING

A neurotransmitter is a chemical messenger that is synthesised (made) within the pre-synaptic neuron. Neurotransmitters are contained within vesicles and are released at the axon terminals of a pre-synaptic neuron that diffuse (spread) across the synapse to affect the post-synaptic neuron. A neurotransmitter binds to the receptors on post-synaptic neurons and will either stimulate or inhibit the action potential of that neuron eliciting a biological response.

Hormones are chemicals produced by the endocrine system, which is made up of a number of glands (a group of cells that produce and secrete chemicals into the body) located throughout the body such as the hypothalamus, pituitary gland, thyroid, adrenal glands, pineal gland and the ovaries and testes. Your endocrine system works with your nervous system to control important bodily functions such as regulating growth, sexual development and function, metabolism and mood. By regulating the amount of hormones released, the endocrine system also helps give your body the energy it needs to function properly. The endocrine system produces a number of different hormones, which are usually secreted directly into the bloodstream and act on distant sites. These include adrenaline, cortisol, insulin and testosterone. Hormones have a wide array of functions throughout the body and act on different body parts.

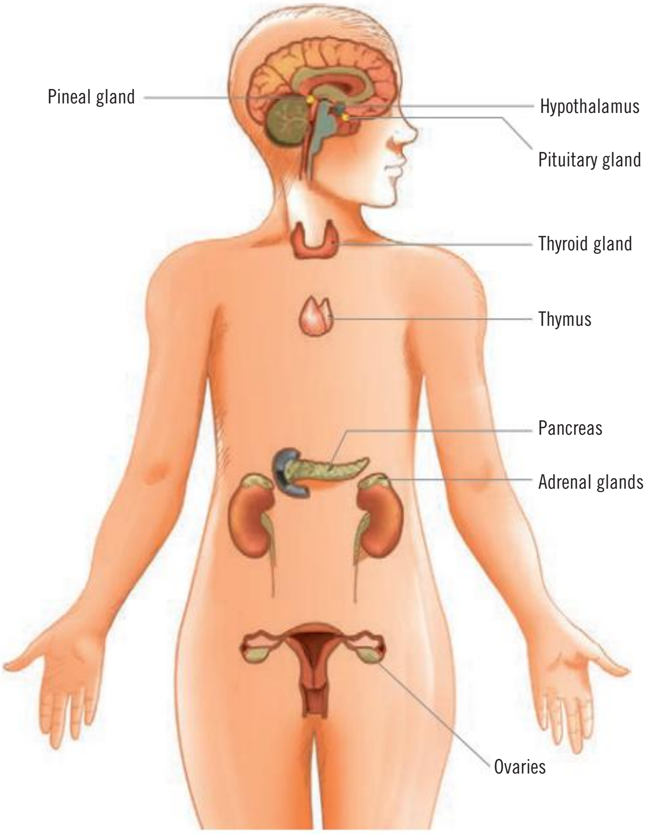

FIGURE 3.14 The human endocrine system involves a number of different glands that secrete hormones into the body.

Another type of chemical messenger comes in the form of a neurohormone. A neurohormone is similar to a neurotransmitter; however, where a neurotransmitter is a chemical that is released from a pre-synaptic neuron into a synapse and acts on adjacent cells very

long-term depression (LTD) The reduced efficacy of synaptic transmission

neurotransmitter A chemical messenger synthesised within a pre-synaptic neuron and transmitted across the synapse

hormones Chemicals produced in the glands and secreted directly into the bloodstream to act on distant sites

endocrine system The collection of glands in the body that produce hormones that regulate bodily function

neurohormone A chemical synthesised in the neuron that is secreted directly into the bloodstream to act on distant sites

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quickly, neurohormones are chemical messengers that are released by neurons into the bloodstream and are carried throughout the body where they act on target cells at specific sites, like a hormone. This allows the neurohormone to have an effect on more distant targets. Therefore, it is not as fast-acting as a neurotransmitter that communicates with an adjacent cell very quickly. Regardless of the distance travelled, neurohormones will interact only with other cells that have specialised receptor sites to receive them. Examples of neurohormones are TRH (thyrotropin releasing hormone), dopamine, adrenaline and noradrenaline. (Table 3.2 summarises basic differences between neurotransmitters and neurohormones.)

Some chemicals produced by the body can play more than one of these roles. That is, they can act as neurotransmitters or neurohormones; it depends on the action of the chemical. For example, adrenaline released into the bloodstream from the adrenal glands can act as a hormone, but the same chemical can act as a neurotransmitter in the brain, hence it can be thought of as a neurohormone. In some cells in the central nervous system, a chemical called noradrenaline (a chemical related and very similar in structure to adrenaline) is converted into adrenaline. The adrenaline can then be transmitted across the synapse to act on receptors on adjacent neurons, hence it is acting as a neurotransmitter in the brain. Adrenaline is also released by the adrenal glands into the bloodstream, and circulates to more distant receptors, acting as a hormone (Bear, Connors, & Paradiso, 2007).

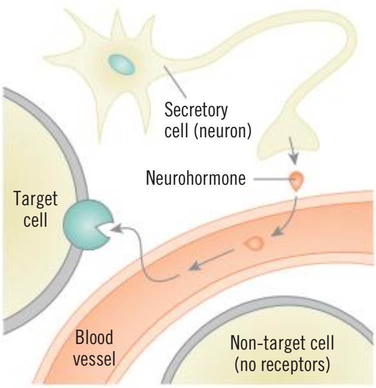

FIGURE 3.15 A neurohormone is a chemical secreted from a neuron that, instead of acting at the synapse with an adjacent neuron, is released into the bloodstream to act on more distant sites.

Chemical structure does not define the difference between a hormone and a neurotransmitter; function does. If a chemical is released in the brain locally at a synapse, it is referred to as a neurotransmitter, but if the same chemical is released into the blood to act at a distant target, then it is called a hormone or neurohormone.

It is generally assumed that when we learn and form memories of the learning (consolidate the information), this involves interaction between multiple brain systems, which is enabled by both neurotransmitter activity and hormones or neurohormones. In the next section we'll take a look at a couple of important chemicals involved in learning and memory: glutamate and adrenaline.

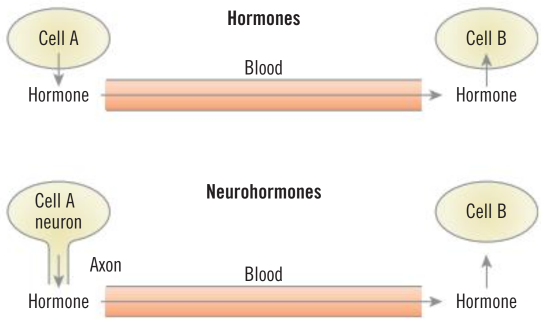

FIGURE 3.16 Endocrine hormones travel via the bloodstream to specific receptor sites. Neurohormones are released from a neuron and travel via the bloodstream to specific receptor sites.

TABLE 3.2 Basic differences between neurotransmitters and neurohormones

NEUROTRANSMITTERS	NEUROHORMONES
» Chemicals released by a pre-synaptic neuron	» Chemicals released by a pre-synaptic neuron
» Released directly into the synapse	» Released directly into the bloodstream
» Can only affect neurons that are directly linked via a synapse	» Carry messages throughout the body so can affect target cells in specific organs at distant sites
» Carry messages from a pre-synaptic neuron to a post-synaptic neuron	» Can travel longer distances than neurotransmitters
» Travel short distances	» Effect is not as quick as neurotransmitters
» Effect is quick	

3.8 CHECK YOUR UNDERSTANDING >>

1 Neurotransmitters:
   A are chemicals released at the synapse of a nerve cell.
   B can stimulate activity in an adjacent neuron.
   C can inhibit activity in an adjacent neuron.
   D All of the above

2 Neurotransmitters are primarily associated with the __________, whereas neurohormones are associated with the __________.
   A synapse; bloodstream
   B soma; dendrites
   C axon; synapse
   D bloodstream; dendrite

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3 What effect do neurotransmitters from one neuron have on the next neuron?
   A They have no effect.
   B They excite it.
   C They inhibit it.
   D They may excite or inhibit it.
4 Hormones are produced in the __________, whereas neurotransmitters are produced in the __________.
   A glands; neuron
   B neuron; bloodstream
   C glands, bloodstream
   D neuron; glands
5 What is the difference between hormones, neurotransmitters and neurohormones?
6 Outline four characteristics of neurotransmitters.
7 Chemical structure does not define the difference between a hormone and a neurotransmitter. Explain this statement.

SYNAPTIC PLASTICITY: THE CHANGING NEURON

Synaptic plasticity is the term used to describe the changes that occur to the synapse, which can lead to either an increase or a decrease in activity between neurons. Plastic changes can occur when the number of receptors changes, the amount of neurotransmitter changes, and when other structural changes occur. Synaptic plasticity is thought to be the basis of learning and memory, because it enables a flexible, functioning nervous system. As we noted earlier, the two processes involved in synaptic plasticity are long-term potentiation (LTP) and long-term depression (LTD), and these processes are particularly important for learning and memory when they occur in synapses in the hippocampus of the brain.

THE ROLE OF GLUTAMATE IN MEMORY: CAUSING NEURONS TO FIRE

As we noted in Chapter 1, glutamate, the brain's most abundant excitatory neurotransmitter, is well known for its contribution to learning and memory, in particular for its role in LTP. Glutamate is an excitatory neurotransmitter; that is, it excites the brain cells or neurons, particularly those involved in cognitive functions. The form of neural plasticity known as LTP takes place at glutamatergic synapses in the hippocampus and other parts of the brain, including the cerebral cortex, making glutamate one of the main neurotransmitters involved when we learn and use our memory systems.

Glutamate is stored in vesicles in the axon terminals, where it is released across the synaptic gap when the pre-synaptic neuron fires an action potential. When the glutamate reaches the post-synaptic neuron, it acts in an excitatory fashion because it increases the probability that this neuron will fire an action potential. Glutamate acts on specific receptors, under certain conditions usually increasing the sensitivity of the next neuron, making it more likely to fire an action potential if enough glutamate is present. In short, glutamate changes neurons, so it is involved in synaptic plasticity.

There are a number of ways that glutamate acts as an excitatory neurotransmitter. Research has shown that there are a number of glutamate receptors that bind glutamate and then produce activation of the cell, including AMPA, NMDA and kainate receptors. These are ionotropic glutamate receptors that are located on the post-synaptic neuron. As the name would suggest, these receptors allow the passage of ions into or out of the cell, such as sodium, potassium and calcium ions. There is much research to support the role that these types of receptors play in the learning and memory processes. AMPA and NMDA have been discussed previously with regard to their role in LTP.

There are also a number of metabotropic glutamate receptors. These receptors activate proteins that, in turn, activate secondary messengers that will go on to affect other parts of the cell. Therefore, metabotropic glutamate receptors operate indirectly, causing a cascade of events leading to changes in the cell, instead of directly influencing the passage of ions travelling in and out of the cell. The metabotropic glutamate receptors are thought to be involved in the modulation of protein synthesis in the post-synaptic neuron, which can result in an increase or a decrease in the excitability of the post-synaptic cell.

synaptic plasticity The term used to describe the changes that occur to the synaptic connection between two or more neurons

glutamatergic synapses Synaptic connections involving the transmission of the neurotransmitter glutamate

ionotropic glutamate receptors Located on post-synaptic neurons, these receptors allow direct passage of ions in or out of the neuron after binding glutamate

metabotropic glutamate receptors These receptors indirectly activate secondary messengers that influence the passage of ions in and out of the neuron

Although each receptor is different, glutamate receptors of one type or another are found virtually everywhere throughout the nervous system, therefore most neurons have some glutamate receptors. Overall, the role of glutamatergic receptors seems variable and dependent on a number of factors. These factors include where they are located in the brain, what role they play in learning and memory, the type of learning task and the initial strength of the pre-synaptic message being transmitted to the post-synaptic neuron.

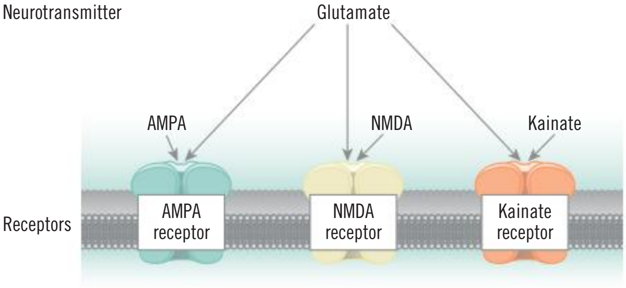

FIGURE 3.17 These three glutamatergic receptors are involved in synaptic plasticity because they allow ion channels to open and increase the number of ions entering the cell.

FIGURE 3.18 During learning, a complex network of systems working together enables the information to be learnt and remembered. Glutamate is the main neurotransmitter involved in excitatory neural transmission.

3.9 CHECK YOUR UNDERSTANDING >>

1 Synaptic changes can include:
   A an increase or decrease in the number of receptors involved in neural transmission.
   B varying amounts of neurotransmitters.
   C structural changes to the neurons.
   D All of the above
2 Which is the most abundant excitatory neurotransmitter in the brain?
   A Adrenaline
   B Noradrenaline
   C Serotonin
   D Glutamate
3 Neurotransmitters are stored in the __________ of the pre-synaptic neuron.
   A axon
   B dendrites
   C nucleus
   D vesicles
4 The three ionotropic glutamate receptors involved in LTP are thought to be which of the following?
   A AMPA, NMDA, calcium receptors
   B LTD, AMPA, NMDA
   C AMPA, kainate, protein receptors
   D AMPA, NMDA, kainate
5 What do the ionotropic receptors have in common?
6 Describe the role of glutamate in synaptic plasticity.
7 What is the main action of the ionotropic receptors that bind glutamate?

THE ROLE OF ADRENALINE IN MEMORY: THE CONSOLIDATION OF EMOTIONALLY AROUSING EXPERIENCES

Many moments of our lives are not given equal weight in memory; that is, we do not remember equally well all of our experiences. Some explanations for this may be that memories of experiences we attend to are more likely to be consolidated than others, or some new information links with information already stored in memory better than other information so it may enhance existing memory stores, or even that some memories are strengthened by repetition or strengthened if we access them regularly (retrieval). For instance, we might be more likely to remember information in class if we know we have a SAC coming up in a week, so we attend to the information the

FIGURE 3.19 The experience when students graduate from secondary school can produce significant emotional responses in some individuals, perhaps leading them to consolidate and remember these events more than other memories.

ISBN 9780170365628

FIGURE 3.20 Experiences such as skydiving are usually well remembered as they elicit an emotional (fear) response in most people.

teacher is telling us and ensure that the relevant parts of the textbook are read and summarised. We may even try to go over the work with a friend, or tell someone about what we are learning, thereby strengthening the memory through repetition and regularly retrieving the information. Another explanation for our superior memory for some experiences over other memories focuses on the effect of certain hormones, such as adrenaline.

All of us have had emotional experiences in our lives. Our personal experiences of emotionally charged events such as birthdays, the loss of a loved one or a significant accident tend to leave us with lasting and vivid memories. For example, studies have found that people have particularly good recollection of where they were and what they were doing when they experienced earthquakes (Neisser et al., 1996) or witnessed an accident (Bohannon, 1988). The strength of memories of events varies with the emotional significance of the events. Studies using animals such as rats have found that evoking a fear or emotional response in the organism leads to superior recall. One study, for instance, demonstrated that when rats were given an electric shock to their feet, they were able to remember the location of where the shock took place. Rats have also demonstrated a good memory of the location of an escape platform when they have been placed in a tank of water. Rats do not particularly like water, so placing them in a tank filled with water would evoke an emotional (fear) response (Roozendaal, Bohus, & McGaugh, 1996; Vazdarjanova & McGaugh, 1998).

Superior or good memory for emotionally significant events (known as episodic memory, a type of long-term memory, which is covered in detail in Chapter 5) is not limited to only unpleasant events. Emotional events that give us pleasure and significant positive emotionally arousing experiences also tend to be remembered well. Why is it that emotionally arousing experiences tend to be well remembered, but events that do not arouse us do not? Psychologists believe that lasting memories do not appear to be created at the time of an experience. Instead, they suggested that experiences initiate neural processes that will consolidate memories over time as information from short-term memory is transferred to long-term memory for relatively permanent storage. These neural changes include the synaptic plasticity caused by the action of the neurotransmitter glutamate, as well as the involvement of a number of other neurotransmitters, hormones and areas of the brain. Let's have a look at the role of a particular chemical, adrenaline, thought to be involved in learning and memory of emotionally arousing experiences.

WHAT IS ADRENALINE?

When we experience emotionally significant events, stress hormones are released into the bloodstream and travel throughout the body. These hormones, including adrenaline, are important in memory consolidation. Adrenaline, also known as epinephrine, is a hormone secreted from the adrenal glands and is involved in the fight or flight response in humans. When a potential threat of danger or a stressor is perceived, the brain sends a message to the adrenal glands that sit on top of the kidneys to activate the release of adrenaline. Adrenaline is released into the bloodstream and is carried around that body where it acts on cells in various locations of the body, to initiate different responses. For example, the release of adrenaline increases heart rate and blood pressure so blood can be carried around the body faster, expands the lungs' air passages so we can take in more oxygen, and enlarges the eyes' pupils so we can take in more light to see better. Adrenaline's main role is to provide energy so that the major muscles of the body can either 'fight' the threat or 'flee' from the threat. Adrenaline is not the only hormone secreted in times of stress or threat. There are others, such as cortisol, which enable an

adrenaline A chemical produced in the body that activates systems for the fight–flight response individual to appropriately respond to the threat – by activating the fight–flight response.

Adrenaline is also secreted from some neurons of the central nervous system such as the brain stem. In this regard it can act as a neurohormone and as a neurotransmitter. Because adrenaline is released at times of acute stress it enhances the likelihood of survival because it arouses the systems

FIGURE 3.21 An eye showing a dilated or enlarged pupil – one of the effects of adrenaline released during a fight–flight response

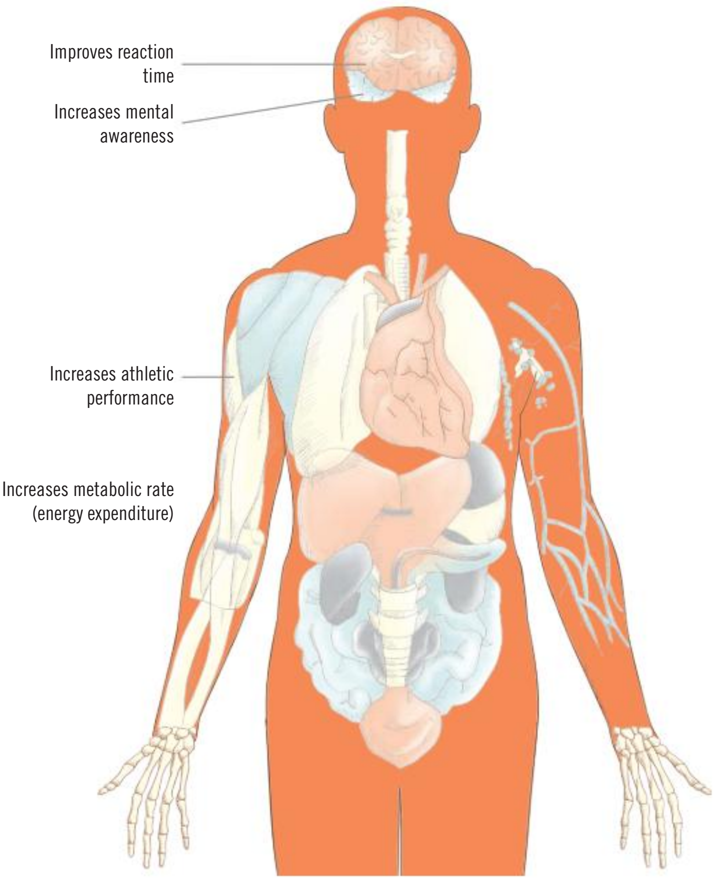

FIGURE 3.22 Adrenaline acts on different areas in the body to increase the level of arousal.

of the body and physically prepares it for action. When stress chemicals such as adrenaline function as neurotransmitters, they affect the storage of memories by activating the **amygdala**, an area of the brain involved in the processing and storage of emotions such as fear, which is discussed in detail in Chapter 5. Normally, people remember things better if they are replayed many times in the mind, but a single emotionally significant event may suffice for neurons to generate long-lasting networks and long-lasting memories.

So what role does adrenaline play in memory and learning? It makes sense that if we were unable to remember potential danger or threats, then our chances of survival would be diminished. Given the function of the sympathetic nervous system activation (fight–flight response), it is logical that activation of the bodily systems, which results from exposure to stress, would enhance attention and, therefore, if we are paying more attention, our memory of the experience should also be enhanced. When adrenaline is secreted into the bloodstream, this allows us to attend to a threat, and very quickly identify methods of escape by getting away from it or overcoming the threat by staying and dealing with it.

For instance, if you were walking down the street on your way to school and were startled by a sudden whooshing noise in the air above and behind you, you would perceive it as a threat. Before you could identify what the noise was and where it was located, you would have crouched down into a protective huddle, raising your hands to protect your head, then looked around quickly to see what the noise or potential danger was. If a magpie suddenly flies past you and narrowly misses your head, you would probably leap up and run away as fast as you could, waving your hands above your head to ward off the bird until you are out of danger. In future, you are likely to remember the experience of being swooped on by the bird and may even navigate a different path to school, thus avoiding the situation. Or, if you were to hear a whooshing noise above you again, you will most likely respond very quickly and hit the ground to avoid being attacked. The ability to learn and remember threats such as these are linked to the secretion of adrenaline because it energises you and contributes to your ability to act quickly when under threat.

Adrenaline is present when we experience both pleasant and unpleasant emotionally arousing events.

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Much research into the effects of adrenaline on memory suggests that adrenaline selectively enhances memory for emotional and arousing information. In adult humans, for instance, a study by Cahill and Alkire (2003) had participants view a series of emotionally evocative images. Immediately afterwards, the researchers administered either a placebo or adrenaline to stimulate sympathetic activation. The participants who received the adrenaline exhibited better memory for the images 1 week later, suggesting that adrenaline is involved in the consolidation of emotional and arousing memory.

3.2 FOCUS ON RESEARCH

HOW COMPUTER GAME PLAY CAN REDUCE INTRUSIVE MEMORIES OF EXPERIMENTAL TRAUMA

Unwanted, intrusive visual memories are a core feature of stress- and trauma-related clinical disorders such as post-traumatic stress disorder (PTSD), but they can also crop up in everyday life. New research shows that even once intrusive memories have been laid down, playing a visually-demanding computer game after reactivating the memories may reduce their occurrence over time.

The findings are published in *Psychological Science*, a journal of the Association for Psychological Science.

'This work is the first to our knowledge to show that a 'simple cognitive blockade' could reduce intrusive memories of experimental trauma via memory reconsolidation processes,' says senior study author Emily Holmes of the Medical Research Council Cognition and Brain Sciences Unit in the UK. 'This is particularly interesting because intrusive memories are the hallmark symptom of PTSD.'

'Currently, there are recommended treatments for PTSD once it has become established – that is, at least one month after the traumatic event – but we lack preventative treatments that can be given earlier,' says Holmes.

'If this experimental work continues to show promise, it could inform new clinical interventions for consolidated memories that could be given a day or so after trauma to prevent or lessen the intrusive memories over time.'

Most people who have experienced a traumatic event don't end up developing PTSD, but they often experience repeated intrusive visual memories of certain moments from the event in vivid detail. Someone who has been involved in a road traffic accident, for example, might continue to re-experience the moment of impact, seeing vividly in their mind's eye the moment a red car crashed into them.

Previous research has shown that people who played the computer game *Tetris* shortly after viewing film of traumatic events experienced fewer intrusive memories over the following week, when they played within 4 hours of viewing the footage. But it's unlikely that many people would be able to receive such immediate treatment following a traumatic event in the real world, so Holmes and colleagues wanted to see whether they might be able to use a similar cognitive procedure to change older, already established memories a day later.

The research draws on existing memory work exploring the theory of reconsolidation as a way of making established memories malleable and vulnerable to disruption, following the reactivation of that memory. They hypothesised that playing *Tetris* – an engaging visuospatial task – after memory reactivation would create a 'cognitive blockade' that would interfere with the subsequent reconsolidation of visual intrusive memories. As a result, the frequency of intrusive memories would be reduced over time.

In two experiments, the researchers had participants view films that contained scenes of traumatic content (for example, footage highlighting the dangers of drunk driving) as a way of experimentally inducing intrusive memories. Participants then returned to the lab 24 hours after watching the film. Using film footage as a form of experimental trauma is a well-established technique for studying reactions, such as intrusive memories, in a controlled setting.

In the first experiment, half of the participants had their memories of the film reactivated by viewing selected stills from the film footage, followed by a 10-minute filler task, and then 12 minutes of playing *Tetris*; the other participants completed only the filler task and then sat quietly for 12 minutes.

The results showed that the participants who had their memories reactivated and played *Tetris* experienced significantly fewer intrusive memories in a diary over the next week than the participants who came to the lab and simply sat quietly for the equivalent period of time.

A second experiment with four groups replicated the findings from the first experiment. Importantly, it revealed that neither reactivation nor Tetris was enough to produce these effects on their own – only participants who experienced both components showed fewer intrusive memories over time.

'Our findings suggest that, although people may wish to forget traumatic memories, they may benefit from bringing them back to mind, at least under certain conditions – those which render them less intrusive,' says study co-author Ella James of the Medical Research Council Cognition and Brain Sciences Unit and the University of Oxford.

'We hope to develop this approach further as a potential intervention to reduce intrusive memories

amygdala A cluster of neurons in the brain's limbic system associated with memory, learning and initiating fear responses

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experienced after real trauma, but we are keen to emphasise that the research is still in the early stages and careful development is needed,' says Holmes. 'Better treatments are much needed in mental health. We believe the time is ripe to use basic science about mechanisms – such as research on memory reconsolidation – to inform the development of improved and innovative psychological treatment techniques.'

Source: Association for Psychological Science. (2015, July 1).

QUESTIONS

1 What was the aim of the experiment?
2 What type of research design was used in the experiment?
3 What is the purpose of a control and experimental condition in this experiment?
4 Describe the results and conclusions of the experiment.

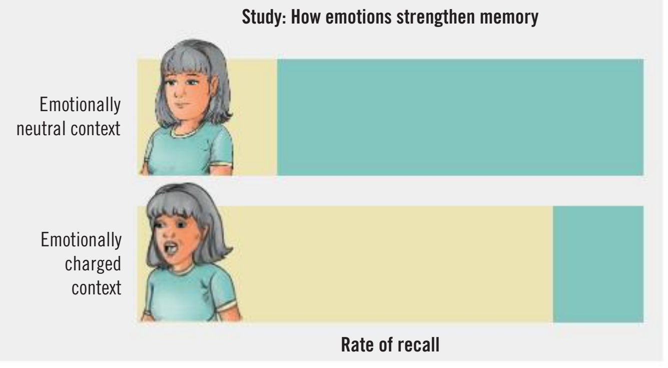

FIGURE 3.23 Adrenaline has been found to selectively enhance memory for emotionally arousing experiences and not for neutral or experiences without the emotionally arousing component.

RESEARCH INTO THE ROLE OF ADRENALINE IN MEMORY

Memory research also suggests that adrenaline and other stress hormones administered after exposure to emotionally arousing experiences improve the consolidation of these events in long-term memory. The studies demonstrate this in a number of different types of studies, ranging from spatial water maze, conditioned taste aversion and object recognition training to inhibitory avoidance studies (Gold & van Buskirk, 1975; Miranda, Quirarte, Rodriguez-Garcia, McGaugh, & Roozendaal, 2008; Okuda, Roozendaal, & McGaugh, 2004; Roozendaal, Bohus, & McGaugh, 1996; Roozendaal, Hahn, Nathan, de Quervain, & McGaugh, 2004).

Do stress hormones also enhance memories of experiences that are not emotionally arousing? The evidence shows us that this is probably not the case. For instance, studies on rats reported that stress hormones improved memory for emotionally arousing experiences when the event was unfamiliar; however, when stress hormones were administered to rats that had habituated to the situation or were familiar with the training, the hormones had no effect (Okuda et al., 2004). In studies using human participants, treatment with adrenaline appears to enhance memory for emotionally arousing material, but not necessarily experiences that are not arousing.

When an emotionally arousing experience is perceived by the brain, the *hypothalamus* (a brain structure responsible for producing many of the body's essential hormones that control a range of physical functions such as temperature regulation, thirst, hunger, sleep, mood and sex drive) sends a signal along the sympathetic nervous system to the adrenal glands, which secrete the hormones adrenaline and noradrenaline. Adrenaline can regulate the strength of memory by regulating the release of noradrenaline from areas in the brain to act on the *amygdala* (a brain structure discussed in detail in Chapter 5). When the amygdala in humans is stimulated, it produces emotion, and in particular fear. When the amygdala is stimulated electrically during research, participants have behaved in an aggressive and or fearful manner. The amygdala provides a rapid, primitive pathway to the cerebral cortex, enabling us to react quickly, which in turn could aid our survival. Activating the amygdala is crucial in order to consolidate emotionally arousing memories. The findings of both animal and human studies provide compelling evidence that stress-induced activation of the amygdala and its interactions with other brain regions involved in processing memory play a critical role in ensuring that emotionally significant experiences are well remembered, and that adrenaline plays a role in activating the amygdala.

Human experiments have also shown that the strength of a memory is regulated by the significance of the experience and that this regulation involves the release of stress hormones. In one experiment, two groups of subjects were read a story and shown a series of slides. They all saw the same slides, but they heard two different stories. One story was 'flat' and emotionally neutral; the other story matched it except for an emotionally arousing description in the middle. Two weeks later, the subjects were asked to state what they remembered of the slides. The group that heard

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the neutral story remembered the slides from all parts of the story equally well (which was poor). There was no difference in recall of the slides from the beginning, middle or end of the story. The other group, however, had significantly superior recall of the slides in the middle, the ones they were looking at when they heard the emotionally arousing description. In a follow-up experiment, half the subjects were given a beta blocker (a drug used to block the effects of adrenaline) before the experiment started. For those who heard the neutral story, the beta blocker made no difference in their recall of the slides. For the participants who heard the emotional story, the beta blocker completely blocked the arousing effect of emotion on memory, preventing the memory from becoming strong.

At times, improving the connection between emotion and memory is a positive outcome because it can lead to remembering events; however, when the connection is too intense and causes an individual to remember particularly traumatic or debilitating memories, this can be problematic. The research involving the effects of adrenaline blockers have some implications for treatment of individuals who suffer from post-traumatic stress disorders, because there is the possibility of blocking the memory using drug therapy.

When adrenaline is released into the bloodstream as a hormone, it does not act directly on the brain as it passes poorly, if at all, into the brain. Instead, it appears that adrenaline influences the brain's function by activating *adrenoreceptors*, specialised receptors located on the vagus nerves (nerves that run around the brain), which project to the base of the brain or brain stem and that are activated by adrenaline. The brain stem then activates the release of noradrenaline, a neurotransmitter that will activate the amygdala and produce the emotional content of the memory. Studies have shown that when the vagus nerve is stimulated after learning, the memory for the learning will be enhanced in both humans and rats (Clark, Naritoku, Smith, Browning, & Jensen, 1999).

Other studies have also provided evidence that arousal influences on memory consolidation involve both adrenaline and cortisol. Administration of drugs that block adrenaline before subjects viewed a series of pictures accompanied by an emotionally arousing story resulted in blocking the enhancing effects of emotional arousal on memory assessed 1 week later (Cahill, Prins, Weber, & McGaugh, 1994). Administration of adrenaline or cold pressor stress (induced by holding an arm in ice water), which induces the release of adrenaline and cortisol (a hormone that helps to arouse the body; discussed in more detail in Chapter 5), immediately after presentation of emotionally arousing pictures enhances subjects' memory of the pictures (Cahill & Alkire, 2003).

With the introduction of new technologies, researchers have been able to use brain imaging techniques such as positron emission technology scans (PET scans), to show some of the activity in the brain when emotionally aroused. Studies have found that the amygdala activation induced by viewing emotionally arousing films increased the memory of the film when tested 3 weeks later (Cahill et al., 1996). A different imaging technique, the functional magnetic resonance imaging (fMRI) technique, which shows the structure and the function of the brain, was used in other studies and found similarly that there is a relationship between amygdala activity during learning and an increase in memory when learning emotionally arousing experiences. In this case, the results showed that the level of emotional arousal had more of an effect on the ability to remember, and that whether the emotional experience was positive or negative did not appear to be critical (Canli, Zhao, Brewer, Gabrieli, & Cahill, 2000).

FOCUS ON RESEARCH 3.3

STIMULATING THE VAGUS NERVE: MEMORIES ARE MADE OF THIS

University of Virginia psychologists have moved the science of memory forward, reporting that stimulating the vagus nerve, which carries sensory messages to and from the brain, releases the neurotransmitter noradrenaline into the amygdala, strengthening memory storage in limbic regions of the brain that regulate arousal, memory and feeling responses to emotionally laden stimuli.

Their findings … outline the neural pathway through which hormones that are released in the body affect specific parts of the brain during meaningful or emotionally arousing events in order to strengthen memories that will later foster sentimental pleasure or torture us with relived trauma.

The researchers, psychobiologists Cedric Williams, Derrick Hassert and Teiko Miyashita, conclude that the vagus nerve is the 'missing link' between the hormone adrenaline *outside* the brain and the neurotransmitter noradrenaline *inside* the brain.

→

'It had always been puzzling how the peripheral release of adrenaline could have these central effects on memory,' says John Disterhoft … a neurobiologist at Northwestern University. 'This work helps us to understand how arousal responses in the body periphery, such as fight or flight, affect the brain – which they must if they are going to enhance learning as much as they are known to do.'

Armed with these new insights, scientists can now more carefully calibrate how they stimulate the vagus nerve to influence the release of noradrenaline, flood the amygdala and strengthen memory. Or they can pursue more efficient blockers to shut out intrusive memories. The implications are many, offering explanations of known phenomena and holding out hope for improved treatments.

Juicing up the brain

Given mounting evidence of vagal nerve interaction with brain biochemistry, the University of Virginia researchers sought direct experimental evidence that stimulating the nerve can cause specific changes in neurotransmitter release.

In the first of two experiments using 31 rats, the researchers surgically implanted electrodes around the left-side vagus nerve. During surgery, they also implanted a microdialysis device that allowed them to sample the concentration of noradrenaline that is released in the amygdala during rest or following vagal stimulation.

Williams and his colleagues stimulated the vagus nerve at a level previously reported by Robert Jensen, his graduate adviser, to improve memory in both laboratory rats (0.4 microAmps for 30 seconds) and humans (0.5 microAmps for 30 seconds). For more than two hours, they collected brain-fluid samples every 20 minutes. In the first experiment, noradrenaline levels increased by 71 percent in the first 20 minutes after the voltage jump and peaked after 140 minutes at a 128-percent increase above baseline. Nothing changed in the unstimulated control group.

This experiment supported the researchers' first hypothesis, that vagal nerve stimulation produces dramatic surges in noradrenaline in a brain area involved with memory storage, a finding that almost certainly generalises to humans. What's more, Williams says, 'The magnitude and time course of changes in amygdala noradrenaline almost mirrored the changes produced by the dose of adrenaline that has been shown to improve memory.'

In the second experiment, the researchers injected the rats with methyl atropine, a drug that blocks the acetylcholine that is released from descending vagal fibers onto peripheral organs, 10 minutes before stimulating the vagus nerve. The blocker – which affects the descending (efferent) fibers of the vagus nerve – didn't change the release of adrenaline any more than did a control solution of saline.

The authors conclude that the findings rule out any role played by negative feedback from the periphery and confirm that the vagus nerve – albeit the ascending fibers – is the mechanism by which peripheral adrenaline activates the release of brain noradrenaline during memory consolidation.

The research solves the mystery of how the adrenal gland could stimulate the release of noradrenaline in the brain, observers say. During stress, the adrenal medulla (near the kidneys) in humans and rats releases adrenaline into the bloodstream, famously causing the 'fight-or-flight' response in the heart, lungs, stomach and elsewhere. However, adrenaline can't cross the blood-brain barrier. So what is the switch that turns on adrenaline? The vagus nerve.

The new evidence provides a close-up look at how emotional events affect the body to influence how well the brain encodes information about exciting or meaningful events. First, emotionally arousing events stimulate the nervous system to release adrenaline. Unable to get into the brain, it does the next best thing: It activates the ascending fibers of the vagus nerve, which in turn stimulate brain neurons in an area of the brainstem known as the nucleus of the solitary tract (NTS).

In this model, NTS neurons release noradrenaline into brain structures that process memory, such as the amygdala and hippocampus. Upon activation, these memory-related regions work harder to properly put the attributes of emotionally arousing experiences into long-term storage.

From vagus to specific

At their most basic, the findings help explain a prior decade of data on how stimulating the vagus nerve (either of the 10th pair of cranial nerves) improves memory processing of recently acquired information.

'These findings fit well with extensive previous evidence that adrenaline regulates memory consolidation, acting via the vagus nerve; that neurons from the NTS release noradrenaline in the amygdala; and that noradrenaline release in the amygdala plays a critical role in regulating the strength of memories,' says James McGaugh, director of the Center for the Neurobiology of Learning and Memory at the University of California …

Adds Robert Jensen, a psychobiologist … at Southern Illinois University: 'Combined with research from other laboratories, the current findings provide strong support for the idea that the neurobiological mechanisms underlying memory modulation by arousal are similar across types of memory tasks and different mammalian species.'

Understanding the pathways of emotional memory can also aid clinical treatment of traumatic memories, observers note. Already, says McGaugh, recent studies show that giving propranolol, which blocks the actions of norepinephrine in the brain, to people who have had traumatic experiences decreases the development of post-traumatic stress disorder symptoms.

Source: Adelson, R. (2004). Stimulating the vagus nerve. *Monitor on Psychology, 35*(4), 36.

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QUESTIONS

1 What was the aim of the experiment?

2 What was the procedure the researchers used with the rats?

3 Can results from this study be generalised to humans? Why or why not?

4 What do the results of the study suggest about the role of the vagus nerve on memory?

3.10 CHECK YOUR UNDERSTANDING >>

1 Emotional responses to a traumatic event are most directly under the control of the:

A somatic nervous system.

B central nervous system.

C autonomic nervous system.

D cerebral cortex.

2 The main difference between a neurotransmitter and a neurohormone is that a neurotransmitter:

A acts directly on a post-synaptic neuron.

B is released into the bloodstream to act on more distant sites.

C is slower acting.

D acts directly on the pre-synaptic neuron.

3 Which of the following is not activated during the fight–flight response?

A Dilation of the pupils

B Release of adrenaline into the body

C Activation of the heart muscles

D Activation of the digestive system

4 Receptors that bind adrenaline are called:

A AMPA receptors.

B adrenoreceptors.

C NMDA receptors.

D norepinephrine receptors.

5 Outline the effect of adrenaline on the body during a fight–flight response.

6 Provide evidence to support the role of adrenaline in the consolidation of emotionally arousing experiences.

7 Which parts of the brain appear to be involved in the consolidation of emotionally arousing experiences?

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CHAPTER SUMMARY

Learning

- Learning is a relatively permanent change in behaviour (or behaviour potential) due to experience. It begins at birth and continues throughout our lifetime. It enables us to function on a daily basis and adapt to changes that are constantly occurring in the world around us.

Memory

- An active information processing system that receives, organises, stores and recovers information when we need it.

Synapse formation

- For learning to occur, neurons need the ability to communicate. The gap between neurons where communication takes place is called the synapse.
- Synaptogenesis refers to synapse formation. Synaptogenesis occurs throughout a healthy person's lifespan, but it occurs most rapidly during early brain development, beginning at about 2 months before birth until approximately 2 years after birth.

Neural plasticity

- Neural plasticity can occur by one of three mechanisms:
  - modification of existing synaptic connections by increasing or decreasing efficacy or strength of the transmission
  - producing growth of new synaptic connections or the pruning back of existing connections
  - modulating the excitability properties of individual neurons.

Long-term potentiation (LTP)

- A form of neural plasticity that leads to long-term excitability of the neurons at the synapse

Long-term depression (LTD)

- A form of neural plasticity that results in long-term depression or a weakened connection between two neurons at the synapse

Neurotransmitters

- Neurotransmitters are chemicals released from the pre-synaptic neuron that cross the synaptic gap to receptor sites on the post-synaptic neuron. These enable chemical messages to travel between neurons and, therefore, throughout the nervous system to the brain and back again.
- Some neurotransmitters have an excitatory effect, and others may have an inhibitory effect.

Neurohormones

- Neurohormones are chemicals that are released from the axon terminals, and instead of crossing the synapse to bind to receptor sites on adjacent cells, they are released into the bloodstream. They can act on cells in more distant sites.
- Some chemicals can do the role of both; act as neurotransmitters and neurohormones (hormones).

Synaptic plasticity

- Synaptic plasticity is the ability of the neuron to change or adapt to changes in the body.
- Synaptic plasticity includes LTP and LTD.

Glutamate

- Glutamate is the most abundant excitatory neurotransmitter in the central nervous system involved in changing the neurons at both the pre-synaptic cell and the post-synaptic cell.
- It is involved in learning and memory in the LTP and LTD processes.

Adrenaline

- Release of adrenaline appears to act on the body as a hormone, and when released from the brain stem, as a neurohormone.
- Adrenaline and noradrenaline are thought to act on the amygdala in the brain when the human body is aroused by emotions such as fear.
- Adrenaline assists in the learning and consolidation of emotionally arousing experiences.

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APPLY YOUR KNOWLEDGE AND SKILLS

SECTION A: MULTIPLE-CHOICE QUESTIONS

Answer the following questions by writing the correct letter in your workbook. Only one answer is correct for each question.

1 The hippocampus is contained within the __________ lobe of the brain.

A occipital
B parietal
C temporal
D frontal

2 Learning is:

A a change in behaviour that involves reflexes, fixed action patterns and maturation.
B a change in behaviour that is relatively permanent and due to reflex actions.
C a change in behaviour that is due to maturation.
D a change in behaviour that is relatively permanent, as a result of experience.

3 The chemicals involved in passing messages across the synapse are called:

A neurotransmitters.
B neurogenetics.
C excitatory chemicals.
D inhibitory chemicals.

4 Plasticity of the brain refers to:

A the brain's ability to remain stable over time.
B the brain's ability to set like 'plastic' when learning occurs.
C the brain's ability to adapt and change when required.
D the brain's inability to adapt and change when required.

5 Synapse formation can occur:

A at any time in a healthy person's life.
B only before the age of 3 years old.
C at any time after the age of 3 years old.
D only in the womb.

6 The term used to describe the formation of a synapse is:

A differentiation.
B multiplication.
C neurogenesis.
D synaptogenesis.

7 Two glutamatergic receptors involved in LTP include:

A AMPA and PET.
B AMPA and NMDA.
C neurotransmitters and neurohormones.
D DNA and NMDA.

8 The chemical thought to be involved in consolidation of emotionally arousing experiences is:

A dopamine.
B seratonin.
C adrenaline.
D insulin.

9 The difference between LTP and LTD is that:

A LTD results in more excitation of the neurons and LTP results in less efficient cells.
B LTD results in less excitation of the neurons and LTP results in more efficient cells.
C LTD only occurs in the hippocampus, whereas LTP occurs everywhere in the brain.
D LTD is faster acting than LTP.

10 Which statement is true for neurotransmitters?

A Neurotransmitters are only found in the brain.
B The most abundant excitatory neurotransmitter is adrenaline.
C Neurotransmitters are released into the bloodstream to act on distant sites.
D Neurotransmitters cross the synaptic gap to bind to receptor sites on the post-synaptic neuron.

11 When glutamate binds to the AMPA and NMDA receptors, what two ions are important to depolarise the post-synaptic neuron?

A Magnesium and calcium
B Calcium and potassium
C Magnesium and potassium
D Calcium and sodium

12 Adrenaline is secreted from the:

A testes and ovaries.
B pancreas.
C hypothalamus.
D adrenal glands.

13 Which part of the brain is thought to play a particularly important role in memory of emotionally arousing experiences?

A The hippocampus
B The amygdala
C The frontal lobes
D The thalamus

14 Hebbian learning refers to the notion that 'neurons that fire together, wire together'. Its defining feature is that:
   A the threshold for firing an action potential is dependent on the type of neuron.
   B the formation of a particular type of neuron occurs at the same stage of development.
   C learning involves increased efficiency in synaptic transmission.
   D neural arrays are formed between similar types of neurons.

15 Synaptic plasticity can include:
   A modification of the strength or efficacy of synaptic transmission.
   B production of new synaptic connections or the pruning of unused connections.
   C modulating the excitability of individual neurons.
   D All of the above

SECTION B: SHORT-ANSWER QUESTIONS

1 Define learning.

2 How do we know that learning has taken place?

3 What is involved in the process of synaptogenesis?

4 Outline two of the effects a neurotransmitter may have on the target cell.

5 The human brain is said to be 'plastic'. What does this term mean when applied to the human brain?

6 Outline three changes to a neuron that occur because of long-term potentiation.

7 What is the difference between long-term potentiation and long-term depression?

8 How is adrenaline involved in the learning and memory process?

9 Compare the similarities and differences between neurotransmitters and neurohormones.

10 Explain the role of glutamate in learning and memory.

SECTION C: EXTENDED-RESPONSE QUESTION

Design an experiment to show the effects of an emotionally arousing video or information on the ability to consolidate information.

Have the members of the class read a short story that is emotionally neutral (perhaps something in the newspaper relating to the weather or similar). In the next lesson, have students report back as many details of the story as they can remember.

Then have the class read a short story that could be emotionally arousing (it could be humorous or sad). In the next lesson, have students report back as many details of the story as they can remember.

Write a report that includes the following:

1 What was the aim of the experiment?

2 Outline the experimental design used. What are the limitations and benefits of using this design?

3 Calculate the number of correct details students could remember of the two stories and discuss any differences between the conditions.

4 Compare these findings to previous studies. Are there any similarities or differences?

5 Outline two ethical considerations when conducting research on human participants.

This question is worth 10 marks.

SECTION D: ASSESSMENT TASK

Read the article below and complete the task that follows.

SHUTTERSTOCK.COM/AFRICA STUDIO

SHOULD YOU DRINK COFFEE BEFORE OR AFTER A LEARNING TASK?

Researchers at Johns Hopkins University in the US conducted a randomised, double-blind controlled experiment into whether caffeine enhanced memory consolidation. Participants were 160 healthy females aged 18–30.

All the participants undertook a memory task. They were given cards that showed random indoor and outdoor objects, and asked to classify them as belonging to the indoors or outdoors. Participants were then given pills to swallow. Half were given pills containing 200 mg of caffeine, and half were given placebos. The levels of caffeine in their saliva were then tested after 1, 4 and 24 hours.

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The next day (24 hours later), participants were tested on their recollection of the previous day's items. They were given cards showing items from the original test, cards showing new items, and cards showing items that looked similar to the originals. Participants were tasked with classifying these items as old (the same as the previous day), new or similar.

The researchers found that a statistically significant percentage of participants in the caffeinated group was more likely to mark the 'similar' items correctly as 'similar' rather than 'old'. This finding showed that the caffeinated participants were better than the non-caffeinated participants at distinguishing between the original items and the other items that had been presented.

Another test was done on the second day, where caffeine was given to participants 1 hour *before* undertaking a learning task. The results of the experimental group were not significantly different to those of the control group.

The researchers also tested different doses of caffeine (100 mg, 200 mg and 300 mg) and found that there was a difference between the results of the 100 mg and the 200 mg doses but not between the 200 mg and the 300 mg dose.

The researchers were concerned that participants may have been aware that they were ingesting caffeine, and that this may have altered the results. On debriefing, however, they found an even split in the number of participants who thought they had ingested caffeine and those who thought they had taken a placebo.

There have been several animal studies that have shown caffeine to have positive effects on preservation of neuronal structures. Studies have also found a positive effect of post-training administration of caffeine on consolidation of memory. The researchers concluded that their study demonstrated that caffeine did enhance consolidation of memories when ingested *after* undertaking a learning task.

Information based on Jogalekar, A. (2014, January 14).

TASK: EVALUATION OF RESEARCH

1 Write a possible hypothesis for this experiment.

2 Identify the operational independent and dependent variables.

3 Which research design was used by the researchers? Discuss some advantages and limitations for selecting this design.

4 What were the findings of the research?

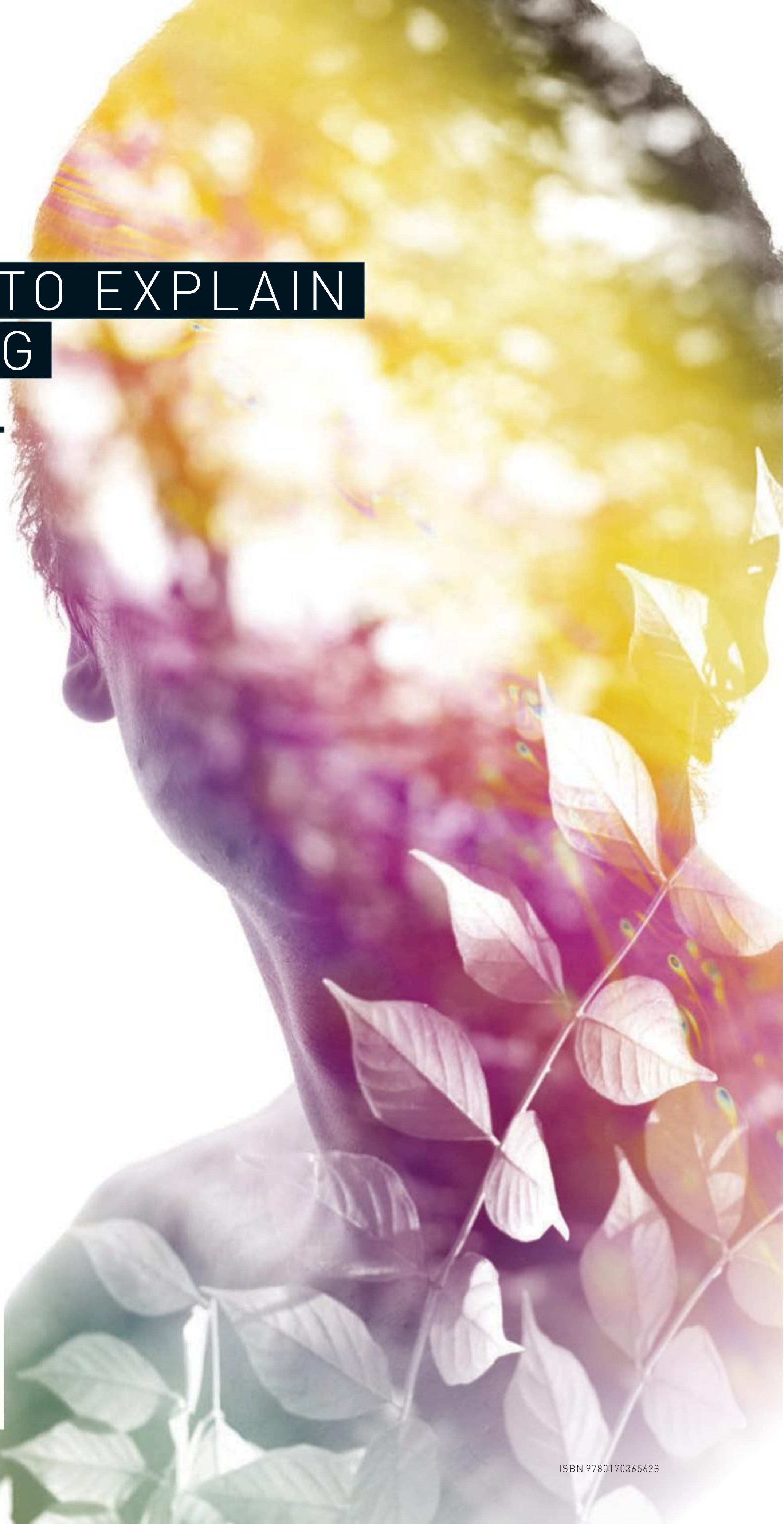
5 Discuss some limitations or possible extraneous or confounding variables for this study.

6 If you were to conduct the study, what improvements could be made to the study?

7 Can the results for the study be generalised?

CHAPTER 04

MODELS TO EXPLAIN LEARNING



GETTY IMAGES/HOLLY HILDRETH

KEY KNOWLEDGE INCLUDES:

- classical conditioning as a three-phase process (before conditioning, during conditioning and after conditioning) that results in the involuntary association between a neutral stimulus and unconditioned stimulus to produce a conditioned response, including stimulus generalisation, stimulus discrimination, extinction and spontaneous recovery
- operant conditioning as a three-phase model (antecedent, behaviour, consequence) involving reinforcers (positive and negative) and punishment (including response cost) that can be used to change voluntary behaviours, including stimulus generalisation, stimulus discrimination and spontaneous recovery (excluding schedules of reinforcement)
- observational learning as a method of social learning, particularly in children, involving attention, retention, reproduction, motivation and reinforcement
- the 'Little Albert' experiment as illustrating how classical conditioning can be used to condition an emotional response, including ethical implications of the experiment.

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WHAT PRODUCES LEARNING?

You may think that simply repeating a response or a behaviour means that it has been learnt. But this is not necessarily the case. For example, you could close your eyes and swing a tennis racquet hundreds of times without learning anything about actually hitting a tennis ball. So how do we learn skills such as how to play tennis? To understand the process of learning, we must understand some of the basic principles behind it.

Reinforcement is the key to some learning. Reinforcement refers to any event that increases the likelihood that a response will occur again. A response is any identifiable behaviour that is elicited by (produced as a result of) a stimulus. Responses may be observable actions, such as blinking or turning a doorknob, or they can also be internal behaviours, such as having a fast heartbeat. A stimulus is any object or event that elicits a response.

Reinforcement can assist the learning process in a number of ways. To teach a dog a trick, you could reinforce correct responses by offering a food reward each time the dog performs the trick. Similarly, you could teach a child to be tidy by praising them for picking up their toys. Reinforcement can also occur in other ways. For instance, if a girl gets stung by a bee, she may learn to fear bees. In this case, the girl's fear is reinforced by the pain she feels immediately after seeing the bee.

How do we know if learning has taken place? Unlocking the secrets of learning begins with noting what happens before and after a response. Events that precede (or come before) a response are called antecedents. The effects of a response are the consequences.

There are many different ways to learn, and these are not necessarily independent of each other. How an organism learns depends on the situation and can vary for each individual. We will now examine some different types of learning that use these principles.

CLASSICAL CONDITIONING: ASSOCIATING A STIMULUS WITH A RESPONSE

If you own a dog and walk it regularly, you may find that your dog can tell when it is time for a walk – whenever you pick up its lead, the dog leaps about excitedly. The dog has learnt to associate you picking up the lead with going for a walk. This learning is the result of classical conditioning, a basic type of learning.

Classical conditioning (also known as Pavlovian or respondent conditioning) is a form of learning based on the repeated association of two normally unrelated stimuli. At its core, classical conditioning depends on reflex responses. A reflex is an involuntary stimulus-and-response connection that is innate. Reflexes are essential for survival because they allow us to react quickly to stimuli that may do us harm. For example, if you are walking outside on a windy day and debris is blown in your face, you automatically blink. This reflex is essential in order to protect your fragile eyes from potential damage that may be caused by the debris. You haven't learnt to blink, instead it is an involuntary response to the wind and debris (stimulus) that you are able to do from birth. Other examples of reflexes include reflexively withdrawing your hand from a hot substance, the pupil in the eye narrowing when it is exposed to bright light, and salivating when you eat various foods. These reflexes are unconditioned, or in-built, and therefore are not dependent on learning. Reflex responses are below the level of conscious awareness; in other words, they are involuntary responses.

To begin learning via classical conditioning, we need a stimulus that reliably triggers a reflex response. Imagine, for example, that a puff of air (the stimulus) is aimed at your eye. The puff of air makes you blink, which is a reflex-based response, every time. Now, assume that we sound another stimulus, a horn, just before each puff of air hits your eye. This process is repeated many times, and soon the sound of the horn alone makes you blink, and the puff of air is not necessary. So, what happened? Clearly, you've learnt something: previously, the horn did not make you blink, but now it does. You have learnt to associate the horn

reinforcement Any event that increases the likelihood that a response or behaviour will occur again

response Any identifiable behaviour, external or internal, that is elicited by a stimulus

stimulus Any object or event that elicits a response

antecedent An event that comes before a response

consequence An event that comes after a response; the effect of the response

classical conditioning A form of learning where two normally unrelated stimuli are repeatedly linked so that existing reflex responses are elicited by new stimuli; also known as Pavlovian or respondent conditioning

reflex A simple response to a stimulus that is innate or involuntary

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with the puff of air, and in consequence, your response is to blink. This is an example of classical conditioning.

Learning by classical conditioning is evident when, after a stimulus that elicits a reflex response is repeatedly associated with a new stimulus that previously did not elicit a response, the new stimulus elicits the response on its own (see Figure 4.1).

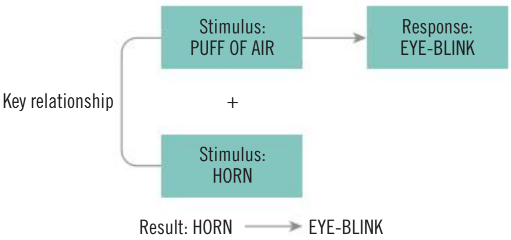

FIGURE 4.1 In classical conditioning, a stimulus that does not elicit a reflex response is paired with a stimulus that does. After many such pairings, the stimulus that previously had no effect begins to produce a response on its own.

4.1 CHECK YOUR UNDERSTANDING >>

1 An antecedent is best described as:
   A any event that comes after a response.
   B any event or stimulus that precedes a response.
   C a reflex response to a stimulus.
   D a learnt response due to the likelihood of a consequence.

2 A reflex can be defined as:
   A an involuntary behaviour that is a simple response to a stimulus.
   B a voluntary behaviour that is a simple response to a stimulus.
   C an involuntary behaviour that is learnt through experience.
   D a voluntary behaviour that is learnt through experience.

3 In classical conditioning, learning takes place by association. This means that an association forms between two events that:
   A are similar in nature.
   B are completely unrelated.
   C have similar consequences.
   D occur closely together in time.

4 Define the terms 'stimulus' and 'response' and use them in an example.

5 Explain how a reflex is involved in learning through classical conditioning.

HISTORY OF CLASSICAL CONDITIONING

In the beginning of the 20th century, something happened in the laboratory of Russian physiologist Ivan Pavlov that would bring him lasting fame. It was this: Pavlov's subjects drooled at him.

Pavlov was studying the digestive system and salivary glands of dogs. The dogs were placed in a soundproof room and a restraining apparatus kept them in position. A tube was surgically attached to the dogs' salivary glands, and this fed their saliva into a cup so that it could be measured (see Figure 4.2).

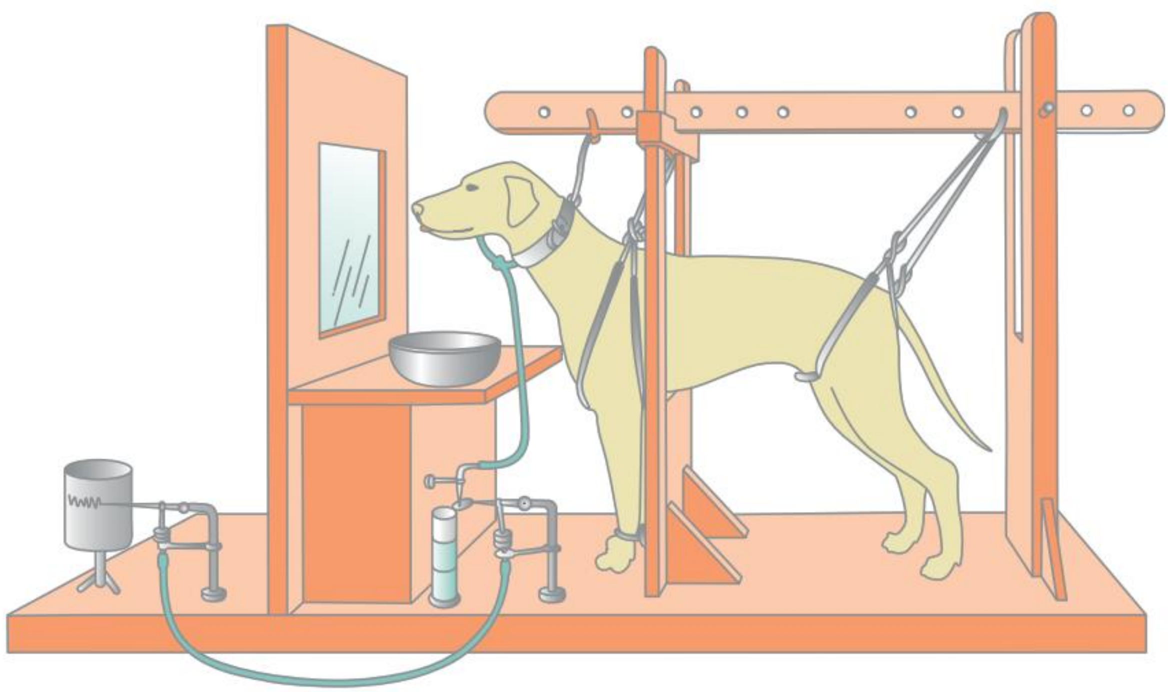

FIGURE 4.2 An apparatus similar to that used in Pavlov's experiments: A tube carries saliva from the dog's mouth to a lever that activates a recording device (far left).

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To produce salivation, Pavlov placed meat powder or some food on the dogs' tongues. After doing this many times, Pavlov noticed that the dogs were salivating before the food reached their mouths. Later, the dogs even began to salivate as soon as they saw Pavlov or his assistants enter the room. Was this misplaced affection? Pavlov knew better.

Salivation is normally a reflex response. You start to salivate so that your body can get ready to break down and digest food. For the animals to salivate at the mere sight of Pavlov, some type of learning must have occurred. Pavlov realised that the dogs had learnt to expect that they would be given food when a person entered the room, because they had learnt the association between people and food. They already had the in-built or reflexive response to salivate when food was presented; thus, they began to salivate at the mere sight of a person, in anticipation of the food that would closely follow. Pavlov called this type of learning classical conditioning.

Pavlov's conditioning experiments: A three-phase process of learning

To understand the classical conditioning learning theory, it is useful to think of the term 'conditioning' as the training or learning process. Before 'conditioning' occurred, the dogs did not produce salivation in response to Pavlov or his assistants. It was only after training, or repeated exposure to the people followed immediately by the food, that the dogs were considered 'conditioned'. Therefore, they produced a response to stimuli (the people) they didn't have any response to initially. After Pavlov's initial observations, he began his famous experiments into classical conditioning.

PHASE 1: BEFORE CONDITIONING (BEFORE LEARNING)

To begin, Pavlov chose a neutral stimulus (NS). A neutral stimulus is a stimulus that does not elicit any specific response before learning has occurred. Any object or event can be a neutral stimulus, as long as it does not elicit any specific response in the organism. Pavlov chose a bell to use as his NS, because the sound of the bell did not elicit any particular response in the dogs. Because Pavlov knew that meat powder would automatically cause the dogs to salivate, he called the meat powder the unconditioned stimulus (UCS). The UCS is a stimulus that is innately capable of eliciting a reflex response. Pavlov also gave the actual reflex response a name – he called it the unconditioned response (UCR) – or non-learnt response.

Neutral stimulus (NS) → No response

Bell → No response

Neutral stimulus (NS) + Unconditioned stimulus (UCS) → Unconditioned response (UCR)

Bell + Meat powder → Salivation

PHASE 2: DURING CONDITIONING (DURING LEARNING)

Acquisition refers to the learning (conditioning) itself; the acquiring or gaining of knowledge or skill. The acquisition process includes the overall period of time taken to acquire the learnt response; that is, the period during which several trials are carried out and learning takes place. During this time, the organism will acquire a response to a previously neutral stimulus by learning to associate it with a previously unrelated stimulus that innately produces a response.

In classical conditioning, the NS must be presented before the UCS numerous times in order to become the CS – all of these trials make up the acquisition process.

In his first experiments, Pavlov rang the bell (NS) loud enough for the dogs to hear it, then he immediately placed meat powder (UCS) on the dogs' tongues, which automatically caused the reflex of salivation (UCR). This process was repeated many times and is the acquisition phase of learning: bell > meat powder > salivation. Eventually, as conditioning took place, the dogs began to salivate when they heard the bell and they no longer needed the meat powder to elicit salivation. By association, the bell, which had previously had no effect, began to evoke the same response as the meat powder. The dogs had acquired a learnt response to the once neutral stimulus.

To acquire a behaviour through classical conditioning, a CR must be reinforced (strengthened) during training. In classical conditioning, reinforcement occurs when the NS is immediately followed by, or paired with, the UCS. It has been found that learning to

neutral stimulus (NS) A stimulus that does not naturally elicit any specific response

unconditioned stimulus (UCS) A specific stimulus that is innately capable of eliciting a reflex response

unconditioned response (UCR) The natural, automatic response to a specific unconditioned stimulus

acquisition The learning itself; the gaining (acquiring) of knowledge or a skill

acquisition process The process of learning the conditioned response

acquisition phase The period of time between presentation of a stimulus and receiving reinforcement

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associate two normally unrelated stimuli occurs most rapidly when the NS (the bell) is immediately followed by the UCS (food). With most reflexes, the optimal delay between the presentation of the NS and the UCS is from half a second to about 5 seconds (Schwartz & Robbins, 1995). When the delay between the presentation of the NS and the UCS is any longer than 5 seconds, the conditioned behaviour is generally not acquired as the organism does not appear to associate or link the two together.

PHASE 3: AFTER CONDITIONING (AFTER LEARNING)

The third phase of classical conditioning involves the learner consistently producing a conditioned response to a previously neutral stimulus without it being paired with the stimulus that innately produces the response. We know that learning has taken place if the organism can now produce a response to what was once the neutral stimulus.

When the bell could consistently produce the response of salivation in the dogs without the meat powder or food, the bell was no longer a neutral stimulus. It had become a conditioned stimulus (CS) – a stimulus that, because of learning, elicited a specific reflex-based response. When the dogs began to salivate at the sound of the bell, this was a new response to the previously neutral stimulus (now the conditioned stimulus) that had occurred as a result of learning. Therefore, we refer to the new salivation response as a conditioned response (CR) – that is, a learnt response to a previous NS. It is important to note that the CR is due to the CS. In the case of Pavlov's dogs, they were producing saliva before conditioning took place because they were presented with food, but after the conditioning, the production of saliva is due to the ringing of the bell. Figure 4.3 gives an overview of this process.

4.2 CHECK YOUR UNDERSTANDING >>

1 In classical conditioning, an organism develops an association between:
- A the conditioned stimulus (CS) and the conditioned response (CR).
- B the neutral stimulus (NS) and the conditioned stimulus (CS).
- C the conditioned stimulus (CS) and the unconditioned stimulus (UCS).
- D the neutral stimulus (NS) and the unconditioned response (UCR).

2 In Pavlov's experiment on salivation in dogs, the NS was ________ and the CR was ________.
- A the meat powder; salivation due to the meat powder
- B the bell; salivation due to the meat powder
- C the meat powder; the bell
- D the bell; salivation due to the bell

3 Learning is said to be complete in classical conditioning when:
- A the NS has become the CS and reliably produces a UCR without the UCS.
- B the NS has become the CS and reliably produces a CR without the UCS.
- C the CS and the UCS produce a UCR.
- D the CS and the UCS produce a CR.

4 Using the language of classical conditioning, explain the three phases of classical conditioning.

5 Use the language of classical conditioning to explain how you would know whether someone has been conditioned.

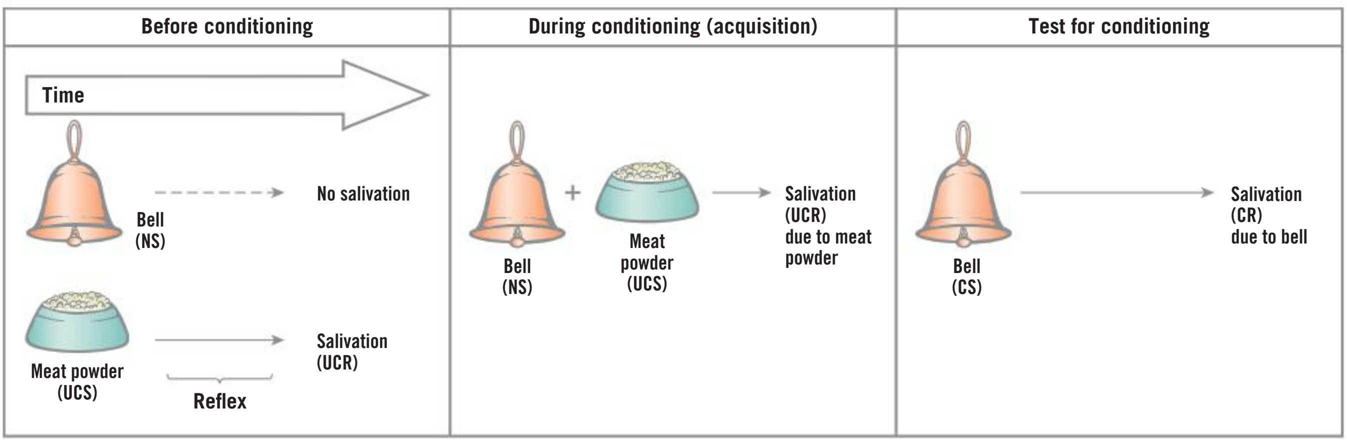

FIGURE 4.3 The classical conditioning process: After being paired with the unconditioned stimulus (UCS) that produced the unconditioned response (UCR), the neutral stimulus (NS) becomes the conditioned stimulus (CS), producing the conditioned response (CR).

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PRINCIPLES THAT INFLUENCE CLASSICAL CONDITIONING

Pavlov soon discovered that the learning that takes place during classical conditioning procedures is subject to a number of principles. If we wanted to observe these principles in action, we might, for example, try to recreate a version of Pavlov's classical conditioning procedure, where we conditioned a dog's salivation response to a bell. The dog's reactions might then be used to explore the following principles of classical conditioning.

Stimulus generalisation: They all look the same to me

After conditioning, **stimulus generalisation** occurs when stimuli similar to the CS trigger the CR (see Figure 4.4). For example, we might find that our dog salivates to the sound of a ringing telephone or doorbell, because these sounds are similar to the sound of the bell used as the CS.

Stimulus generalisation explains why many shops carry imitations of nationally known products. For many customers, positive attitudes conditioned to the real products tend to generalise to the cheaper knock-offs (Till & Priluck, 2000).

FIGURE 4.4 This cat has learnt to salivate when it sees a cat food box. Because of stimulus generalisation, it also salivates when shown a similar-looking box of washing powder.

An example of stimulus generalisation is when you condition a person to blink each time you play a particular note on a piano. If you play slightly higher or lower notes that are similar in pitch to the conditioned note, blinking may occur almost as often as when the correct note is played – so, generalisation occurs. However, as these new stimuli become less similar to the original CS, generalised responding decreases. If the notes you play are significantly higher or lower and bear little resemblance to the conditioned note, the person is not likely to blink in response (see Figure 4.5). If the person does not blink when notes other than the correct note are played, they have learnt to discriminate.

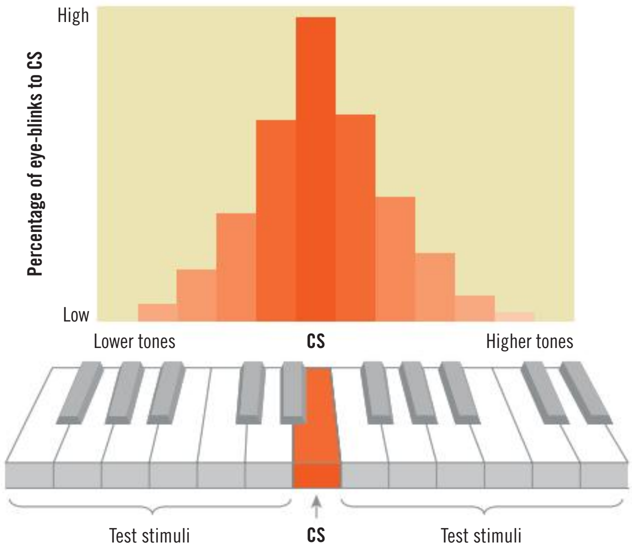

FIGURE 4.5 A person conditioned to blink when a particular note is played (CS) is less likely to respond as the notes become more dissimilar to the CS.

Stimulus discrimination: Knowing the difference

Let's consider one more idea with our dog. Suppose the dog is again conditioned with the bell as the CS. As an experiment, we occasionally sound a horn instead of the bell but never follow it with the UCS (food). The dog will not salivate to the sound of the horn because it perceives the horn to be a different stimulus to the CS (the bell). The dog has now learnt to discriminate, or respond differently, to the different stimuli even though they may sound similar – the bell produces salivation but the horn does not. **Stimulus discrimination**, therefore, is when an organism will only produce the CR when exposed to the CS; they will not have a CR to other stimuli, even if the stimuli are similar to the CS.

conditioned stimulus (CS) A stimulus that evokes a specific response due to learning

conditioned response (CR) A reflex response to a previously neutral stimulus that occurs after learning has taken place

stimulus generalisation When stimuli similar to the conditioned stimulus produce the conditioned response

stimulus discrimination The ability to discriminate between stimuli so that only a specific stimulus produces the conditioned response

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Extinction and spontaneous recovery: Gone but not forgotten

After conditioning has occurred, what would happen if the UCS no longer followed the CS? If the UCS never again follows the CS, the CR will eventually extinguish. Let's return to the dog and the bell. If you ring the bell (CS) many times and do not follow it with food (UCS), the dog's expectancy that 'bell precedes food' will weaken. As this occurs, the dog will lose its tendency to salivate (CR) when it hears the bell. Thus, we see that a classically conditioned response can be weakened by removing reinforcement – in this example, the food no longer reinforces the bell. This gradual decrease in the strength or frequency of a response that has been conditioned, when the UCS is no longer present, is called extinction.

Several extinction sessions may be necessary to completely reverse conditioning. If the bell (CS) is rung until the dog stops salivating (CR), it might seem that extinction of the CR is complete. However, if the bell is again rung after a period of apparent extinction, the dog may suddenly produce the CR and start to salivate. The reappearance of a CR following a period of apparent extinction is called spontaneous recovery. This response, however, is usually weaker and more short-lived than the original CR.

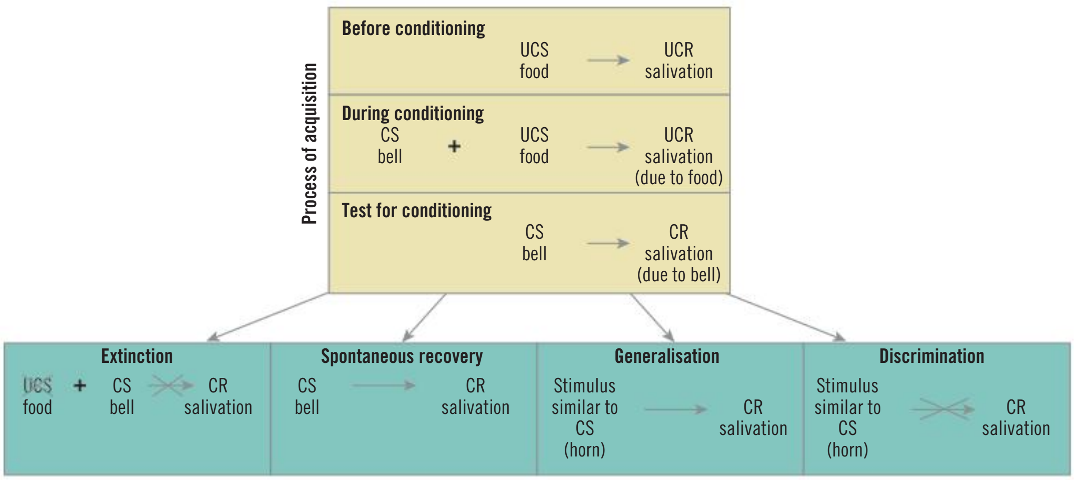

FIGURE 4.6 Classical conditioning: A summary of the processes of acquisition, extinction, spontaneous recovery, generalisation and discrimination

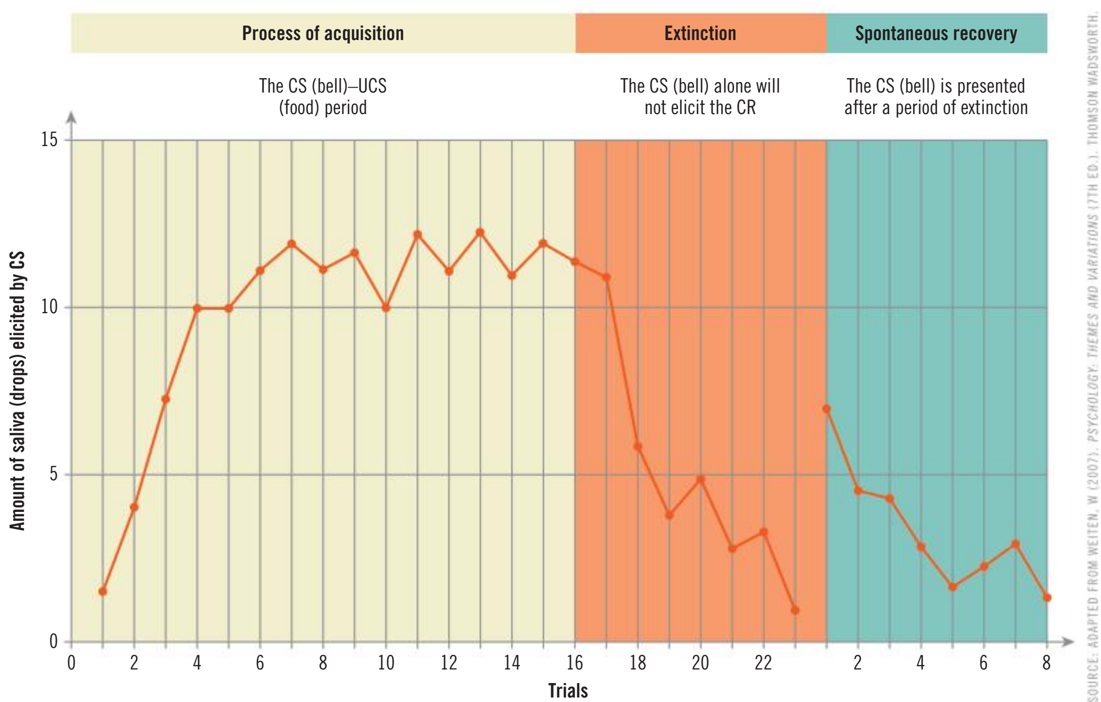

FIGURE 4.7 A graph of the results of one of Pavlov's experiments, showing acquisition (learning), extinction (when the CS is presented a number of times alone) and spontaneous recovery after a period of extinction

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4.1 TRY IT YOURSELF >>

CLASSICAL CONDITIONING

Create a scenario that shows the before, during and after conditioning phases of a behaviour learnt through classical conditioning. In your example include the elements of spontaneous recovery, extinction, stimulus discrimination and generalisation.

Scenario:	
Before conditioning:	
During conditioning:	
After conditioning:	
Extinction:	Spontaneous recovery:
Stimulus discrimination:	Stimulus generalisation:

4.3 CHECK YOUR UNDERSTANDING >>

1 After Pavlov had conditioned his dogs to salivate to the bell, he repeatedly presented the bell without presenting the food. As a result, __________ occurred.
   A stimulus generalisation
   B stimulus discrimination
   C latent learning
   D extinction

2 Hannah is extremely afraid of rats but not of hamsters or guinea pigs. This phenomenon is called:
   A spontaneous recovery.
   B stimulus discrimination.
   C stimulus generalisation.
   D reflexive awareness.

3 Mary's cat runs to the back door when the microwave bell sounds as this usually signals that her dinner is about to be served. The cat also runs to the back door when Mary's doorbell rings. When Mary's cat responds to the doorbell, it is demonstrating:
   A stimulus discrimination.
   B stimulus generalisation.
   C spontaneous recovery.
   D extinction.

4 Identify the NS, UCR, UCS, CR and CS in the following example.

   As a child, you were playing in the backyard one day when a neighbour's pet cockatoo flew into the yard. It did not bother you, but your mother (who is terrified of birds) screamed, snatched you into her arms and ran inside with you. Her behaviour caused you to cry. Every time the bird flew into the yard, your mother would react in the same way. You now have a fear of cockatoos, and when you see one you start to feel scared.

5 Using the scenario in the question above involving the classically conditioned fear response to cockatoos, explain how the concepts of extinction, spontaneous recovery, stimulus discrimination and stimulus generalisation could apply.

OPERANT CONDITIONING: A THREE-PHASE MODEL OF LEARNING

Imagine that you are at a shopping centre and you are hungry. You are nowhere near the food court, but you spy a vending machine against the wall. You deposit your last two dollars to buy a chocolate bar. You press the button, but nothing happens. You press the other buttons, try the coin return, and look around for some help. Still nothing. Impulsively, you kick the machine. Then, as you turn away, out pops a chocolate bar plus 50 cents in change. Once this happens, chances are you will repeat the 'kicking response' in the future. If it pays off several times more, kicking vending machines may become a regular behaviour because you have learnt that a desired consequence follows your actions. In this case, your learning is based on operant conditioning.

ANTECEDENT, BEHAVIOUR AND CONSEQUENCE: THE ABC OF OPERANT CONDITIONING

Operant conditioning (also known as instrumental learning) is the learning process in which the likelihood of a behaviour being repeated is determined by the consequences of that behaviour. Operant conditioning can be broken into three phases: the antecedent, the behaviour and the consequence(s) (the ABC of operant conditioning).

The antecedent (A)

An antecedent is the stimulus that comes before or is the precursor to the response in operant conditioning. An antecedent is sometimes referred to as a discriminative stimulus because it creates the conditions or environment that primes or signals

extinction The gradual decrease in strength or frequency of a conditioned response when the unconditioned stimulus is no longer available

spontaneous recovery The reappearance of a conditioned response to the conditioned stimulus after a period of apparent extinction

operant conditioning A learning process in which the likelihood of a behaviour being repeated is determined by the consequences of that behaviour

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for the organism to behave towards the stimulus in a particular way; that is, it gives clues to help the person distinguish the most appropriate response to the stimulus. Asking an individual to 'get to work' or asking the dog to 'sit' are both examples of antecedents that prompt the organism to behave in a particular way – in these cases, to do the work and sit. Objects in the environment, such as traffic signs and signals can also be viewed as antecedents – when a driver sees a stop sign, this is the stimulus that precedes the behaviour of 'stopping'.

The behaviour (B)

The behaviour is the response to the stimulus the organism makes because of the antecedent stimulus. Generally, most operant responses (behaviours) are considered voluntary because the learner decides what their response will be. Therefore they play an active role in the learning process. The individual in the vending machine scenario behaved in such a way voluntarily; they made a choice about whether to kick the machine or do something else.

The consequence (C)

A consequence then follows the behaviour and may result in either pleasant or unpleasant circumstances for the organism, thus they influence the likelihood of the behaviour being repeated or not repeated in the future when the person is exposed to the antecedent stimulus. In the scenario involving the vending machine, the vending machine is the antecedent, which primes the organism to behave in a particular way. How? When the individual behaves by 'kicking' the vending machine, the consequences (in this case a positive reinforcement of chocolate and money are the result) help determine how the individual will behave when they are presented with the antecedent in the future. If they experience a pleasant consequence, they are more likely to repeat the kicking behaviour in the future. Alternatively, if the consequence following their kicking behaviour were to be punishment, perhaps by receiving a fine or being yelled at by the shopping centre security, this unpleasant circumstance would reduce the likelihood of the kicking behaviour being repeated in the future.

A behaviour or response to an antecedent or discriminative stimulus is followed by a consequence. Consequences can come in the form of reinforcement or punishment or there may be no consequence at all. If a consequence is pleasant for the person, it reinforces the response, or makes it stronger. Therefore, reinforcement makes it more likely that the response will be repeated (such as receiving food after kicking a vending machine). If the consequence comes in the form of a punishment, it is unpleasant for the person, so it weakens the response and this makes the consequence less likely to be repeated (such as being reprimanded for kicking a vending machine). Sometimes the response may produce no change in the person's circumstance, so there is no consequence at all.

Imagine that you are learning to drive your parents' car. As you approach a set of traffic lights, the lights turn from green to amber and then red. As you perceive this change in the lights to red (antecedent stimulus), you slow the car down (behaviour) until it comes to a halt at the intersection, thus the consequence is to avoid an accident with cars travelling in the other direction with the green light and also a potential fine or loss of licence for disobeying the law.

4.2 TRY IT YOURSELF >>

OPERANT CONDITIONING: ABC

Construct a table and include four more examples of operant conditioning using the ABC of the three-phase model.

ANTECEDENT	BEHAVIOUR	CONSEQUENCE
Teacher asks a question	You answer correctly	Praise from teacher

THE SKINNER BOX AND RAT STUDIES

Most studies of operant conditioning take place in a conditioning chamber – an apparatus designed by American psychologist B. F. Skinner for the study of operant conditioning in animals. For this reason, this device is often called a Skinner box. A typical Skinner box is a small, cage-like chamber. There is little in the box to stimulate the animal. The walls are bare, except for a metal lever, one or more stimulating lights, and a tray or hatch into which food pellets can be dispensed (see Figure 4.8). The operation of a Skinner box helps us to understand the process of operant conditioning.

In one of Skinner's experiments into operant conditioning, he placed a hungry rat inside a Skinner

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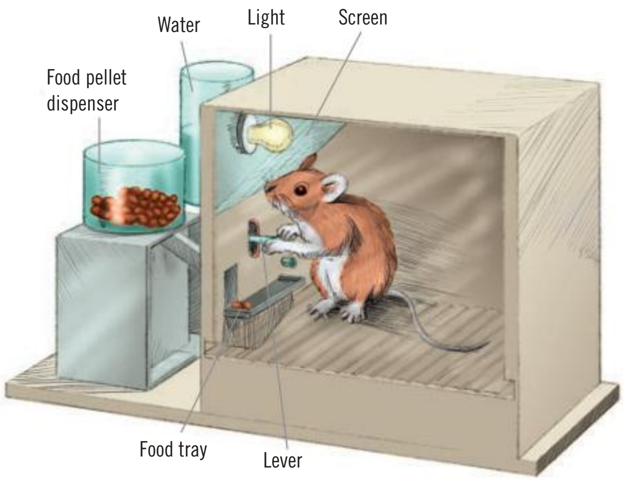

FIGURE 4.8 The Skinner box

box. His aim was to train the rat to make a response based on receiving reinforcement. Hunger kept the rat motivated to seek out food as a reinforcer.

When Skinner placed the rat in the box, the lack of stimulation meant there was little for it to do after it had explored the corners of the cage. After investigating the cage, it ultimately (and probably accidentally) placed a paw on the lever. When the lever was pressed, a food pellet (or a drop of water) was dispensed into a tray so the rat could eat it. When the rat pressed the lever again, the same thing happened. Soon the rat settled into a pattern of pressing the lever and receiving food.

In follow-up experiments, Skinner used a light to teach the rats to know when to expect a reinforcer. When the lever was pressed and a light was illuminated, the food appeared in the tray. When the lever was pressed and the light did not illuminate, no food appeared in the tray. The rats learnt to press the lever several times until the light illuminated, then sought out their food.

We should note that in these situations the rat did not acquire new skills – the rat was already physically able to depress the lever. The food reward only altered how frequently the rat pressed the lever. In operant conditioning, reinforcement is used to alter the frequency of responses, or to mould them into new patterns.

Similar to classical conditioning, operant learning is based on information and expectancies. In operant conditioning, we learn that a particular stimulus is associated with a particular response, which is then associated with a consequence (Dragoi & Staddon, 1999). From this point of view, a reinforcer tells a person or an animal that a response was 'correct' and worth repeating, and punishment tells a person or an animal that a response was 'incorrect' and therefore not worth repeating.

4.4 CHECK YOUR UNDERSTANDING >>

1 The three-phase model of operant conditioning includes the following sequence:
- A antecedent, consequence, behaviour.
- B discriminative stimulus, consequence, behaviour.
- C consequence, behaviour, antecedent.
- D antecedent, behaviour, consequence.

2 Three-year-old Violet always kicked and screamed when her mother dressed her. One morning, Violet's mother gave her a toy and was then relieved to be able to finish dressing Violet in peace and quiet. In terms of the three-phase model of operant conditioning, if the antecedent stimulus in this scenario is considered to be the mother beginning to dress Violet, then the behaviour would be:
- A Violet playing with the toy.
- B Violet kicking and screaming.
- C Violet quietly dressing herself.
- D Violet stopping the kicking and screaming.

3 In many situations, parents and children can reinforce each other. So if the antecedent stimulus is now considered to be Violet kicking and screaming, then the operant response would be:
- A the mother giving Violet a toy.
- B the mother continuing to dress Violet.
- C the mother being relieved that Violet is quiet.
- D the mother asking Violet to be calm and quiet.

4 Every morning David's alarm goes off to alert him that it is 7 a.m. and time to get out of bed. When David hears the alarm, he turns it off and gets out of bed, which enables him to get to school on time. Identify the elements of the three-phase model of operant conditioning in this example.

5 Use an example from your own experience where you have learnt something as a result of operant conditioning. Identify the antecedent, behaviour and consequences in your example.

REINFORCEMENT

If a consequence increases the likelihood of a behaviour occurring in the future, it acts as a reinforcer because it has made the behaviour stronger. According to operant conditioning theory, there are two types of reinforcement, positive reinforcement and negative reinforcement.

behaviour The actions and mannerisms in which an organism behaves in response to a particular situation or stimulus

The idea that reward affects learning is certainly nothing new to parents (and trainers of animals). However, parents, as well as teachers, politicians, supervisors and even you, may use reward in ways that are inexact or misguided. The problem begins with the term 'reward' in itself – to be correct, it is better to say 'reinforcer'. Why? Because rewards do not always increase responding, whereas reinforcers do. What is reinforcing for one person may not be for another. For example, if you give liquorice lollies to a child as a 'reward' for good behaviour, it will work only if the child likes liquorice.

Therefore, in terms of operant conditioning, we always use the term 'reinforcer'. In operant conditioning, psychologists define an operant reinforcer as any event that follows a response or behaviour and increases the probability of the response or behaviour being repeated.

Reinforcement in operant conditioning must be appropriate (desirable) for the learner; otherwise they will not produce the desired response. Alternatively, if the consequence is not seen as desirable by the learner, it may act to reduce the probability of the response being repeated. For example, unless your teachers offer some type of reinforcement that you see as worthwhile to gain (such as a smile and praise or the achievement of a good grade) for completing homework, you may not do your homework. If your teacher offered you extra work as a reinforcer for doing your homework, you may find this undesirable and in the future you may not complete your homework.

Positive reinforcement

Positive reinforcement occurs when a pleasant or desirable event follows a response and generally increases or strengthens the likelihood of that response occurring again. You may have received positive reinforcement at some time during your school life; for example, when you received praise for completing a maths question or painting a beautiful portrait. Of course you are going to be pleased with this praise and will want to receive it again, so in future you will be more likely to repeat the behaviour to again receive this positive reinforcement.

Negative reinforcement

Negative reinforcement occurs when an unpleasant stimulus is removed, reduced or prevented, thus creating a positive consequence, and this in turn strengthens or increases the frequency or likelihood of a desired response. So if an organism does a desired behaviour, then an unpleasant event or stimulus will be removed. Negative reinforcement increases the rate of responding, but it does so by ending discomfort. For example, imagine that you have a headache and in response to that headache you take an aspirin. Your aspirin-taking behaviour will be negatively reinforced if the headache stops; the likelihood of you taking an aspirin next time you have a headache is increased because you have received a pleasant consequence after doing a behaviour and this in turn caused an unpleasant situation to end.

Positive and negative reinforcement can both be used to obtain a desired behaviour. For example, a rat could be taught to press a lever to obtain food (positive reinforcement), or the rat could be taught to press a lever to turn off a continuous mild electric shock it receives through the bottom of its cage (negative reinforcement). Either way, the desired behaviour (pressing of the lever) would increase because it leads to a pleasant consequence (receiving food or ceasing the electric shock). Often, positive and negative reinforcement combine in the same situation. For example, if you are uncomfortably hungry, eating a meal is reinforced by the nice-tasting food (positive reinforcement) and also by the end to the feeling of hunger (negative reinforcement). Next time you feel hungry you will eat something because you have learnt that eating takes away the unpleasant feeling of hunger and you will also enjoy the taste of the food.

4.5 CHECK YOUR UNDERSTANDING >>

1 Receiving a gold star on your work in primary school was a form of praise and was intended to:
   A act as a positive reinforcement and increase the likelihood of you repeating the behaviour.
   B act as an antecedent so that you would recognise how much work you had completed.
   C act as negative reinforcement and increase the likelihood of you repeating the behaviour.
   D cause extinction of the learnt behaviour.

2 Michael was home alone with his children when they started to fight and argue in the lounge room. To stop the fight, Michael sent one child to their room, and the other he ordered outside. Michael could then watch the football without the children fighting. What was the consequence for Michael?
   A Positive reinforcement
   B Negative reinforcement
   C Discriminative stimulus
   D Stimulus generalisation

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3 The child Michael sent to their room enjoyed playing with the toys and didn't want to leave when told they were allowed to come out. The consequence of being sent to their room was:
   A positive reinforcement.
   B negative reinforcement.
   C stimulus discrimination.
   D extinction.
4 Compare the similarities and differences between positive and negative reinforcement. Give an example of each.
5 Explain the difference between a reward and a reinforcer.

PUNISHMENT

Many people mistake negative reinforcement for punishment. However, while negative reinforcement increases the likelihood that a behaviour will occur again by removing an unpleasant stimulus, punishment involves a response being followed by the introduction of an unpleasant stimulus (a punisher) which applies something unwanted – and this decreases the likelihood of that response occurring again. Punishment, in the form of reprimands, jail sentences, firings and failing grades, is commonly used to change undesirable behaviour.

The difference between negative reinforcement and punishment can be seen in a hypothetical example. Let's say your bedroom is next door to your brother's or sister's room and their stereo is blaring loudly. If you pound on the wall and the volume suddenly drops (negative reinforcement), you will be more likely to pound on the wall when they play loud music in the future. But if you pound on the wall and the volume increases (punishment), or if your sibling comes into your room and yells at you (punishment), there is less likelihood that you will pound on the wall again.

A punisher is any unpleasant consequence that reduces the likelihood of a behaviour being repeated. It is not always possible to know ahead of time what will act as a punisher for a particular person. For example, if Jessica gets a poor grade on her psychology SAC because she spent too much time on the computer instead of studying, and her mother reprimands her for the poor grade, in the future Jessica is likely to study more and limit her use of the computer. In this instance, the reprimand was a punisher. However, if Kirsty is in the same situation as Jessica, but Kirsty is also starved for attention of any kind from her parents, for Kirsty this reprimand might actually reinforce her poor behaviour because it results in her getting attention from her parents. In this case the reprimand is not a punisher.

Response cost: A different type of punishment

Isn't it also punishing to have privileges, money or other positive things taken away from you? Yes – punishment also occurs when a reinforcer or positive state of affairs is removed. This type of punishment is called response cost. Response cost is sometimes referred to as 'negative punishment' as it involves removal of a pleasant stimulus or circumstance as a consequence of an undesirable behaviour. The term 'response cost' is perhaps more intuitive than 'negative punishment' because it infers that the behaviour, such as doing something illegal like driving too fast, will 'cost' you in the form of a fine or loss of your licence. If a desirable state or a reinforcer is taken away as a consequence of a particular behaviour, this will reduce the likelihood of that behaviour occurring in the future. Examples of response cost include parents who 'ground' their teenage children for misbehaviour (by taking away their freedom) and drivers who are fined or lose their licence for breaking the road laws (by taking away their money or their privilege to drive a car).

Variables affecting punishment

Many people assume that punishment stops undesirable behaviour, but this is not always true. In fact, the effectiveness of punishers greatly depends on their timing, consistency and intensity.

Punishment works best when it occurs as the response is being made, or immediately afterwards (timing), and when it is given each time a response occurs (consistency). Thus, you could effectively

positive reinforcement When a pleasant or desirable event follows a response and generally increases or strengthens the likelihood of that response occurring again

negative reinforcement When a response removes, reduces or prevents an unpleasant stimulus and creates a positive consequence; it increases or strengthens the likelihood of that response occurring again

punishment Any event following a response that decreases the likelihood of the response occurring again because it introduces an unpleasant stimulus

punisher Any unpleasant stimulus that reduces the likelihood of an unwanted behaviour occurring again

response cost When a reinforcer or positive state of affairs is removed following a response, and this decreases the likelihood that this response will occur again

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punish a dog that barks incessantly by spraying water on its nose each time it barks. Ten or 15 such treatments are usually enough to greatly reduce barking. This would not be the case if you did not apply punishment every time you heard the dog bark, or if you left it too long between the barking behaviour and the punishment. If you discovered that your dog dug up a tree in the backyard while you were not at home, punishing the dog when you get home hours later will do nothing to prevent the behaviour being repeated next time you are absent.

For punishment to be effective it must be an appropriate deterrent; in other words, it must 'fit the crime'. If it is too harsh (intensity) it may lead to avoidance behaviour or fear; conversely, it must also be severe enough to act as a deterrent to repeating the undesirable behaviour.

Limitations of punishment as a learning technique

The major limitation of using punishment as a learning technique is that it only tells a person or animal that a response was 'wrong'. It does not indicate what the 'right' response is, so it does not teach new, desirable behaviours. Generally speaking, punishment is painful, frustrating or both; therefore, it sets up a powerful environment for learning aggression. For example, if a child is punished, the child may feel angry, frustrated and hostile and may express their emotions by being aggressive towards someone else. If the child enjoys this aggressive act because it helps them release anger and frustration, their aggression has been reinforced instead of punished and will probably be repeated again in other frustrating situations. In a study of classroom discipline problems, it was found that physical punishment, yelling and humiliation are generally ineffective in changing behaviour. However, positive reinforcement, in the form of praise, approval and reward, is much more likely to quell classroom disruptions, defiance and inattention (Tulley & Chiu, 1995). Additionally, sometimes the people associated with giving the punishment become feared, resented or disliked by those being punished.

Table 4.1 outlines the types of consequences we have examined. Figure 4.9 shows how the consequences relate to each other.

TABLE 4.1 Types of consequences

CONSEQUENCE	WHAT IT INVOLVES	EFFECT ON FUTURE BEHAVIOUR
Positive reinforcement	Introducing something the organism likes (applying something pleasant)	Strengthened – response likely to be repeated
Negative reinforcement	Removing something the organism doesn't like (removing something unpleasant)	Strengthened – response likely to be repeated
Punishment	Introducing something the organism doesn't like (applying something unpleasant)	Weakened – response not likely to be repeated
Response cost	Removing something the organism likes (removing something pleasant)	Weakened – response not likely to be repeated

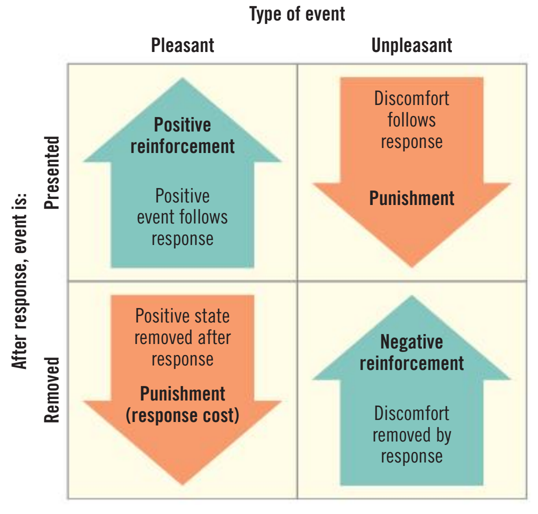

FIGURE 4.9 Types of reinforcement and punishment: The impact of an event depends on whether it is presented or removed after a response is made. The arrows depict the likelihood of a response occurring again in the future.

4.6 CHECK YOUR UNDERSTANDING >>

1 A punisher could be unintentionally functioning as a reinforcer if:

A spontaneous recovery occurs.

B it comes too late after the behaviour.

C the frequency of the behaviour increases.

D the frequency of the behaviour decreases.

2 Julian was swinging on his chair in class and fell off, hurting his back. This is an example of:

A negative reinforcement.

B positive reinforcement.

C punishment.

D response cost.

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3 Now, whenever Julian sees a chair (the antecedent), he makes certain he sits on it properly (behaviour) in order to avoid the pain and embarrassment (consequence) caused by the fall. This is an example of:
   A negative reinforcement.
   B positive reinforcement.
   C punishment.
   D response cost.
4 Forms of punishment (including response cost) are criticised as they only focus on undesirable behaviour and do not necessarily lead to the acquisition of desirable behaviour. Identify and explain two factors that make the use of punishment and response cost effective.
5 Write a scenario depicting the use of punishment or response cost as a consequence. Clearly identify the antecedent, the behaviour and the consequence.

PRINCIPLES THAT INFLUENCE OPERANT CONDITIONING

Stimulus generalisation

Is stimulus generalisation the same in operant conditioning as it is in classical conditioning? Basically, yes. Operant stimulus generalisation is the tendency to respond in the same way to stimuli similar to the antecedent stimulus; that is, when similar stimuli produce the same (or similar) conditioned responses to a previously learnt stimulus.

FIGURE 4.10 Sniffer dogs are taught to use stimulus discrimination to recognise contraband such as drugs, explosives and foods.

A rat placed in a Skinner box may learn to generalise stimuli if it is reinforced when it presses the lever after a coloured light goes on in the box. If the light is initially red and the rat receives a food pellet after it presses the lever, then the light changes to orange and the rat again receives a food pellet when it presses the lever, it may learn to press the lever no matter what colour the light is. If the stimulus is similar to the original, then a similar response may be transferred to those stimuli.

Stimulus discrimination

As stated earlier, stimulus discrimination refers to the ability to respond only to certain stimuli and not to others, even if they are similar.

If a rat placed in the Skinner box is reinforced for lever-pressing when a light is on but not when it is off, responses continue to be made when the light is on, but seldom, if at all, when the light is not on. This means the rat has learnt to discriminate between light and dark. Likewise the rat may press the lever with different amounts of force, and if only strong responses are reinforced, the rat will in turn press more forcefully. If only the weak presses are reinforced, then eventually the rat will only respond with a weak lever press.

Through operant stimulus discrimination, an organism will learn to differentiate between stimuli that signal reinforcement and non-reinforcement. As a result, their response pattern will shift to match these antecedent stimuli (stimuli that precede reinforced and non-reinforced responses).

Stimulus discrimination is demonstrated by sniffer dogs who locate drugs and explosives at airports. Operant discrimination is used to teach these dogs to recognise contraband. During training, they are reinforced only for approaching containers or bags baited with drugs, explosives or food – not simply any bags or containers (see Figure 4.10).

Spontaneous recovery (following apparent extinction)

Learnt responses that are not reinforced, can gradually fade away. This process is called operant extinction, which refers to the learnt response to the antecedent

operant stimulus generalisation The tendency to respond to stimuli similar to stimuli that precede operant reinforcement

operant stimulus discrimination The ability to differentiate between stimuli similar to the stimuli that signal reinforcement and non-reinforcement

operant extinction When the learnt response gradually decreases in strength or rate of response after reinforcement stops

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gradually decreasing in strength or rate of response when reinforcement stops. Just as acquiring an operant response takes time, so does extinction. For example, if a dog was taught to sit down by commanding him to 'Sit', and was reinforced with a food treat each time he did so, would he stop sitting if no more food was given? Yes he may, but not immediately. Likewise, if there is a student who constantly disrupts the class, their behaviour may extinguish over time if they were ignored and therefore didn't receive reinforcement in the form of attention from the teacher and other students.

Antecedent → Behaviour → Consequence
Command 'Sit' → Dog sits → Food treat

In the example above, when the food treat is removed as a consequence, the dog's sitting behaviour will eventually stop. When the dog consistently ignores the command, extinction has occurred.

Even after a period of apparent extinction, the previously reinforced response may suddenly return. This is **operant spontaneous recovery**. For example, if the dog's sitting behaviour has stopped because he has not been reinforced for the behaviour, the dog may hear the command 'Sit' and produce the conditioned response of sitting again. Generally, when an organism shows spontaneous recovery of the conditioned response, the behaviour produced will be weaker than the original conditioned response. It also will not continue for long if reinforcement is not given, and after a shorter period of time the behaviour will once again become extinct.

According to Skinner, essentially every response to stimuli can be understood as an operant response that occurs because in the past it has been reinforced, or similar responses have been reinforced (and we have applied generalisation). In some cases we are aware of the relationship between the response and reinforcement, such as when we study we get a good score on a SAC or when we work in part-time employment and we get paid. In some cases, however, we may not be aware of a relationship, but it exists nonetheless (Gray, 1994). An experiment conducted many years ago by Hefferline and colleagues (1959) illustrated that humans can learn subtle conditioned responses to stimuli without their apparent awareness. This study is examined in Focus on research 4.1.

FOCUS ON RESEARCH 4.1

GIVING THE THUMBS UP

Hefferline and colleagues placed adult participants into two groups. Participants were to sit in comfortable chairs and listen to music for an hour. Static was occasionally superimposed over the music.

One group was told that the experiment was about the effects of music on body tension. They were not told anything about the static or whether or how it could be removed. The second group was told that static would sometimes be heard over the music and that they would be able to turn the static off, but that they needed to discover the response to turn it off.

The response to turn off the static, for both groups, was in fact a small twitch of the left thumb. Participants in both groups were connected to an electrical recording system, so that the experimenter could sit in another room and monitor their muscle activity. When a participant's left thumb twitched, a signal was sent to the experimenter, and the experimenter would turn off the static for a set period of time.

Hefferline and colleagues found that all participants made the thumb-twitch response, and made it increasingly as the experiment progressed, thereby removing the static sounds for increasingly longer periods as the session progressed. Interestingly, however, while participants reported noticing a decrease in the instances of static, none of them could identify the response they had made to make the static stop. Even participants in the group that was given the task of discovering the response did not correctly identify the left thumb-twitch as the response to turn off the static. One participant humorously claimed that it involved 'subtle rowing movements with both hands, infinitesimal wriggles of both ankles, a slight displacement of the jaw to the left, breathing out, and then waiting' (Hefferline et al., 1959).

Although none of the participants could identify the correct response, they must have unconsciously learnt it, because all participants made the response consistently and increasingly during the experiment. It is interesting to think that it is possible that in everyday life we make unconscious connections between our responses and reinforcement, as we fine-tune our behaviour to learn and develop skills, and to accomplish tasks.

QUESTIONS

1 What was the aim of the experiment?
2 What was the difference between the two groups of participants?
3 The experimenters used deception in the procedure of this experiment. Was this ethical?
4 What were the results of the study?

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4.7 CHECK YOUR UNDERSTANDING >>

1 In operant conditioning, when an organism responds to stimuli similar to the antecedent, they are using:
   A stimulus generalisation.
   B habituating.
   C adaptation.
   D stimulus discrimination.

2 In operant conditioning, a response will eventually disappear if reinforcement is withheld. This is called:
   A spontaneous recovery.
   B stimulus generalisation.
   C stimulus discrimination.
   D extinction.

3 The unexpected reappearance of the conditioned behaviour to the antecedent stimulus after a period of extinction is called:
   A generalisation.
   B spontaneous recovery.
   C shaping.
   D positive reinforcement.

4 Using the language of operant conditioning, provide an example of stimulus generalisation and stimulus discrimination.

5 Morgan is an 8-year-old boy who has difficulties learning. A psychologist is working with Morgan. Morgan continually interrupts their sessions by getting out of his chair and walking around the room. The psychologist wants to teach Morgan to stay in his chair for the entire session. Using the language of operant conditioning, explain how the psychologist could change Morgan's behaviour.

4.2 FOCUS ON RESEARCH

PIGEON-GUIDED MISSILES

Behavioural analyst, author, innovator, poet, social philosopher, and Harvard professor of psychology, Burrhus Frederic Skinner (1904–1990) was certainly a highly influential jack-of-all-trades. He invented the operant conditioning chamber, the cumulative recorder, the teaching machine, and pioneered his own scientific philosophy, 'Radical Behaviorism'. What he is perhaps less revered for is his development of a rather unique and potentially calamitous missile guidance system during WWII.

The US Navy was in need of a weapon capable of countering the formidable German Bismarck class battleships. Missile technology did already exist; the problem was that the guidance systems were too large and too primitive for the missiles to be considered effective. While the military desperately worked on these rudimentary electronic guidance systems, Skinner, keen to be of service, sought government funding for a top secret project to overcome the problem. His idea sounded simple: he would train pigeons to guide the missiles, tapping a target on a screen with their beaks to control the direction.

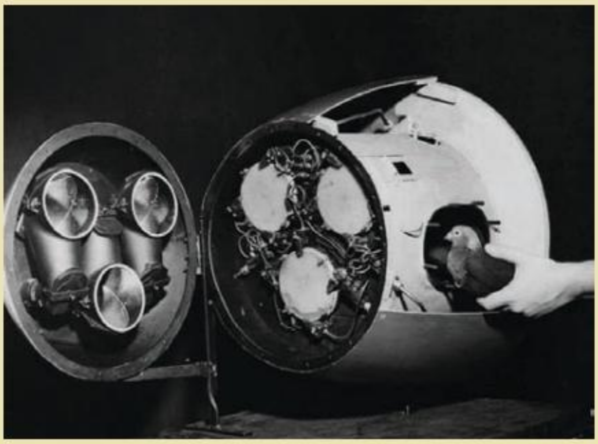

FIGURE 4.11 A pigeon-guided missile

The nose cone of the missile would be split into three compartments, with a lens projecting an image of the intended target onto a screen at the front. A pigeon in each compartment, trained by operant conditioning to recognise the target, would peck at it continually. Pecks to the centre of the screen caused the missile to fly straight, whilst off-centre pecks tilted the screen which would alter the missile's course.

At first, and to Skinner's frustration, government funding for the project did not come flooding in. However, after a shaky start, the National Defense Research Committee overcame initial scepticism to contribute $25 000 to the cause. This seemed to pay off. Test runs were successful; the pigeons pecked reliably, holding the missiles on course even when falling at a rapid pace, undaunted by the terrifying noise of war. Project Pigeon seemed to be taking off. In fact the pigeons were so compliant in his experiments and so rapid in their general behaviour that Skinner vowed never again to work with rats.

Yet despite this early success, Skinner could not get his project to be regarded with the respect he felt it deserved by the necessary authorities. And so, on 8 October 1944, the programme was discontinued. The military were of the opinion that 'further prosecution of this project would seriously delay others which in the minds of the Division have more immediate promise of combat application'. Namely (although unbeknownst to Skinner), Radar.

Skinner was bitter. 'Our problem was no one would take us seriously,' he complained. One of the arguments against his project was that perhaps, as a professor and student of human behaviour, he should have second-guessed: few people would feel confident in the knowledge that, guiding their 1742 kg weapons of mass destruction was not a highly complex electronics system, but three brainwashed pigeons frantically pecking at a rudimentary screen.

Source: Military Times (2010, November 10). Pigeon-guided missiles. *Military History Monthly*.

operant spontaneous recovery The reappearance of a previously reinforced response after a period of apparent extinction

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QUESTIONS

1. According to the article, what was the aim of Skinner's training with pigeons?
2. Explain the process using the three-phase model of operant conditioning Skinner may have used to train the pigeons.
3. Discuss two possible ethical issues with this research.

4.3 TRY IT YOURSELF >>

CONDITIONING COMPARISON

Complete the table comparing classical conditioning to operant conditioning.

CLASSICAL CONDITIONING	OPERANT CONDITIONING
Explanation of learning:	Explanation of learning:
Role of learner:	Role of learner:
Three phases of learning:	Three-phase model of learning:
Extinction	Extinction
Spontaneous recovery	Spontaneous recovery
Stimulus discrimination	Stimulus discrimination
Stimulus generalisation	Stimulus generalisation

OBSERVATIONAL LEARNING: A METHOD OF SOCIAL LEARNING

Early theories to explain how behaviour is learnt focused on an individual's inner forces in the form of needs, drives and impulses, often operating below the level of awareness. These theories were driven by personality theorists, and because they theorised that behaviour was caused by forces within the individual, explanations into how behaviour is learnt followed this line of thinking. These theories were criticised for many reasons, including the lack of empirical evidence to support them.

Focusing on the possible inner forces that might drive behaviour enabled psychologists to interpret the events that had already happened, but they still could not predict how people would behave in given situations (Mischel, 1968). They realised that if a theory is to help us adequately understand human behaviour, it must accurately identify the factors causing the behaviour and the determinants that produce related changes in behaviour. This realisation started a shift in the focus from internal factors that caused changes to behaviour, to external influences. Research into whether behaviour is influenced by the environment was able to demonstrate that behaviour can be produced, eliminated and then reinstated by varying external influences. This became known as social learning theory. Social learning theory is based on the assumption that the learner can make symbolic mental representations of the modelled behaviour they observe, rather than learning through specific stimulus-response associations such as classical and operant conditioning (Bandura, 1971).

There is little doubt that many skills are learnt by what psychologist Albert Bandura (1971) called **observational learning**, or modelling. Observational learning occurs when we watch (observe) the actions of another person (a **model**) and note the consequences of that person's actions, then we decide whether to imitate them or not. In other words, modelling is any process in which information is imparted by example, before direct practice is allowed (Rosenthal & Steffek, 1991).

The value of learning by observation is obvious. Imagine trying to tell someone – not show them – how to tie a shoelace, do a dance step, swim or play a guitar. Bandura believes that anything that can be learnt from direct experience can be learnt by observation. This is because humans have the capacity to learn large, integrated units of behaviour indirectly through observation without having to build up the patterns gradually through direct experience. Often, this allows a person to skip the tedious trial-and-error stage of learning where you learn from making a series of incorrect responses until you eventually find the correct response.

It seems obvious that we learn by observation, but how does it occur? By observing a model (someone who serves as an example), a person may learn new

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TABLE 4.2 Attention, retention, reproduction, motivation and reinforcement in observational learning

	ATTENTION	RETENTION	REPRODUCTION	MOTIVATION/REINFORCEMENT
Observer factors in observational learning	Observers cannot learn unless they pay attention to what's happening around them.	Observers must be able to remember what was happening around them at the time of observation by making a mental representation of the observed behaviour	Observers must be capable (physically and psychologically) of reproducing the act.	Observers will only learn what they have observed if they have some motivation or reason to do so. The presence of reinforcement can be an important aspect to motivation.
Other factors	If the observer likes or can identify with the model, then learning is more effective.	Information is more readily retained if the observer can encode and structure the information in an easily-remembered form.	Some tasks require the use of skills the observer will not have; e.g. carefully watching a clown juggle will not necessarily mean you can learn to juggle. It is a skill that requires coordination and practice.	If the person observing the model is appropriately reinforced, they are more likely to repeat the task. Also, if the model being watched is reinforced, the observer is more likely to perform the task.

responses, to carry out or avoid previously learnt responses, or a general rule that can be applied to various situations.

ELEMENTS OF OBSERVATIONAL LEARNING

For observational learning to occur, several factors must be involved. These include attention, retention, reproduction, motivation and reinforcement.

- *Attention*: The learner must pay attention to the model; the learner must perceive the model to be interesting in one way or another. If the learner does not pay attention or recognise the important features of the model's behaviour, then they will not learn through observation. Simply exposing an individual to a model will not mean that they will attend closely to them. It has been found that models with interesting qualities are more likely to succeed in grabbing the learner's attention and models who lack pleasing characteristics tend to be ignored.
- *Retention*: The learner must remember (retain) what was done by the model so that the information can be encoded and stored in their memory system for later use. The learner does this by making a mental representation of the model's behaviour using two representational systems, one using images and the other using verbal representations.
- *Reproduction*: The learner must be able to reproduce (form a reproduction, or copy, of) the modelled behaviour, so they must have the psychological and physical capacity to be able to demonstrate the modelled behaviour. For example, most people watching a world-record level shot-putter will not be able to replicate the behaviour just by paying attention and storing a mental representation of the throwing actions. Unless they have the physical strength, they won't be able to demonstrate the learning. However, they may be able to demonstrate that they have learnt through observation by achieving a rough approximation of the behaviour and improve by practising and making adjustments on the basis of the feedback they gain in their performance.
- *Motivation*: The learner must have the desire, or motivation, to repeat the observed behaviour.
- *Reinforcement*: The learner must perceive some form of reward for repeating the observed behaviour. Normal reinforcement determines if it will be repeated thereafter.

Table 4.2 summarises these factors. In general, models who are attractive, trustworthy, capable, admired, powerful or high in status also tend to be imitated (Bandura & Walters, 1963; Brewer & Wann, 1998).

observational learning When learning occurs by watching (observing) others and noting the consequences of their actions, then imitating or not imitating their behaviour

model Someone who serves as an example in observational learning

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4.8 CHECK YOUR UNDERSTANDING >>

1 Helen recently saw her young daughter, Charlotte, hit her doll violently with a spoon. Helen wants to reduce Charlotte's aggressive behaviour towards her doll. In terms of observational learning, Helen should:

A remove the doll and spoon from Charlotte.

B smack Charlotte every time Charlotte hits her doll.

C speak kindly and behave in a caring way towards Charlotte's doll.

D provide negative reinforcement for Charlotte whenever Charlotte hits her doll.

2 Robyn carefully watches a chef on television baking a cake so that she can improve her cooking skills. The chef is a well-known expert in the culinary world and Robyn is trying to copy his technique. Robyn wants to improve her sponge cakes to impress her family. Robyn wanting to improve her baking skills to impress her family relates to which factor that might influence Robyn's learning?

A Attention

B Retention

C Reproduction

D Motivation

3 Robyn is not able to whisk the cake mix as fast as the chef on the television because her arms are not strong enough. Which factor may be involved in Robyn's inability to learn through observation in this instance?

A Attention

B Retention

C Reproduction

D Motivation

4 Identify one difference and one similarity between learning using observation and operant conditioning.

5 Peter has always wanted to learn how to surf so that he can go surfing with his brother. He buys himself a surfboard and goes to the nearest surf beach to watch the surfers and learn how to surf. Using the five stages of observational learning, explain the learning process that Peter would go through.

CHILDREN LEARN BY IMITATING MODELS: BANDURA'S BOBO DOLL EXPERIMENTS

In a series of classic experiments in the 1960s, Albert Bandura set out to test social learning theory – that new patterns of behaviour can be acquired through direct experience or by observing the behaviour of others. Specifically, he wanted to test whether children would learn to behave aggressively if they observed models (in most cases adults) act aggressively. He used preschool-aged children who watched an adult attack a large blow-up clown: the Bobo doll. The first study used adult models (live, in person), that either did or did not play aggressively with a Bobo doll (Bandura, Ross & Ross, 1961). A follow-up study investigated whether filmed models were as influential as live models (Bandura, Ross & Ross, 1963a). The researchers found that aggression in the children increased in both cases when the model behaved aggressively towards the Bobo doll; that is, whether they observed the live adult model in the room or whether they observed the filmed version (see Figure 4.12). Bandura and his colleagues conducted many more studies into the effect of modelling on aggressive behaviour in children. We will now look at some specific experiments undertaken by Bandura.

In one study, Bandura and colleagues used adult models who interacted with each other, rather than with Bobo dolls. Bandura's subjects were preschool-aged children who were invited, one at a time, to play in a room filled with toys. On the way to the toy-room, the researcher took each child on a detour via the researcher's office, on the pretext that the researcher had to collect something. While each child waited outside the office, they were exposed to one of four conditions. In the first condition, children were instructed to watch a video on a television that showed two adult models playing, and then one model physically attacked the other. The attacker was then rewarded with toys and treats to eat. In the second condition, children were shown a video that depicted the same aggressive attack, but this time the attacker was punished. In the third condition, children were shown a video where two models played together without any aggression. In the fourth condition, children were not shown a video at all as they waited outside the office.

Each child was then taken to the toy room and left alone to play with various toys. Among the toys there were two Bobo dolls. The children were observed through a one-way mirror, and the number of aggressive acts towards the Bobo dolls was recorded.

The results showed that the children who observed the film where the aggressive attacker was rewarded displayed significantly more aggressive acts when playing alone than children from any of the other conditions. A summary of the results is shown in Figure 4.13. Logic would tell us that the children attacked the Bobo doll instead of being aggressive with the other toys because the Bobo doll was the most similar of the toys to human form, and hence the best imitation of the behaviour they had witnessed.

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FIGURE 4.12 A preschool-aged child imitates the aggressive behaviour of an adult model he has just seen in a film, in one of Bandura's experiments.

Another study by Bandura and colleagues used preschool-aged children again – this time the children were divided into three groups. The first group saw a live adult sit on a Bobo doll, punch it, hit it with a hammer and kick it around the room. The second group saw a movie of these actions. A third group saw a cartoon version of the aggressive acts.

In each of the conditions, the aggressive model was either rewarded with lollies and praise from another adult, punished verbally and physically with a smack, or neither rewarded nor punished. Later, after all of the children had watched the model, the children were frustrated by having some attractive toys taken away from them. Then they were allowed to play with the Bobo doll in a room where experimenters could watch each child's behaviour through a two-way mirror. Some children were offered incentives such as sweets and praise for imitating the model's behaviour, and some were not. During their play with the Bobo doll, most children imitated the adult's attack. Some even added new aggressive acts of their own! Interestingly, the cartoon was only slightly less effective in encouraging aggression than the live adult model and the filmed model (Bandura, Ross & Ross, 1963b).

The results of the experiment indicate that the consequences for the model that the children viewed had an effect on the behaviour displayed by those children when placed in the room with the Bobo doll. Children who saw the model being rewarded or suffering no consequences for their behaviour were more likely to display aggressive behaviour themselves. Children who watched the model receiving punishment were less likely to display aggressive behaviour. Most children tended to behave aggressively if given a reinforcement to do so, even if they had seen the model receiving punishment. In general, boys were more aggressive than girls, although girls behaved nearly as aggressively as the boys if offered a reward (see Figure 4.14). These results indicate that the children had learnt the model's behaviour, even if they didn't imitate the model until they were offered a reward to do so. Bandura suggested that although an individual may display no evidence of having learnt a behaviour from observing a model, a cognitive (mental) form of the model's response has still been made, and may not be used (elicited) unless an incentive (reward) to do so is present.

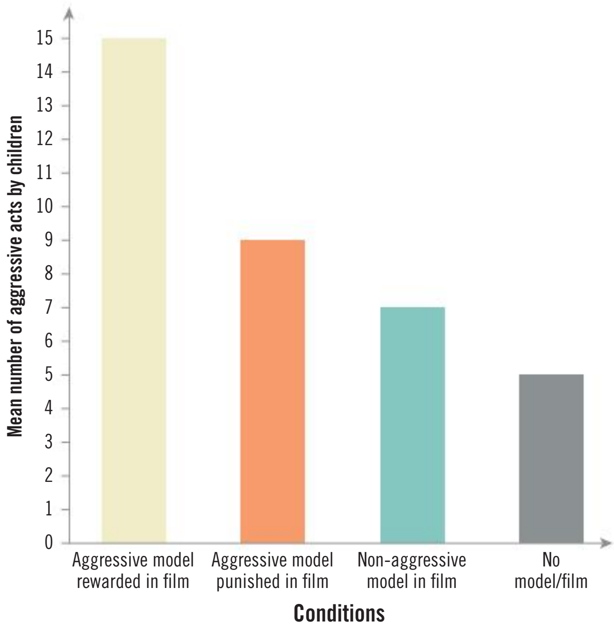

FIGURE 4.13 Results from one of Bandura's modelling experiments

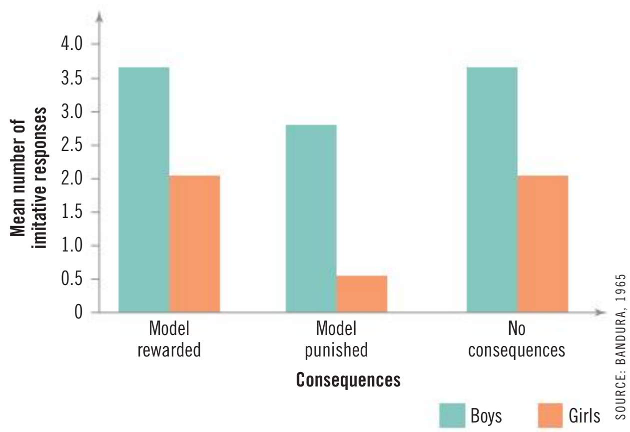

FIGURE 4.14 The effect of observed consequences on imitative behaviour from Bandura's 1965 experiment on observational learning and aggression.

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The aggressive behaviour exhibited by the children in Bandura's experiments demonstrate the components of observational learning in the following way:

- *Attention*: The children had to pay attention to the adult modelling the aggressive behaviour.
- *Retention*: The children would store a mental representation of the modelled behaviour in the form of images (of the physical acts) and verbal (the language the models used) representations in their memory, in order to use the information at a later time when they were placed in a room with the Bobo doll.
- *Reproduction*: The children would need to have the physical and psychological capacity to perform the observed aggressive behaviour.
- *Motivation*: The children needed to want to learn the aggressive behaviour, and some were motivated in some conditions by vicarious reinforcement (seeing the consequences for the model).
- *Reinforcement*: Some of the children were motivated to learn the behaviour by other factors such as tangible reinforcement (praise and food). Interestingly, in most of Bandura's experiments there were gender differences in that girls exhibited fewer aggressive acts compared to the boys, except in the experiment where they were offering an incentive to perform the learnt behaviour. This demonstrates that observational learning can occur without the learner replicating the behaviour immediately. It is not until they are motivated (and this may be by a reinforcer) that evidence of the learning is apparent.

FOCUS ON RESEARCH 4.3

EARLY EXPOSURE TO TV VIOLENCE PREDICTS AGGRESSION IN ADULTHOOD

What is this study about?

There is increasing evidence that early exposure to media violence is a contributing factor to the development of aggression. However, much of the past research on media violence has focused on short-term effects and reported significant relations only for boys. This study draws on social-cognitive observational-learning theory, desensitization theory, and social comparison theory to examine the longitudinal relationship between early exposure to TV violence and adult aggressive behaviour for both males and females.

This study is a follow-up of the 3-year longitudinal study conducted by Huesmann and his colleagues in 1977. In the original study, which included 557 children from five countries (aged 6–10 years), researchers gathered information on childhood TV-violence viewing, identification with aggressive TV characters, judgments of realism of TV violence, aggressive behaviour and intellectual ability, as well as parents' socioeconomic status (measured by educational level), aggressiveness, parenting practices and attitudes, and parent's TV usage (i.e., TV-viewing frequency and TV-violence viewing).

In this follow-up study, researchers interviewed and gathered collateral data (i.e., archival records and interviews of spouses and friends) on 329 participants from the original sample. At the time of the follow-up, the participants ranged in age from 20 to 25 years. Researchers administered measures of adult TV-violence viewing and adult aggressive behaviour, and obtained archival data on criminal conviction and moving violation records from state records.

What did the study find?

The results of this study revealed that early childhood exposure to TV violence predicted aggressive behaviour for both males and females in adulthood. Additionally, identification with same sex aggressive TV characters, as well as participants' ratings of perceived realism of TV violence, also predicted adult aggression in both males and females. Furthermore, while a positive relationship was found between early aggression and subsequent TV violence viewing, the effect was not significant. These findings suggest that, while aggressive children may choose to watch more violent TV programming, it is more plausible that early childhood exposure to TV violence stimulates increases in aggression later in adulthood.

Gender differences were also observed in the expression of aggression. Specifically, men were more likely to engage in serious physical aggression and criminality, whereas women were more likely to engage in forms of indirect aggression. Men and women reported similar frequencies of engaging in verbal aggression, general aggression, and aggression toward spouses. For men, the effects were exacerbated by their identification with same sex characters and perceptions of realism in TV violence.

The longitudinal relationships observed in this study held true, even after controlling for the effects of early aggressive behaviour in childhood, socioeconomic status, intellectual ability, and various parenting factors. These findings support the hypothesis that the causal effects of media violence exposure found in laboratory settings can be generalized to real life from childhood to adulthood.

How does this relate to the ACT against violence program?

Children are increasingly becoming heavy media consumers. Research indicates that much of the media directed at children contains violent content. While media violence exposure may have short-term effects on adults, its negative impact on children is enduring. As this study suggests, early exposure to TV violence places both male and female children at risk for the development of

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aggressive and violent behaviour in adulthood. The ACT program addresses the impact of media violence on the development of young children, and teaches parents strategies for reducing their children's exposure to media violence.

Source: American Psychological Association (2003)

QUESTIONS

1 What was the aim of the most current study?
2 What methods did the researchers use to obtain their data?
3 What were the conclusions drawn by the research?
4 Do you think that this study could be generalised? Why or why not?
5 Discuss two possible extraneous variables in these studies.

4.9 CHECK YOUR UNDERSTANDING

1 With reference to Bandura's research in which children watched an adult model interact aggressively with a Bobo doll, which statement is most correct?
   A Children never imitated the adult model's behaviour.
   B Boys and girls were equally aggressive to the Bobo doll in all conditions.
   C Children who watched the adult model being punished were less likely to imitate aggressive behaviour.
   D Girls always imitated the adult model's behaviour, whereas boys did not imitate the adult model's behaviour.
2 Bandura's Bobo doll experiments showed that:
   A girls are more aggressive than boys.
   B if the children observe the model's behaviour and do not imitate the behaviour they observed, it means that the behaviour was not learnt.
   C if the children observe the model's behaviour being punished, they will be more likely to imitate the behaviour they observed.
   D if the children observe the model's behaviour being reinforced, they will be more likely to imitate the behaviour they observed.
3 Bandura's famous Bobo doll study on observational learning indicates that aggressive behaviour is affected in all of the following examples except one, which is:
   A Aggressive behaviour increases when the model is rewarded.
   B Aggressive behaviour decreases when the model is punished.
   C Aggressive behaviour increases when the observer is rewarded.
   D Aggressive behaviour increases when the observer is punished.
4 Using the process of observational learning, explain how the children in Bandura's studies learnt aggressive behaviour from a model.
5 Bandura's studies contained some extraneous variables. Identify these variables, explain how they may have influenced the results and discuss how Bandura could have controlled them.
6 Claire wants to learn how to drive so that she can get her licence and be more independent. To learn how to drive, every time Claire gets into the car with her mother, she watches what she does. Outline the observational learning process Claire would use to learn how to drive.

ETHICAL ISSUES IN LEARNING EXPERIMENTS

John B. Watson (1878–1958) was a psychology professor at the Johns Hopkins University from 1908 until 1920. Watson and his assistant, Rosalie Rayner, are probably best known for their rather unethical experiment into classical conditioning using a baby named Little Albert B. In their demonstration of classical conditioning, Watson and Rayner (1920) set out to condition 9-month-old Little Albert to have an emotional response of fear to laboratory rats and other white objects.

THE LITTLE ALBERT EXPERIMENT

At the time of the experiment, Watson was investigating how specific fears might be conditioned. He hypothesised that a child would react with fear when they heard a loud noise, and that this fear was an innate (inborn) or unconditioned response. Therefore, according to classical conditioning theory, he could pair a loud noise with other stimuli in order to condition a child to have an emotional response (fear) to stimuli that normally would not be feared by a child.

Watson and Rayner chose as their participant the child of a worker at the clinic in which the experiment would take place. It is believed that Little Albert's mother was unaware that her son would be used in an experiment on conditioning fear responses, but that she was paid $1 for his participation (American Psychological Association, 2015). As there was no rule of informed consent in 1920, this is one of the reasons why this experiment is now considered unethical and would not be conducted today. Little Albert was considered suitable for the experiment, as he was a placid child who rarely cried or seemed sad;

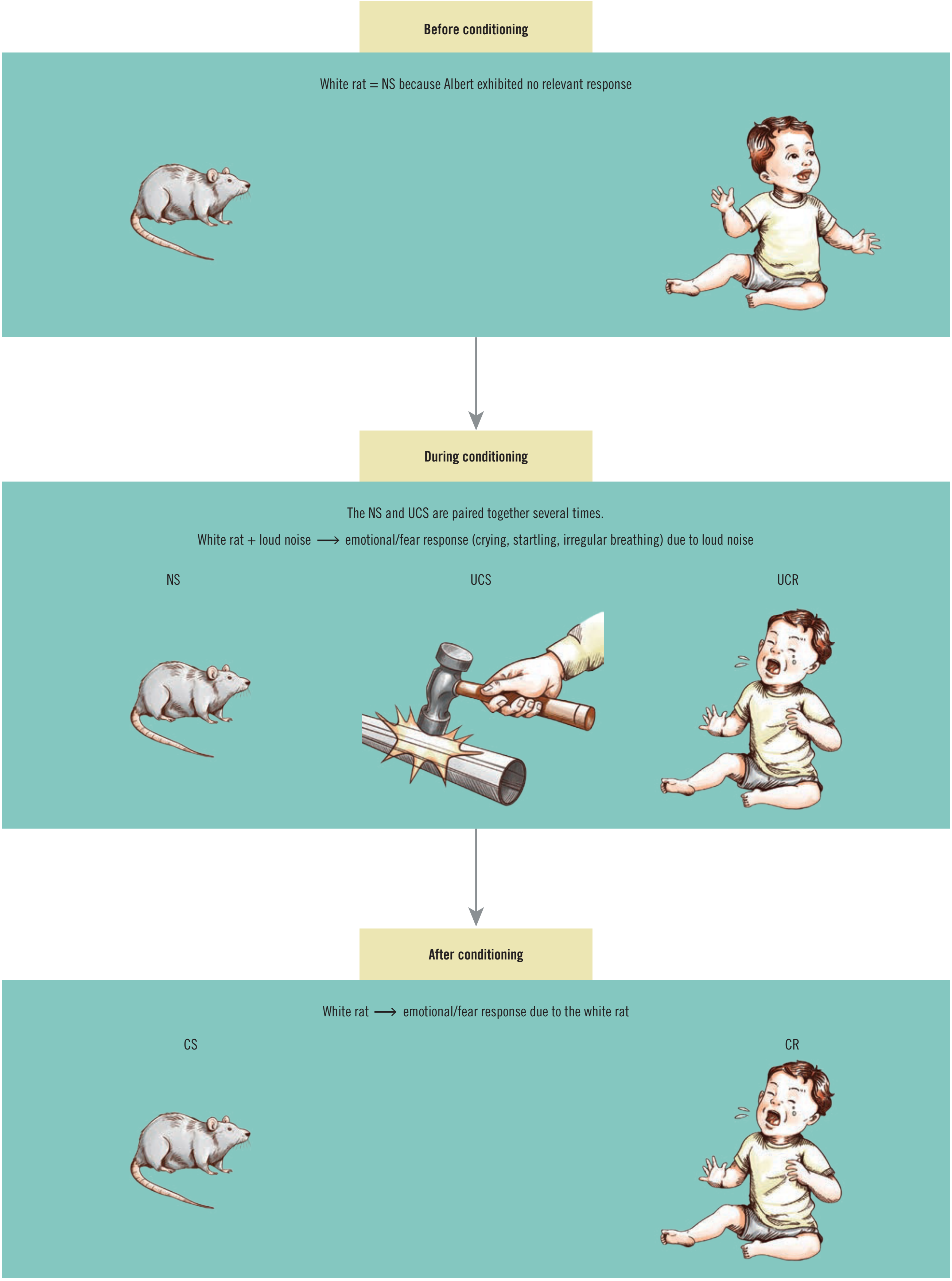

FIGURE 4.15 Conditioning of Little Albert

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his emotional stability was one of the main reasons for using him as a participant. Watson also felt that relatively little harm could be done to Albert during the experiment.

To determine that Albert was capable of a fear response (UCR), Watson and Rayner pre-tested him by presenting him with scary masks and loud noises – they found that he was capable of the fear response.

For the experiment, Albert was placed on the floor in the middle of the room, and a white laboratory rat (NS) was placed nearby. Albert was allowed to play with the rat and showed no fear of the rat at this stage, in fact he played readily with the animal.

This procedure was repeated, and then the next stage of the experiment was conducted. Whenever Little Albert reached out to touch the rat (NS), Watson struck a steel bar behind Albert's head with a hammer, resulting in a loud noise (UCS). Albert reacted to the noise by starting violently; his breathing became irregular and he raised his arms. The second time the bar was struck, Albert had the same reaction, but this time his lips began to pucker and tremble. The third time, Albert started to cry. After several repetitions of this step, Albert would burst into tears and tremble (CR) at the mere sight of the rat (CS), and would become distraught. Clearly, Albert was conditioned: he had built up an association between the rat and an unpleasant stimulus (loud noise).

Five days later, Little Albert showed stimulus generalisation of his conditioning, as he reacted with fear when presented with a white rabbit, a fluffy dog and a sealskin coat, not to mention some of his toys that were similar to the rat (Myers, 2001). At this stage, Albert's mother discovered what they were doing to her child – in response, she quit her job and left the area. Watson and Rayner therefore had no chance to reverse (extinguish) the conditioning.

Ethical implications

Psychologists have had little success in replicating Watson and Rayner's findings with other children, because of the ethics surrounding such experiments. Watson and Rayner breached almost every modern-day ethical consideration; yet interestingly, they probably would not have obtained the results they did obtain if they did not breach these guidelines.

Put simply, today's ethical guidelines (rightly) make it prohibitive for psychologists to replicate the Little Albert experiment.

There are a number of reasons why Watson and Rayner's experiment is now considered unethical:

- The experiment was designed to condition an emotional response of fear in the participant. It could therefore reasonably be assumed that the participant would be emotionally traumatised by the experiment, and that he may have suffered lasting psychological harm as a result.
- Watson failed to seek proper permission from Albert's mother – no informed consent was obtained and withdrawal rights were not explained. Albert's mother apparently was not informed about the nature of the experiment or any details regarding possible risks to her son.
- Watson did not debrief either Albert or his mother, to extinguish the conditioned fear response, and though no-one is sure what became of Albert immediately after the experiment, he may have been left with an irrational fear of anything white and fluffy. He sadly died at the age of six due to acquired hydrocephalus. Watson was dismissed from the university at around the time the experiment ended (because of an affair he was having with Rayner) and this may have contributed to the lack of de-conditioning Albert received (APA, 2015).
- Watson failed to follow the ethical principles of confidentiality. He published results of his experiment without ensuring that Little Albert would remain anonymous.

FIGURE 4.16 A film still from Watson and Rayner's 1920 experiment with 9-month-old 'Little Albert'

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4.10 CHECK YOUR UNDERSTANDING >>

1 In John Watson's famous study, Little Albert was conditioned to fear rats by associating them with an unpleasant, loud noise. If Little Albert had then been repeatedly exposed to the white rat, but without the noise, his fear response would have:

A become stronger.

B been extinguished.

C generalised to all white furry objects.

D spontaneously recovered.

2 By today's standards, Watson and Rayner would not meet ethical requirements in their experiment on Little Albert because:

A they did not stop the experiment when Albert became distressed.

B they did not inform Little Albert's mother about the nature of the experiment.

C they did not extinguish Little Albert's fear response.

D All of the above

3 In Watson and Rayner's famous experiment, they conditioned Little Albert to fear a white rat. At the end of this experiment, the white rat represents:

A the conditioned response.

B the unconditioned response.

C the conditioned stimulus.

D the unconditioned stimulus.

4 Name the ethical principles that Watson and Rayner breached when they did each of the following.

a Failed to tell the mother of the nature and purpose of their experiment and gain her written permission to use her son

b Failed to stop the experiment when Little Albert showed distress

c Failed to extinguish Little Albert's fear of white fluffy objects

d Published information that could have identified Little Albert in the future

5 Discuss the reasons why Watson and Rayner's study could not be replicated today.

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CHAPTER SUMMARY

Classical conditioning

- Classical conditioning occurs when a neutral stimulus (NS) is associated with an unconditioned stimulus (UCS) to elicit a response.
- Before conditioning: the NS will produce no relevant response.
- During classical conditioning: the UCS causes a reflex response called the unconditioned response (UCR). If the NS is consistently paired with the UCS, it becomes a conditioned stimulus (CS) capable of producing a response by itself. This response is a conditioned (learnt) response (CR).
- After conditioning: the CS leads to a CR.
- When the CS is followed by the UCS, conditioning is reinforced (strengthened).
- When the CS is repeatedly presented alone, conditioning is extinguished (weakened or inhibited). After extinction seems to be complete, a rest period may be followed by the temporary reappearance of a CR. This is called spontaneous recovery.
- Through stimulus generalisation, stimuli similar to the CS will also produce the CR. Generalisation gives way to stimulus discrimination when an organism demonstrates the CR only when the specific CS is present.

Operant conditioning

- Operant conditioning occurs when an antecedent precedes a voluntary behaviour, which is followed by a consequence. Reinforcement in operant conditioning increases the frequency or probability of a response being repeated, whereas punishment decreases it. This result is based on the law of effect.
- If an operant response is not reinforced, it may extinguish (disappear). But after extinction seems complete, it may temporarily reappear (spontaneous recovery).

Different kinds of operant reinforcement

- In positive reinforcement, a reward or a pleasant event follows a behaviour. In negative reinforcement, an unpleasant stimulus or event is removed when a correct behaviour is made so that a behaviour that ends discomfort becomes more likely.

Punishment

- Punishment decreases responding. Punishment occurs when a behaviour is followed by the onset of an unpleasant event or by the removal of a positive event (response cost).
- Punishment is most effective when it is immediate, consistent and of an appropriate intensity.

Principles of conditioning

- Antecedents that precede a reinforced behaviour tend to control the behaviour on future occasions (stimulus control). Two aspects of stimulus control are generalisation and discrimination.
- In generalisation, an operant response tends to occur when stimuli similar to the antecedent are presented.
- In discrimination, responses are given only in the presence of the antecedent stimuli and not stimuli that are similar to the antecedent.

Observational learning

- Much human learning is achieved through observation or modelling.
- Observational learning is influenced by the personal characteristics of the model and the success or failure of the model's behaviour. Studies have shown that aggression is readily learnt by modelling, particularly in children.
- There are five aspects of observational learning: attention, retention, reproduction, motivation and reinforcement.

Watson and Rayner's Little Albert experiment

- Watson and Rayner conditioned an emotional/fear response in a child by pairing a white rat with a loud noise that caused a reflexive emotional/fear response in the child. Over a number of trials where the white rat and loud noise were paired together, the child became fearful and produced an emotional response to the white rat alone. This fear response was then generalised to other similar stimuli.
- Watson and Rayner failed to adhere to the following ethical considerations: do no psychological or physical harm, seek informed consent, explain withdrawal rights, debrief and ensure confidentiality.

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APPLY YOUR KNOWLEDGE AND SKILLS

SECTION A: MULTIPLE-CHOICE QUESTIONS

Answer the following questions by writing the correct letter in your workbook. Only one answer is correct for each question.

1 In classical conditioning, an organism develops an association between:

A the neutral stimulus and the conditioned stimulus.
B the conditioned stimulus and the unconditioned stimulus.
C the conditioned stimulus and the conditioned response.
D the neutral stimulus and the unconditioned response.

2 Unlike operant conditioning, what does classical conditioning involve?

A Reflexive responses
B Stimulus discrimination
C Stimulus generalisation
D Voluntary responses

3 Toto the airport sniffer dog has been trained to detect bags containing illegal substances such as drugs, but to ignore other bags. Toto has been trained in:

A good manners.
B negative reinforcement.
C stimulus discrimination.
D stimulus generalisation.

4 Watson's experiments with 'Little Albert' are an example of the __________ conditioning of __________.

A classical; a fixed action pattern
B classical; an emotional response
C operant; a phobic reaction
D operant; maturation

5 Barnabus the rat was trained in a Skinner box to press a lever to receive food. The rat underwent:

A stimulus training.
B classical conditioning.
C respondent conditioning.
D operant conditioning.

6 A punisher could be unintentionally functioning as a reinforcer if:

A conditioning is used.
B it comes too late after the behaviour.
C the frequency of the behaviour goes up.
D the frequency of the behaviour goes down.

7 Amanda's horse, Apples, had a habit of biting people. After a long period of conditioning, the horse had not bitten anyone for quite a few weeks. Then one day, Apples suddenly bit Amanda's friend on the arm. The appropriate term for the reappearance of this behaviour is:

A counter-conditioning.
B generalisation.
C negative conditioning.
D spontaneous recovery.

8 Which of the following statements about learning is incorrect?

A Learning can be defined as a relatively permanent change in behaviour that occurs as a result of experience.
B Learning is an ongoing process that continues throughout the lifespan.
C Learning can only occur when an organism is motivated to learn.
D The change in behaviour associated with learning may be delayed and actually occur some time after learning has taken place.

9 Bandura was best known for his studies with:

A dogs and reflex conditioning.
B cats and trial-and-error learning.
C children and aggressive behaviour.
D pigeons and ping-pong games.

10 Steven had never cooked a meal in his life, although he always watched his mother preparing the evening meal. Steven moved out of home to go to university, and tried to cook a meal for himself. To his surprise he was capable of cooking reasonably well. What method of learning did Steven use to gain the knowledge to cook for himself?

A Classical conditioning
B Learning set
C Operant conditioning
D Observational learning

11 James regularly disturbs the class by telling jokes when the teacher is talking. James is told to sit at a table by himself at the back of the room. The teacher tells James that he can rejoin the class when he sits quietly and does not tell any jokes for 15 minutes. The teacher is using which of the following to change James' behaviour?

A Positive reinforcement
B Negative reinforcement
C Punishment
D Shaping

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12 In classical conditioning, Pavlov found that after repeatedly pairing a bell with food, a dog will salivate when the bell is presented. Salivation to the bell is:

A an unconditioned stimulus.
B an unconditioned response.
C a conditioned stimulus.
D a conditioned response.

13 If you touch a hot stove with your hand, you will reflexively pull away. According to Pavlov, pulling your hand away from the stove would be termed:

A an unconditioned stimulus.
B an unconditioned response.
C a conditioned stimulus.
D a conditioned response.

14 Qaisha rubbed some 'stop itch' cream on the spot where a mosquito had stung her and the itching stopped. The next week she was stung by a mosquito and immediately reached for the 'stop itch' cream. According to operant conditioning theory, this is an example of:

A positive reinforcement.
B negative reinforcement.
C punishment.
D response cost.

15 Yin had never cooked before, although in the past he had spent time in the kitchen with his mother when she was cooking. The first night he tried, Yin was able to cook spaghetti even though he had never cooked it before and did not have a recipe. In terms of observational learning, which of the following elements enabled Yin to be able to cook spaghetti?

A Attention, reproduction
B Motivation, incubation
C Cognition, reinforcement
D Cognitive representation, stimulus generalisation

SECTION B: SHORT-ANSWER QUESTIONS

1 Compare the acquisition process for operant and classical conditioning.

2 Briefly describe Pavlov's original experiment using the language of classical conditioning.

3 Using an example, briefly describe the three-phase model of operant conditioning.

4 Describe each of the elements of observational learning.

5 Imagine that you are a psychologist. Little Albert (not so little any more) comes to you seeking help to overcome his fear of white rats. What learning process could you use to help Albert overcome it? Detail the steps you would use.

6 Watson's experiment with Little Albert is considered unethical by today's standards. Describe three aspects of the experiment that are considered unethical.

7 Define operant stimulus discrimination and stimulus generalisation and provide an example to illustrate how they apply.

8 Using Pavlov's original example of classical conditioning, explain how extinction and spontaneous recovery may occur.

9 Bandura conducted a number of experiments using children. What was the general aim of the experiments?

10 Using the language of classical conditioning, outline how Watson and Rayner conditioned a fear or emotional response in Little Albert.

SECTION C: EXTENDED-RESPONSE QUESTION

Bernard suffers from a fear of dogs. Using your knowledge of learning theories, detail how Bernard may have acquired his fear of dogs via classical conditioning and operant conditioning. Finally, if you wanted to help Bernard overcome his fear, what would you suggest Bernard do? In your response, ensure that you use the appropriate psychological terminology.

This question is worth 10 marks.

SECTION D: ASSESSMENT TASK

Create a flow chart of Bandura's study on learning aggression through observation on children.

In your flow chart include:

- an introduction (aim, hypothesis, information regarding social learning theory)
- the method (participants, procedure)
- the results (may include descriptive statistics, graphs, tables)
- a discussion (possible limitations, conclusions).

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CHAPTER 05

MEMORY

KEY KNOWLEDGE INCLUDES:

Process of memory

- the multi-store model of memory (Atkinson–Shiffrin) with reference to the function, capacity and duration of sensory, short-term and long-term memory
- interactions between specific regions of the brain (cerebral cortex, hippocampus, amygdala and cerebellum) in the storage of long-term memories, including implicit and explicit memories.

Reliability of memory

- methods to retrieve information from memory or demonstrate the existence of information in memory, including recall, recognition, relearning and reconstruction
- the effects of brain trauma on areas of the brain associated with memory and neurodegenerative diseases, including brain surgery, anterograde amnesia and Alzheimer's disease
- the factors influencing a person's ability and inability to remember information, including context and state dependent cues, maintenance and elaborative rehearsal and serial position effect
- the reconstruction of memories as evidence for the fallibility of memory, with reference to Loftus' research into the effect of leading questions on eye-witness testimonies.

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MEMORY: OUR LINK TO THE PAST, PRESENT AND FUTURE

Imagine what life would be like if most of your memories were wiped out. How would you communicate if you could not remember what words meant or even what you had just said? How would you recognise your family and friends? Your past would be a complete blank.

Now imagine what life would be like if you could remember your past, but could not form new memories of things that happen in the present. This is demonstrated in the film *Memento* (2000), where the character of Leonard Shelby can accurately recall details of his life before his 'accident', yet he cannot remember what happened 15 minutes ago, let alone where he is or where he's going (see Figure 5.1). To remember basic survival information such as 'Where do I live?' or 'Which car is mine?', Leonard relies on a series of annotated Polaroid snapshots and an endless stream of handwritten notes.

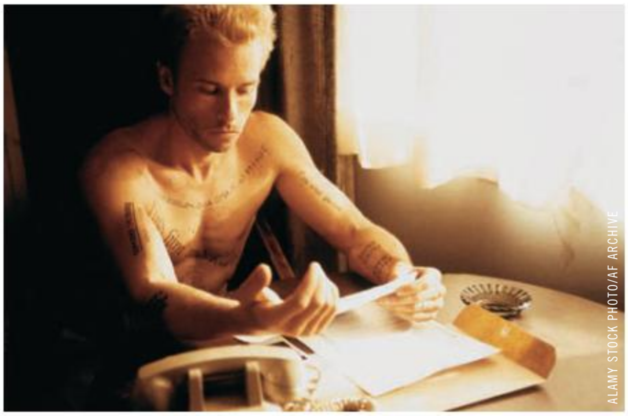

FIGURE 5.1 In the film *Memento*, actor Guy Pearce plays Leonard Shelby, a man unable to form new memories.

Life without a functioning memory would be terrifying and confusing. Memory connects our past and present experiences and provides us with a sense of identity. Memory also helps us to adapt to the constant changes of daily life and to plan for the future. It plays a major role in determining our behaviour, and is crucial for our survival.

ENCODING, STORING AND RETRIEVING INFORMATION

Memory is an active information-processing system that receives, stores, organises and recovers information (Baddeley, 1996).

Memory begins when our senses take in different types of information from our external and internal environments. Because this information cannot be processed in its raw sensory form (for example, light rays or sound waves), it has to be converted into – or represented in – a form (or code) that our brain can work with later. This conversion process is known as **encoding**.

Encoded information is then stored (held or retained) in the memory system for a period of time – this is known as **storage**. If stored information is to be used later, it must be retrieved, or taken out of storage. **Retrieval** involves locating information stored in memory and bringing it into consciousness when needed, to complete a cognitive task.

memory An active information-processing system that receives, stores, organises and recovers information

encoding The process that converts information into a usable form (code) that can be stored and represented in the memory system

storage The retention of information in the memory system over time

retrieval The process of locating information stored in memory and bringing it into consciousness when needed, to complete a cognitive task

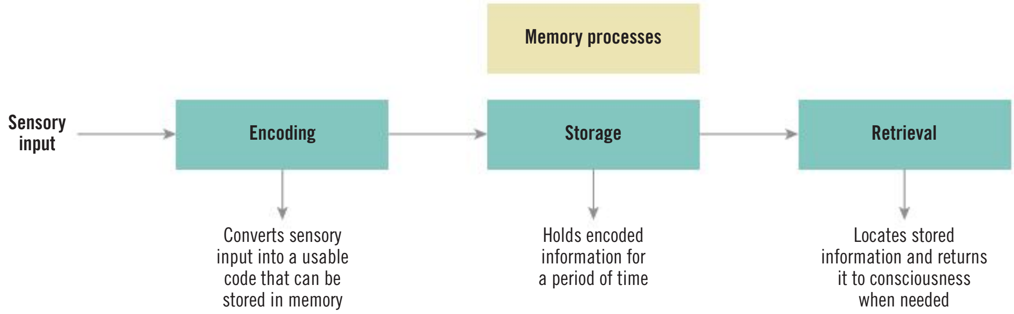

FIGURE 5.2 Memory is an active system that processes sensory information by encoding, storing and retrieving it.

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ATKINSON AND SHIFFRIN'S MULTI-STORE MODEL OF MEMORY

Atkinson and Shiffrin's (1968) multi-store model of memory visualises memory as a system consisting of multiple memory stores, through which a stream of data flows for processing. This model emphasises the storage structures, and suggests that if information is to be stored for a long time, it must pass through three memory stores: sensory memory, short-term memory (STM) and long-term memory (LTM) (see Figure 5.3). Each store operates independently, but all operate at the same time and their control processes are interrelated.

SENSORY MEMORY

New sensory information – in the form of sight, sound, taste, smell and touch – enters memory when it is registered in sensory memory (see Figure 5.4). Sensory memory stores information briefly. However, while duration is brief – for up to a few seconds – psychologists believe the capacity of sensory memory is unlimited.

Although we have no conscious control over sensory memory, we are not overwhelmed by incoming data because we do not select all of it for attention. Information is held just long enough to encode it into a usable form and transfer it to the STM store for further processing. If we ignore information that enters our sensory memory, it fades rapidly and we forget it.

Psychologists believe sensory memory contains a sensory register for each of our senses. The registers hold the information as an exact copy of its original sensory form (for example, visual information is held as an image; auditory information is held as an echo). The two main sensory registers for memory are iconic memory and echoic memory.

FIGURE 5.4 All the information you process about what you see, hear, smell, taste and feel in the busy environment is initially registered in your sensory memory.

Iconic memory: Registering images

Iconic memory is the sensory register for visual information – such as shape, size and colour – which it stores in the form of an icon for approximately 1/3 to 1/2 of a second. For example, if you look at a flower and then close your eyes, an icon (a fleeting mental image with picture-like qualities) of the flower will persist in your consciousness. The intensity of the visual stimulus (for example, its brightness) determines how long the icon will last, but most last no longer than half a second – just long enough for encoding to begin. Because visual information changes constantly, we must deal with it quickly (see Figure 5.5). If we held images for longer than we do, we might miss important new information. If we held it for shorter periods, images would succeed one another so quickly that we would perceive our world as a blur (see Figure 5.6).

Echoic memory: Registering sounds

Echoic memory is the sensory register for auditory information. Storage time (duration) is temporary and sounds remain as an echo (a brief continuation

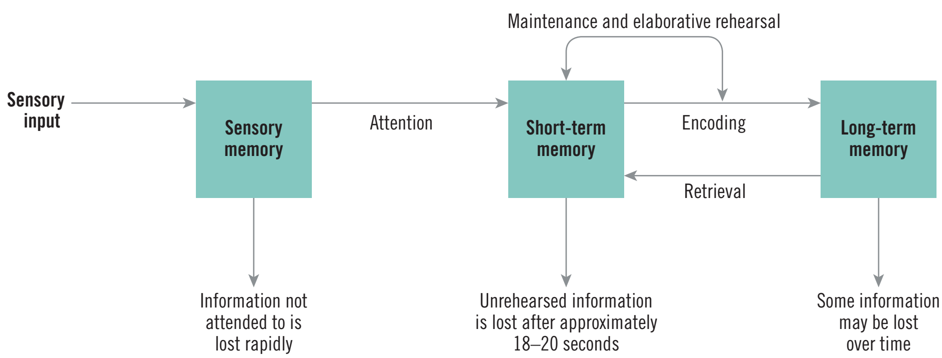

FIGURE 5.3 The multi-store model of memory: According to Atkinson and Shiffrin, human memory consists of three separate but interrelated memory stores through which a stream of data flows for processing.

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FIGURE 5.5 Because the image of this sparkler persists briefly in iconic memory, when the sparkler is moved fast enough, the blending of after-images causes people to see a continuous circle instead of a succession of individual points.

of activity in the auditory system after the stimulus has ended) for up to 3–4 seconds. This is long enough for the sounds to be encoded and selected for attention. If duration was shorter, language would sound like a series of distinct sounds instead of whole words or phrases we can understand. For instance, if someone says 'aeroplane' you hear 'aeroplane' because 'aero' is held in your echoic memory until you hear 'plane'. Echoic memory provides us with a smooth, integrated and continuous experience of auditory information. Table 5.1 gives an overview and comparison of iconic and echoic memory.

FIGURE 5.6 If iconic memory did not clear quickly, we would see the world as a blur, as in this photograph. You may not be able to guess that this is an image of two people on a motorbike.

TABLE 5.1 Overview of iconic and echoic memory

	ICONIC MEMORY 	ECHOIC MEMORY 
What it holds	Exact replica of visual information (an icon)	Exact replica of auditory information (an echo)
Duration stored	Approximately 1/3–1/2 of a second	Approximately 3–4 seconds
Storage capacity	Relatively unlimited	Relatively unlimited

SHORT-TERM MEMORY (STM)

Short-term memory (STM) stores a limited amount of information for a brief period, unless the information is rehearsed. STM holds all the thoughts, information and experiences that you are aware of at any given point in time.

STM receives information from two sources: sensory memory and long-term memory (LTM). When you encounter something new (for example, a distinctly coloured bird), information such as shape, colour, texture and sound that was registered in sensory memory is sent to STM. To give this information meaning, your STM immediately starts comparing it to the existing information about birds that you have gained from past experience and have stored in LTM. In this way, STM also manages the retrieval of information from LTM.

If information is not attended to, it simply drops out of the system. If it is attended to, further processing and encoding occurs.

multi-store model of memory The memory model that visualises memory as a system consisting of multiple memory stores through which a stream of data flows for processing

sensory memory The first stage of the multi-store model of memory; it receives and stores an unlimited amount of sensory information for up to a few seconds

sensory register A subsystem of sensory memory that receives and stores specific sensory information received from a sense organ

iconic memory The subsystem of sensory memory that receives and stores an unlimited amount of visual information in the form of a visual image for approximately 1/3 to 1/2 of a second

echoic memory The subsystem of sensory memory that receives and stores an unlimited amount of auditory information in the form of an echo for up to 3–4 seconds

short-term memory (STM) The second and most active memory system in the multi-store model of memory; stores a limited amount of information entering from sensory memory or retrieved from LTM for a short period of time unless the information is rehearsed

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STM capacity

STM has a limited storage capacity and can hold only small amounts of information. Psychologist George Miller (1956) found that an average adult's STM is limited to the magic number 7 (+ or – 2) – that is, approximately seven single items (give or take one or two) of unrelated information at one time (Miller, 1956). To demonstrate this, read the following number set once. Then close the book and write as many of the numbers as you can in the correct order.

8 5 1 7 4 9 3

If you were able to correctly reproduce seven digits, you have an average STM capacity. Now try the same again using the following number set, which is probably beyond your STM's capacity.

7 1 8 3 5 4 2 9 1 6 3 4

If you were able to correctly recall all of these numbers, your STM is extraordinary!

When STM is full, new single items can be added only by dropping (displacing) some of the old ones. This limited capacity means that STM is very sensitive to interruption, making it very difficult for STM to do more than one task at a time.

Can our STM ever hold more than 7 (+ or – 2) single items of information at once? Although STM's storage capacity is limited, if we group separate items of information so they form a larger single item, we can effectively increase STM's normal storage capacity. This process is known as chunking. An information 'chunk' can be made up of numbers, letters, words, phrases or familiar sentences. Figure 5.7 demonstrates the impact of chunking on STM's capacity.

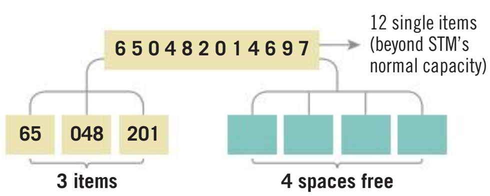

FIGURE 5.7 By grouping separate items of information to form a larger, single item, we free up space in STM for more information.

5.1 TRY IT YOURSELF >>

INCREASE YOUR STM'S CAPACITY

You will need: a partner, paper and a pen.

1 Read aloud each of the following number sets to your partner, giving a 2-second pause between each number. After reading each set, allow your partner time to write the number set in the correct order.

- a 9-7-5-4
- b 3-5-2-6
- c 5-6-7-0-8
- d 6-4-3-2-1
- e 3-5-0-2-1-7
- f 9-5-3-7-8-1
- g 8-5-3-8-9-1-2
- h 2-3-4-1-5-7-8-0
- i 8-4-3-7-8-2-9-1-6

2 Note the last number set your partner remembered correctly. What does this suggest about the limit to STM storage capacity?

3 Now, repeat the same procedure using the following number sets (allow a 2-second pause between each chunk within the sets).

- a 604-575
- b 492-342
- c 111-133-9
- d 983-251-4
- e 382-43-24
- f 947-342-45
- g 903-539-325
- h 78-342-578
- i 382-290-176-8

4 Count the number of correct responses, noting the last complete number set your partner remembered correctly.

5 Compare this result with the earlier one. What differences do you note? How might you explain this?

STM duration

STM has a limited duration, holding only small amounts of information for approximately 18–20 seconds before the information starts to disappear. If unimportant excess information remained for longer, we might miss out on new and vital information. For example, if a bank teller serves a customer who is withdrawing $552.89 from a savings account, the teller keeps the amount of money in his short-term memory for a short period of time, as he serves the customer. By the time the next customer steps up to the window, the amount has vanished from the teller's memory, and his STM is 'clear' so as to deal with the next transaction.

STM's duration, however, can be prolonged by rehearsal, which involves actively manipulating information to hold it in STM for longer than the usual 18–20 seconds. Rehearsal is discussed in more detail later in the chapter.

5.1 CHECK YOUR UNDERSTANDING >>

1 Which of the following statements is correct?

- A Echoic memory lasts for approximately 3 or 4 seconds.
- B STM's capacity is limited but its duration is unlimited.
- C We cannot consciously increase the duration of STM because STM is beyond our voluntary control.
- D Iconic memory is an exact replica of auditory information.

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2 Sensory memory stores information:
   A according to its meaning.
   B for an unlimited time.
   C as an exact replica of its original sensory form.
   D sent from both short-term and long-term memory.
3 Sensory memory has all the following characteristics except for which one?
   A Visual information lasts for about a quarter of a second.
   B It holds an exact image of each sensory experience.
   C Auditory information lasts about 4 seconds.
   D Its normal capacity is approximately 7–9 bits of information.
4 The capacity of STM for most people is:
   A 6–11 single bits of information.
   B 4–10 single bits of information.
   C 5–9 single bits of information.
   D unlimited.
5 Why is sensory memory beyond conscious control, but STM is under conscious control?
6 Explain one reason why STM has a limited duration.
7 Explain how sensory memory helps us adapt to our changing environment so that our survival chances are enhanced.

LONG-TERM MEMORY (LTM)

According to the multi-store model of memory, once information in STM has been processed, it is transferred to a third memory store, long-term memory (LTM).

Capacity and duration

Long-term memory is believed to have unlimited capacity. In terms of duration, it is believed that if information reaches LTM it is stored relatively permanently. When required at a later date, we retrieve information by locating it in LTM and returning it to conscious awareness. In this way, information not only flows from STM to LTM, but can also flow back from LTM to STM. And, once a LTM has been formed, it can be stored for a lifetime. However, this does not mean that we can always retrieve all memories stored there. There are a number of theories about why we cannot remember every LTM we have formed and stored – or why we forget. *Retrieval failure theory* suggests we forget because we cannot access the correct retrieval cues needed to activate a specific memory. *Decay theory* suggests we forget because the chemical memory trace of the information created when the memory was formed fades over time due to lack of use. *Interference theory* attributes forgetting to a specific memory being blocked from entering our consciousness by other memories, and the theory of *motivated forgetting* suggests that we don't want to remember painful or traumatic memories, so we consciously or unconsciously block their retrieval.

LTM is not merely a form of STM that holds an unlimited amount of information for a longer period of time. Information in LTM is organised and stored in a hierarchical network of concepts (nodes) connected by meaningful links. If you make an error when trying to retrieve a memory from LTM, it probably relates to meaning. For example, if you are trying to recall the word 'car' from a memorised list, you are more likely to mistakenly say 'truck' or 'automobile' than you are to say 'star'.

STORING LONG-TERM MEMORIES

Studies of people with memory problems have found that while some may be unable to learn new information such as a telephone number, an address or a person's name, they can learn to solve complex puzzles in the same amount of time as normal subjects (Squire & Zola-Morgan, 1988). This finding supports the theory that not only is LTM a separate memory store, but it stores different types of memories. Broadly speaking, psychologists separate these memory types into two general categories, known as *implicit* and *explicit* memories.

IMPLICIT (PROCEDURAL) MEMORY: NON-CONSCIOUS MEMORY OF SKILLS AND ACTIONS

Memory of learnt actions and skills stored in LTM and retrieved unconsciously or unintentionally is called implicit memory. Implicit memory operates

magic number 7 (+ or – 2) The number of single items of information that the average short-term memory can hold at any one time

chunking Grouping separate items of information to form a larger single information unit (chunk) so our short-term memory can hold more than the usual seven single items of information at any given moment

long-term memory (LTM) The third memory system in the multi-store model of memory; used for relatively permanent storage of an unlimited amount of information

implicit memory A long-term memory of learnt actions and skills that we store in LTM and retrieve unconsciously (often referred to as procedural memory)

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automatically and helps us perform tasks that we don't have to consciously think about doing. Because it involves the unconscious memory of learnt actions, habits and skills, or how to do things that usually consist of step-by-step procedures that are difficult to express in words or symbols, implicit memory is often referred to as procedural memory. Implicit memory is our 'knowing how to' memory that enables us to carry out learnt tasks without conscious effort. Riding a bike, tying a shoelace and brushing our teeth are all tasks that depend on implicit memory. Rather than expressing that we know how to do something by verbalising our knowledge, we imply that we have this knowledge by performing the required action.

When we complete familiar tasks, we demonstrate skills usually acquired through repetition and practice. Once we have made the initial conscious effort to learn the skills, we can complete the task more or less automatically without consciously recalling how to do so. For example, once you learn how to type on a keyboard you store this memory in your LTM. The skills involved become routine, and you can perform them without consciously retrieving the memory of them.

Long-term implicit procedural memories often involve complicated sequences of movements that we are usually unaware of or that we are unable to articulate. Therefore we can usually only fully express a procedural memory as an action. This may explain why even patients with amnesia are able to perform routine procedures and why a gymnast, for example, may be able to perform but not describe in words the exact movements required for a routine. Because procedural memories are difficult to express in words we are unable to verbally 'declare' them, so procedural memory is also considered to be a form of non-declarative memory.

Procedural memory primarily involves learning new motor skills that are believed to be registered in brain areas beyond conscious control, such as the cerebellum. Thus they represent the more basic, 'automatic' elements of learning and memory related to actions. This is probably why they are the LTM type that is most resistant to forgetting (as the saying goes, we never forget how to ride a bike!).

5.2 TRY IT YOURSELF >>

AN EXAMPLE OF IMPLICIT MEMORY AT WORK

Sit at your computer and type the following sentence without looking down at your hands: 'Psychology is a fascinating subject.' Now, without looking, try naming the 10 letters that appear in the top row of your keyboard.

Since most students are good typists, you probably could easily type the sentence in the Try it yourself 5.2 activity without having to consciously think about where each letter appears on the keyboard. That task requires implicit memory. Having to recall which letters appear in the top row of your keyboard, however, is something that would require explicit memory. Since you have probably never sat down and intentionally committed the order of those keys to memory, it is not something that you are able to easily or unconsciously recall.

EXPLICIT (DECLARATIVE) MEMORY: CONSCIOUS MEMORY OF FACTS AND PERSONALLY SIGNIFICANT EVENTS

Explicit memory is the LTM store for explicit, or specific, factual information (such as names, faces, words, dates, ideas and rules) and events that have a personal significance (such as your first day at primary school). Explicit memories are consciously recalled and expressed (or declared) in words or symbols, so they are often referred to as declarative memories. For example, knowing that Melbourne is the capital of Victoria or that you received a blue bicycle for your 10th birthday are examples of declarative memory.

Explicit memories are generally more complex than implicit memories. They require a person to be consciously aware of previously having a specific experience and they must be retrieved intentionally, whereas implicit memory does not. Explicit memory is usually assessed by traditional tests of recall or recognition. Explicit memories are often holistic, in that they involve the recall of many different aspects of a situation. For example, to consciously recall something, such as your memory of events that occurred yesterday, you not only recall the event, but you also recall the context in which the event occurred; that is, the time of day, the place and other objects and people that were present (Hall, 1998).

Explicit declarative memory is our memory for 'knowing what' and psychologists believe it can be divided into *semantic memory* and *episodic memory*.

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Semantic memory: Memory of meaning

The names of objects, the days of the week and months of the year, simple mathematical concepts, words and language, and other general facts are quite resistant to forgetting. Such impersonal facts and rules make up the part of LTM called semantic memory (see Figure 5.8).

Semantic memory holds the factual information we use for making meaning so we understand the world around us. Semantic memory involves general factual information about the world that does not involve the memory of personally significant events or episodes that are tied to a specific time or place. It would be rare, for instance, to remember when and where you first learnt the names of the seasons, but do you know whether snow falls in winter or summer? Most people know the answer to this question without remembering a specific episode in which they learnt the information.

FIGURE 5.8 We store impersonal factual information and rules in semantic memory. These memories allow us to make meaning. For example, information about kittens – they are small animals, they are furry, they have four legs, they have one tail and they meow – is stored in our semantic memory. This enables us to instantly recognise them as being different from other animals.

Episodic memory: Memory of time and place

Episodic memory is a type of autobiographical memory because it stores personally significant events or episodes that are related to a specific time or place, such as a special birthday celebration or your first day at secondary school. In an episodic memory, people see themselves as the centre of a past event, and the emotions they felt and the context in which they felt them are part of the memory, not just the facts of the event. For example, if you remember a particularly significant basketball match you attended, you would remember the facts related to the game (such as who won and by how many goals), but you might also remember information such as people's faces, the taste of the food you were snacking on, what form of transport you took, or the phone call you got that interrupted your concentration on the game and caused you to miss seeing the final goal being thrown.

Episodic memory can be affected by a number of things, including neurodegenerative diseases such as Alzheimer's disease (discussed later in this chapter), tumours, severe vitamin B deficiency or physical trauma to the brain. Brain damage is more likely to impair episodic memory than semantic memory, and in dementias such as Alzheimer's disease the impairment of episodic memory is frequently the first symptom to appear (Klein, Loftus, & Kihlstrom, 2002; Rosenbaum et al., 2005). As a general rule, people convey episodic memories by stating, 'I remember when …', whereas they convey semantic memories by stating, 'I know that …' (Tulving, 1972).

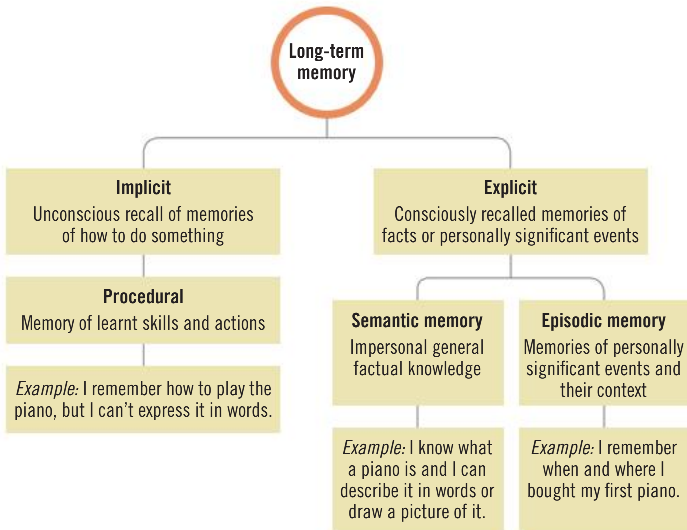

FIGURE 5.9 LTM is divided into explicit and implicit memories. Explicit memories can be further divided into semantic or episodic memories. Implicit memories consist of procedural memories.

procedural memory A type of implicit LTM for learnt actions and skills that can usually only be expressed as actions

explicit memory A long-term memory of events and factual information that can be intentionally and consciously recalled

declarative memory A type of explicit LTM for specific factual information that can be expressed in words; subgroups are semantic memory and episodic memory

semantic memory A type of declarative memory for impersonal factual knowledge about the world

episodic memory A type of declarative memory for personally significant events associated with specific times and places

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Evidence that suggests that implicit and explicit memory are different forms of long-term memory often focuses on studies of amnesic patients. One famous case study of an amnesiac was that of Henry Gustav Molaison (better known as HM), who became unable to form new long-term memories after experimental surgery in the 1950s to reduce epileptic seizures. One study required HM to draw a figure while looking at its reflection in a mirror. HM showed improvement every time he was presented this task, but when asked if he had done it before, he could not remember doing it. This demonstrated that, though HM's explicit memory was damaged, his implicit memory remained intact because he retained motor skills previously practised.

5.2 CHECK YOUR UNDERSTANDING >>

1 You remember some chess moves from last week's game. This is an example of:
   - A an episodic memory.
   - B a procedural memory.
   - C a semantic memory.
   - D All of the above

2 Which of the following characteristics do episodic and semantic memories have in common?
   - A They are both forms of implicit memory.
   - B They are easily described in words.
   - C They are both forms of procedural memory.
   - D They both hold memories that have personal significance.

3 Your ability to use the mouse attached to your computer is an example of what type of memory?
   - A Procedural
   - B Semantic
   - C Declarative
   - D Episodic

4 Which type of memory is retrieved unconsciously?
   - A Explicit memory
   - B Implicit memory
   - C Semantic memory
   - D Episodic memory

5 Procedural memory is the memory used for:
   - A riding a bike.
   - B applying the rules for fixing a car tyre to fixing a puncture in a bike tyre.
   - C knowing the names of famous cyclists.
   - D remembering the road rules for cyclists.

6 Use an example to illustrate the difference between implicit and explicit memory.

BRAIN AREAS INVOLVED IN LTM STORAGE

Psychologists believe that no single brain structure is responsible for memory. Research results, such as those provided by Karl Lashley (1950), suggest that memory is the result of the interaction of a number of brain areas working simultaneously. In one experiment, Lashley trained rats to solve a maze and then removed various parts of their brain. When he retested their memory of the maze, the rats demonstrated some memory deficit, but retained partial memory of how to solve the maze. The amount of memory remaining seemed to depend on the total amount of brain tissue removed, not on the particular portion of the brain removed. Lashley concluded that a single memory can be stored in various parts of the brain; therefore, memory depends on the integration of activity in several brain areas. Studies of people with brain damage also suggest that we process and store explicit and implicit memories in different areas of the brain. These areas include the cerebral cortex, hippocampus, amygdala and cerebellum.

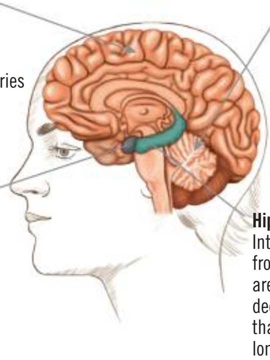

FIGURE 5.10 The cerebral cortex, hippocampus, amygdala and cerebellum are all involved in the formation and storage of long-term memories.

THE CEREBRAL CORTEX

The cerebral cortex, the outer layer of the brain, shares neural links with all other brain structures and it plays a key role in our physiological and psychological behaviour. The cerebral cortex is divided into two hemispheres: the right hemisphere and the left hemisphere. Each hemisphere contains four lobes (the frontal lobe, parietal lobe, occipital lobe and temporal lobe) that are differentiated by their structure and function, and each lobe contributes to

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memory. The cerebral cortex contains approximately 70 per cent of the neurons in the central nervous system as well as the major association areas of the brain. Neuroscientists believe that association areas are responsible for higher cognitive processes, such as learning and problem-solving. Neuroscientists also believe association areas contribute to memory because they receive sensory and motor information from other brain areas, integrate it and relate it to information already processed and stored in memory.

How does it do this? The forward area of the frontal lobe, the prefrontal cortex, evaluates information sent from all lobes and it has neural links that relay information to and from the hippocampus and amygdala, two midbrain structures heavily involved in memory (discussed in detail shortly). As a result, it contributes to the formation of short-term declarative memories and storage of long-term declarative memories. The cerebral cortex also communicates motor information to the cerebellum, so it is involved in the formation and storage of procedural memories. The parietal lobe is involved in processing bodily (somatic) sensations, and it contributes to memories involved in our spatial thinking and ability to navigate our environment. The occipital lobe processes memories for visual information.

The temporal lobe is involved with the processing of auditory information and language, and complex stimuli such as faces and scenes. It also contributes to memories associated with the senses of smell and sound. Because the hippocampus, the structure believed to be responsible for transferring short-term memories into long-term memories, extends into the temporal lobe, the temporal lobe helps to form new declarative memories. Brain imaging techniques, such as PET and MRI scans, show that individuals who experience severe memory loss typically have damage in the temporal lobes. This suggests that the temporal lobes play a major role in memory formation and storage, particularly declarative and episodic memory (Smith & Kosslyn, 2007). For example, MRI scans of sufferers of Alzheimer's disease who experience progressive memory loss show severe temporal lobe shrinkage, particularly towards the middle of the lobe. Alzheimer's disease is discussed in more detail later in this chapter.

Research findings indicate that severe damage to the left temporal lobe results in difficulty remembering and understanding language, causing an inability to name familiar objects, places or faces (Lah, Lee, Grayson, & Miller, 2006) and make appropriate emotional responses. As a result, psychologists believe that the names of familiar people and objects are stored in the left temporal lobe, as well as factual information and information relating to personally significant events that can be expressed in words. In addition, when Wernicke's area (a collection of neurons in the left temporal lobe responsible for understanding written and spoken language) is damaged, people cannot remember the meaning of words or the rules of language. This language deficit suggests that the left temporal lobe is responsible for language comprehension and the formulation of meaningful sentences. Research has also shown that damage to the right temporal lobe can result in impaired memory for non-verbal information, such as recognising familiar faces, music and pictures.

THE HIPPOCAMPUS: SHORT-TERM EXPLICIT MEMORIES

Located below the cortex and buried deep within the centre of the brain, the two structures that form the hippocampus extend into the temporal lobes of both brain hemispheres (see Figure 5.10). Current neural models of declarative memory formation suggest that structures in the medial temporal lobe, including the hippocampus, play a critical role in memory formation and storage (Eichenbaum, 2000).

The hippocampus forms part of the limbic system, an interconnected network of structures that includes the cingulate gyrus and the amygdala. Psychologists believe the hippocampus is the centre for STM because it is heavily involved in forming (encoding) new explicit (declarative) memories. For example, PET scans show increased activity in the hippocampus when people recall words, suggesting that it plays a major role in the memory of language. The fact that people who experience severe hippocampal damage also experience memory loss for language also supports this view.

A range of factors can lead to hippocampus dysfunction. These include prolonged stress, anxiety,

hippocampus A brain structure buried deep within the brain and extending into the temporal lobes; associated with memory formation and storage

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depression and post-traumatic stress disorder. Physical factors such as injury, disease (for example, Alzheimer's) or viral infections can also damage the hippocampus and result in memory dysfunction.

Organising spatial information and the ability to navigate through space is also believed to be linked to hippocampal activity. For example, brain imaging technologies show that your right hippocampus becomes more active if you mentally plan a drive across town (Maguire et al., 2000). Damage to this area can make it difficult to navigate through space and many amnesia sufferers who experience hippocampal damage often get lost in 'familiar' surroundings such as their own neighbourhood.

Memory formation

The hippocampus does not function in isolation and it has direct neural connections to a number of brain areas involved in memory. Neuroimages of brains active during memory formation show that the hippocampus receives input from all association areas and sends signals back to them as well as other areas (Alkire, Haier, Fallon, & Cahill, 1998). Memories are believed to be formed when the hippocampus receives and integrates information from the areas of the cortex that initially receive and process the various features that comprise the memory. When the hippocampus receives this information it integrates it to form a memory of a single multi-faceted event rather than a collection of separate memories. The hippocampus is also believed to receive information about emotions generated by a particular event from the amygdala (a brain structure involved in the regulation of emotions, which is discussed shortly) that it integrates into a memory.

Studies of individuals who suffer damage to their hippocampus suggests that if the hippocampus is damaged, specific types of new information may not be able to enter the memory system. This results in an inability to form new explicit or declarative memories or learn new information. Individuals with hippocampal damage have difficulty forming new memories, particularly episodic memories involving information or events related to the self. They find it difficult to concentrate and to learn new factual information; however, their ability to learn new skills or procedures appears unaffected, leading to the belief that the hippocampus is not involved in the formation or storage of implicit procedural memories. For example, people with damage to their hippocampus may not be able to remember who visited them yesterday but they can learn to solve a new puzzle or play a musical instrument, even if later they cannot remember learning how to do it. If the damage is severe, they may lose the ability to carry out an extended sequence of actions – such as making a cup of tea or dressing themselves – because they forget what they had planned to do.

Memory storage and consolidation: Transfer from STM and storing in LTM

Studies of people with memory deficits have also led to the belief that the hippocampus plays a crucial role in the consolidation of memories, a process that transfers information between STM and LTM (Garrett, 2009). They suggest the hippocampus acts as a sort of 'switching station' where new information in the form of an explicit declarative (both semantic and episodic) memory is passed from STM into LTM for more permanent storage in the relevant area of the cerebral cortex (Jonides, Lacey, & Nee, 2005).

The fact that some people who have damage to their hippocampus can still remember events from early in their life suggests that long-term memories are not stored permanently in the hippocampus. Psychologists believe that the hippocampus encodes and temporarily stores declarative memories and then transfers them to other brain areas for long-term storage.

The hippocampus' role in memory formation and storage is clearly illustrated by a famous case study of 'HM', the amnesic patient discussed earlier. Two years after an operation to minimise epileptic seizures damaged his hippocampus, 29-year-old HM continued to give his age as 27. He also reported that it seemed as if the operation had just taken place. His memory of events before the operation remained clear, but he found forming new LTMs almost impossible. When his parents moved to a new house a few blocks away on the same street, he could not remember the new address. Month after month, he read the same magazines over and over without finding them familiar. HM still had a short-term memory, but if you met him and then left the room to return 15 minutes later, he would not recognise you. Yet, he vividly remembered his early past, and he could retain small bits of new information for short periods. At one point, HM was asked to remember three numbers. By making elaborate associations, he managed to

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retain the numbers for 15 minutes. But moments later, he could not recall the digits or the train of associations that had helped him recall them. He could not even remember being assigned the task (Milner, 1965). Although the damage to HM's hippocampus compromised his explicit memory, his implicit memory remained intact. He could learn to trace shapes in a mirror, a task that requires procedural memory, but he never had any explicit recollection of having performed this task or of the people who administered the test to him.

THE AMYGDALA: ADDING EMOTION TO MEMORIES

The **amygdala** is a cluster of neurons in the brain's limbic system that play a key role in memory, learning and initiating emotional responses, particularly responses related to aggression and fear (Sigurdsson, Doyère, Cain, & LeDoux, 2007). From the Greek word for 'almond', the amygdala consists of two cell masses that extend into both hemispheres. Specifically, the amygdala is located deep within the brain, close to the hippocampus (see Figure 5.10).

The amygdala has neural connections to a number of brain areas (such as the brainstem, the hippocampus and the cortex), so it receives and integrates sensory input from all our senses at any one time. Although the amygdala contributes to a range of behaviours, it is particularly influential in forming memories of intense emotionally significant experiences and in survival-related behaviours. The amygdala evaluates environmental stimuli for danger or threat. It determines the emotional significance of a stimulus before the cerebral cortex receives the information and regulates our emotional response to it. In doing this, the amygdala contributes to the formation and storage of long-term memories and learning. In particular, it influences memories of emotionally arousing experiences associated with facial recognition and identification of threatening stimuli. By adding an emotional element to a memory, the amygdala helps to strengthen the memory so it becomes more memorable.

Sensory stimuli reach the amygdala via two different but complementary pathways. The thalamus, the brain structure that receives all sensory stimuli and directs them to the appropriate cortical area for processing, provides the short, imprecise route by relaying stimuli directly to the amygdala before we know exactly whether they pose a danger and what the danger is. The frontal lobe's prefrontal cortex also receives the information from the thalamus and evaluates it as a potential threat. When the amygdala is activated by this information, it evaluates its emotional significance. Then, it initiates the appropriate emotional response and sends signals to other brain areas that results in a release of hormones and/or neuromodulators that produce the somatic, autonomic and endocrine (hormonal) signs of fear. As a result, changes occur in our arousal level and motivation, which in turn influence a variety of cognitive functions, such as our attention level and perception of stimuli. For example, if you hear a sound that your amygdala assesses as threatening, you will feel distressed and form a memory of the sound that associates it with fear. Because the amygdala regulates emotions and provides a primitive 'quick pathway' to the cortex, it enables us to instantly react to dangerous stimuli before we have fully comprehended the situation. So, if the noise is unexpected, you will automatically experience a range of physiological changes associated with the fight–flight response, such as accelerated heart rate and dilated pupils. These changes prepare you to respond instantaneously and appropriately to the threat. Because of this automatic response, the amygdala is also believed to be involved in fear conditioning. Fear conditioning results from learning to associate a stimulus with fear. When the amygdala is stimulated, animals will often respond with aggression or rage.

Damage to the amygdala may threaten our physical and social survival. We may become incapable of feeling an appropriate emotional response or perceiving the emotional responses of others. If this happens, our risk assessment and fear response is impaired because the 'emotion' is taken out of decision. We may ignore important stimuli that signal an environmental threat or we may become inappropriately fearful of non-threatening stimuli and develop an anxiety disorder. Animal studies suggest that when emotional arousal is high while learning a task and forming a new memory, it is likely that memory retention for that task will be high.

consolidation The process by which information is transferred from STM to LTM for relatively permanent storage

amygdala A cluster of neurons in the brain's limbic system associated with memory, learning and initiating fear responses

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The findings of human brain imaging studies are consistent with those of animal studies: the degree of activation of the amygdala by emotional arousal during encoding of emotionally arousing material (either pleasant or unpleasant) correlates highly with subsequent recall (McGaugh, 2004).

5.1 FOCUS ON RESEARCH

VERY YOUNG FOUND TO PROCESS FEAR MEMORIES IN UNIQUE WAY

Very young brains process memories of fear differently than more mature ones, new research indicates. The work significantly advances scientific understanding of when and how fear is stored and unlearnt, and introduces new thinking on the implications of fear experience early in life.

'In the real world, we become fearful, extinguish that fear, reacquire it at another time, and then conquer it yet again,' says John Krystal of Yale University. 'Typically, we think about the long-term, negative impact of fear learning, such as lifelong problems with anxiety. But this work highlights an avenue for adapting to early stresses that apparently can occur only early in life: to erase a learnt fear from memory.'

Study co-authors Jee Hyun Kim and Rick Richardson, of the University of New South Wales in Sydney, homed in on the amygdala. The amygdala is critical for emotional learning and plays a central role in dulling the memory of a fear.

Kim and Richardson trained rats that were 16 and 23 days old – the human equivalent of children and budding adolescents – to associate a specific sound with a mild shock to the foot. After subsequent training, when the sound was not followed by a shock, the animals' fearful reaction to hearing the sound faded. Technically, this is known as 'extinction', and depended on the function of the amygdala. In a second round of training, the researchers reintroduced the fear but anaesthetised the amygdala to temporarily inactivate it. When they tried to re-extinguish the fear, they found only the older rats were able to do so without the amygdala.

The researchers concluded that the age at which the initial extinction training occurred was critical to whether or not the rats' fear faded the second time independently of the amygdala. The authors suggest that in the very young, it is primarily the amygdala that extinguishes fearful memories, but that mechanisms independent of the amygdala develop later.

This raises the possibility that fears unlearnt at an early enough age are, in fact, erased. As brains develop, however, and related structures near the amygdala mature, these structures take on a greater role. Thus, fear in adolescence and later in life may not be erased, but instead be, for example, inhibited by a process of overlaying neutral memories on top of the initial fear reaction. The initial memory could still exist and be called on again.

'Extinction in the young brain might forever erase early traumatic learning – but accepting this hypothesis will have to wait for more research,' says Mark Bouton, of the University of Vermont, who did not participate in the research. 'What might change as the brain develops is where and how fear learning and extinction are stored and how they can be retrieved.'

Source: Society for Neuroscience. (2008, February 18). Very young found to process fear memories in unique way. *ScienceDaily*.

QUESTIONS

1 Identify the aim of this research.
2 Write a dot-point summary of the method used by the researchers.
3 State the results of the research.
4 What conclusion(s) can be drawn from these results?
5 Explain why young rats were used as participants in this study instead of human children and adolescents.

THE CEREBELLUM: FORMING AND STORING IMPLICIT/PROCEDURAL MEMORIES

The **cerebellum** is a large wrinkled structure that lies under the cerebral cortex and sits at the base of the brain at the rear of the brain stem (see Figure 5.10). The cerebellum forms part of the hindbrain, the brain region responsible for lower functions that occur without conscious effort. Often referred to as 'the little brain', the cerebellum is divided into two hemispheres that have neural connections to other cortical structures involved with processing of information at a higher level.

The cerebellum is involved in the processing of memories related to learnt motor skills and habits, therefore it is our storehouse for implicit procedural memories. It is responsible for posture and muscle tone but the cerebellum's primary functions are balance and the fine control and coordination of skeletal muscles used in voluntary movement, particularly sequential movements. To do this the cerebellum transmits motor information to and receives motor messages from the cerebral cortex. If your cerebellum was damaged, you would find it difficult to complete movements that would normally be automatic and effortless, such as walking, playing a musical instrument, tracking movements with your eyes, shaking hands or typing a text message,

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because these activities require the interaction and coordination of many muscles. You may still be able to move your limbs voluntarily, but because you cannot control your motor movements, they may be difficult, jerky or uncontrolled. As most motor skills are acquired through practice, proper functioning of the cerebellum is necessary if you are to learn new motor skills (Garrett, 2009). Damage to the cerebellum can also result in difficulty speaking, because the muscles of the vocal cords, windpipe and mouth involved in speaking will not be able to be coordinated.

5.3 CHECK YOUR UNDERSTANDING >>

1 Which of the following is not one of the major roles of the hippocampus?
   - A Transferring information from STM to LTM
   - B Transferring information from LTM to STM
   - C Forming short-term declarative memories
   - D Receiving information from other brain areas and integrating it into a single event

2 When you are learning a new concept in psychology, the area of your brain that would be most active would be the:
   - A amygdala.
   - B cerebral cortex.
   - C cerebellum.
   - D hippocampus.

3 A person with a dysfunctional cerebellum would experience problems with:
   - A forming and storing new explicit memories.
   - B forming and storing new implicit memories.
   - C responding to stimuli with appropriate emotions.
   - D transferring information from STM to LTM.

4 A person with a dysfunctional amygdala would experience problems with:
   - A forming and storing new explicit memories.
   - B forming and storing new implicit memories.
   - C responding to stimuli with appropriate emotions.
   - D transferring information from STM to LTM.

5 Outline the role of the amygdala in memory.

6 Explain why damage to the hippocampus causes memory problems.

RETRIEVAL METHODS: ACCESSING INFORMATION STORED IN LTM

We store information in our LTM so that we can use it at a later date. These memories are stored in various parts of our brain that are linked together by neural networks. Memory retrieval therefore requires revisiting the nerve pathways the brain created when forming the memory. Retrieval effectively locates a memory stored in LTM and returns it to consciousness where it can be accessed. So when we retrieve information, we are demonstrating the existence of information in our memory system. However, the retrieval process doesn't always work perfectly. Before we look at how reliable our memory is, let's look at the different methods available to retrieve information stored in LTM.

Psychologists employ a number of retrieval methods to demonstrate that information has been processed and stored in LTM. These methods include recall, recognition, relearning and reconstruction.

RECALL

What is the name of the first song on your favourite album? Who wrote Hamlet? Who won the AFL Premiership in a particular year? If you can answer these questions, you are demonstrating **recall**. To recall means to supply or reproduce facts or information that is stored in LTM, using few or no cues for assistance.

Tests of recall present you with minimal cues – usually only the question you are being asked – and often require that you recall something verbatim (word for word). If you study a poem until you can recite it without looking, then each time you recite it you will be recalling it. Or, if you complete a fill-in-the-blanks question, you are using recall.

There are three different methods of recall – *free recall*, *serial recall* and *cued recall* – and any of them can be used when retrieving information.

Free recall requires that you reproduce information from your memory in any order, without the use of specific cues. If you tried to remember the songs on your favourite album using free recall, then you would recite these titles in any order, rather than in the order they appear on the album.

cerebellum A structure attached to the rear of the brainstem responsible for implicit memory of learnt skills and actions

recall A measure of retention that involves retrieving stored information using few or no cues for assistance

free recall Recalling information from memory in any order with no cues for assistance

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FIGURE 5.11 Remembering who won an AFL Premiership in a particular year is an example of recall.

Serial recall occurs when you reproduce information from memory in the order in which it was originally presented, without the use of specific cues. If you were asked to remember the songs on your favourite album in the order they are listed, you would be using serial recall.

If cues are supplied, such as the first word of each song title on your favourite album, then you would be using **cued recall** to access your memory of the album contents. Cued recall is when you reproduce information from memory, but you are given cues or prompts to assist recall.

Because recall involves the use of very few memory cues, it is usually the least effective at producing information when compared to the other measures of retention (recognition and relearning). It is therefore considered the least sensitive measure of retention. Of the types of recall, cued recall is the most sensitive measure of retention, followed by free recall and then serial recall. Try it yourself 5.3 allows you to investigate the relative sensitivity of the three types of recall.

5.3 TRY IT YOURSELF >>

THE RELATIVE SENSITIVITY OF DIFFERENT TYPES OF RECALL

You will need:

- a pen
- paper
- a word list (featuring 10 three-letter words)
- three groups of participants (or one group of participants, but you will need three different word lists).

1. Read the word list to your first group of participants. Ask them to write down the words from the list in the order in which they were read. This will assess the sensitivity of serial recall.
2. Read the word list to your second group of participants. Ask them to write down as many words as they can recall in any order. This will assess the sensitivity of free recall.
3. Read the word list to your third group of participants. Ask them to recall as many words as possible in any order, but provide them with the first letter of each word to be recalled. This will assess the sensitivity of cued recall.

QUESTIONS

1. Find the average number of correct responses for each group.
2. Which group achieved the highest number? Was this expected?
3. From your results, which is the least and the most sensitive measure of recall?

RECOGNITION

Try to write down the names of all the people that were in your English class last year. While you might be able to remember a few, you are probably surprised by how many you have forgotten. However, to really test your memory of your classmates we could use a test of recognition – a more sensitive measure of memory than recall.

Recognition involves identifying the correct answer from a list of possible alternatives, collectively known as **distracters**. For example, in order to remember who was in your English class last year, you might be asked to choose names from a list of all people in your year level. Because you would only have to recognise names rather than recall them from your LTM, you would probably find that you remembered more students' names than you thought. Another recognition test may involve taking a multiple-choice test on facts and ideas that are related to a topic you studied (see Figure 5.12). You have probably had the experience of being unable to answer a question, yet when you have been told the answer, you realised you knew it all along. This is another example of recognition.

Why is recognition superior to recall? Recognition tests of memory are 'easier' because they provide retrieval cues that serve as prompts or reminders of information that could not otherwise be recalled. In other words, it is easier to retrieve 'correct' information because it is presented among incorrect alternatives. Thus, recognition is usually superior to recall because recognition accesses memories or information that recall cannot access.

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FIGURE 5.12 A good method of testing long-term memory using recognition is through the use of multiple-choice tests.

CARTOONSTOCK/REX MAY-BALOO

FIGURE 5.13 Some people report that they never forget a face – this highlights the effectiveness of recognition.

5.4 CHECK YOUR UNDERSTANDING >>

1 A multiple-choice exam relies on which way of retrieving information from LTM?
   A Recall
   B Recognition
   C Relearning
   D Reconstruction

2 The most sensitive method for establishing the content of LTM is:
   A recall.
   B recognition.
   C relearning.
   D reconstruction.

3 Which of the following is not true of recognition?
   A It is a more sensitive testing procedure than recall.
   B Recognition yields a savings score based on the number of items initially identified correctly.
   C Recognition can be greatly influenced by the presence of distracters.
   D Exams involving multiple choice are an example of the recognition procedure.

4 Most students perform better on tests using ________, compared to tests using ________.
   A recall; recognition
   B recognition; recall
   C encoding; recognition
   D encoding; chunking

5 Explain why recognition is a more sensitive measure of retention than recall.

6 What is the difference between the retrieval methods of recognition and cued recall? Use an example to support your answer.

7 A memory researcher was interested in how we retrieve information from memory. She wanted to see if there were any differences in the way people remembered the names of their workmates 5 years later. She asked one group of the workers to write down the names of as many of their workmates as they could. She showed a photograph of the workers to a second group and asked them to name as many as they could. Name and describe the retrieval processes used by each group.

RELEARNING

The process of relearning refers to learning something that has been previously learnt, to measure the amount of information retained from the original learning. In a classic experiment, psychologist Harold Burtt (1941) read a short passage in Greek to his son. He did this each day when the boy was between 15 months and 3 years of age. At age eight, the boy was asked if he remembered the Greek passage. He showed no evidence of recall. He was then shown selections of the passage he had heard, and selections from other Greek passages. Could he recognise the one he had heard as an infant? No.

Had the psychologist stopped there, he might have concluded that his son retained no memory of the Greek he heard as a toddler. However, the psychologist then asked his son to memorise the original passage as well as others of equal difficulty. This time, the earlier learning became evident: the boy memorised the passage he heard in childhood 25 per cent faster than he memorised the others (Burtt, 1941).

Psychologists believe that relearning is typically the most sensitive measure of retention – more

serial recall Recalling information from memory in the order or sequence in which it was learnt, with no cues for assistance

cued recall Recalling information from memory with some cues or hints for assistance

recognition A measure of retention that involves identifying previously learnt information from a list or group of alternatives

distracter A false item, similar to the correct item, that is included with items to be recognised and can lead to unreliable identification

relearning A measure of retention that involves learning information that has been previously learnt and stored in LTM as a means of assessing whether any information was retained from the original learning sensitive than recognition and recall; that is, it is the most successful. This is because you may have shown no evidence of remembering the information when asked to recall or recognise it, but by relearning and therefore revisiting the information, some evidence of retention may exist. You may be able to learn the revisited information faster, hence demonstrating some retention of original learning. Relearning allows you to access memory stores that cannot be accessed by other tests of retention.

Savings score

When we test a person using the relearning method, how do we know how much of the original learning was retained? Traditionally, relearning is measured by a savings score. A savings score calculates the percentage of information retained from original learning. It does this by subtracting the time or number of trials it takes to relearn the information on the second occasion from the time or number of trials taken to originally learn the information. This figure is then divided by the time or number of trials taken to originally learn the information, and multiplied by 100 to convert the amount to a percentage. The formula for calculating the savings score is below.

$$\text{Savings score} = \frac{\text{(time/trials for original learning} - \text{time/trials for relearning)}}{\text{time/trials for original learning}} \times 100$$

Let us say it takes you one hour to learn the 50 states of America. In two years' time, you relearn the information. When relearning, it only takes you half an hour. Using the savings score, you can figure out how much information has been retained:

$$\begin{aligned}\text{Savings score} &= \frac{60\text{ (mins)} - 30\text{ (mins)}}{60\text{ (mins)}} \times 100\\ &= \frac{30}{60} \times 100\\ &= 50\%\end{aligned}$$

The savings score may not be needed to perform every calculation. As with the example above, it can be seen without doing the equation that the information was learnt in half the time; therefore, 50 per cent of the original information must have been retained. If it took a child 20 attempts to learn to tie their shoelaces on Monday and then on Tuesday, after relearning, it only took them five attempts, it can be seen without necessarily having to do the calculations that the skill was learnt in one quarter of the time; therefore, 75 per cent of the original learning must have been saved.

RECONSTRUCTION

If you wanted to test a person's memory of an event, you may ask them to tell you what they remembered about it at a later date. In other words, you ask them to reconstruct the memory. Memory reconstruction involves remembering past events and features of past events you have stored in LTM and putting them together during memory recall at a later date. For example, if you were asked to recall your last birthday party certain features and fragments may come back to you, such as where it was held, who was there, what you were wearing and what happened. While you are remembering, all of these features and events are recalled, and then put together to reconstruct the memory of your last birthday. Although this seems easy enough to do, the process of reconstructing an accurate memory may be harder than you think.

Research conducted by British psychologist Sir Frederic Bartlett (1932) illustrated just how problematic reconstructing memory was. Bartlett wanted to test his theory that people's recall of events is often inaccurate because memory is subject to individual interpretation or construction. He asked his English participants to read a North American Indian folktale called 'The War of the Ghosts'. He chose this story because his participants were unlikely to be familiar with it. When he asked them to recall the story, Bartlett found that the remembered version was shorter than the original and his students had changed many of the original words and phrases to more familiar words and concepts (for example, they changed 'canoe' to 'boat'). Bartlett suggested that the students had fitted the story into their own experiences so that it made sense and it was this revised or reconstructed story that they recalled.

Based on these results, Bartlett suggested that when we form a memory we do not store information exactly as it is presented to us in the same way a video camera would record an event and replay it exactly as it was recorded. He suggested that, initially, memory formation is distorted by personal interpretation, which can be influenced by our learnt or cultural norms and values, our expectations, what we pay attention to and the way we make sense of our world. When we recall the information at a later date, it is this reconstructed version that is recalled. Bartlett hypothesised that

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we attempt to fit the new information into schemas or mental 'units' of knowledge that correspond to frequently encountered people, objects or situations. We form schemas because they allow us to make sense of information so we can predict what is going to happen and what we should do in any given situation. He called this process 'effort after meaning'. Bartlett said schemas are therefore capable of distorting unfamiliar or unconsciously 'unacceptable' information in order to 'fit in' with our existing knowledge or schemas. This reconstruction can, therefore, result in a memory that makes more sense to us but, because it is subject to individual interpretation, does not always accurately represent the past event.

A reconstruction test could consist of a variety of materials. These include wordlists, pictures and scenes, sentences, prose passages and video. The person would be introduced to the material and then, in its absence, asked to recall its content as accurately as possible. Reconstruction demonstrates how memories are often not accurate records of prior experiences. In other words, we create memories and store them in the way that makes the most sense to us.

5.5 CHECK YOUR UNDERSTANDING >>

1 When Suzie was 19 she completed the first two units of a French language course. Five years later, she began the course again and found that she learnt the course content 25 per cent more quickly than she did originally. This is probably because:
   A relearning is the most sensitive measure of memory.
   B the savings score could be calculated.
   C the cued recall is a superior measure of memory than free recall.
   D she was older and therefore her memory worked better.
2 Which of the following is the best way of testing retrieval of long-term memories?
   A Recall
   B Recognition
   C Relearning
   D All of the above
3 Research on memories that become distorted to fit our schema indicates that this process occurs during:
   A memory formation.
   B memory retrieval.
   C memory consolidation.
   D relearning.
4 Provide an example of how you could use relearning to track your progress in Psychology.
5 In reference to memory, explain what schemas are.
6 Provide an example of how you could test out the theory of reconstruction on someone using a video clip of an event.

EFFECTS OF BRAIN TRAUMA ON MEMORY

If our memory system is to function effectively, our brain needs to be healthy and fully functional. If our brain suffers some form of trauma, then normal memory processes and functions may be disrupted. This disruption can be total, partial, temporary or permanent and it can cause cognitive, emotional, physical or behavioural dysfunction.

Brain trauma involves physical damage to the brain and it should not be confused with a head injury. Head injuries generally involve damage to the scalp or skull; however, head injuries can result in brain trauma. If a person experiences brain trauma, the damage their brain sustains may result in some form of memory impairment that causes an inability to form, store or retrieve memories. Brain trauma can result from external causes such as a car or sporting accident, an assault to the head, electroconvulsive therapy or brain surgery. Internal causes such as tumours, infections, chronic alcoholism, malnutrition, infection or neurological diseases such as Alzheimer's disease can also result in brain trauma.

EFFECT OF BRAIN SURGERY

Brain surgery is a major medical event carried out to correct physical abnormalities in the brain. It is a complex and invasive procedure that requires the patient to have a general anaesthetic and undergo

savings score A formula that calculates the percentage of information retained from original learning after relearning has occurred

memory reconstruction Remembering past events and features of these events and putting them together during memory recall

schemas Preconceived ideas that represent aspects of the world or the things in it, influenced by culture and experience

brain trauma Brain trauma involves physical damage to the brain that results in emotional, physical or behavioural dysfunction a craniotomy, an operation to open the skull. During brain surgery, the neurosurgeon cuts through an area of the scalp above where the problem in the brain is located. A hole is then created in the skull so the bone flap can be removed and the targeted area of the brain accessed.

Like all forms of surgery, brain surgery carries health risks associated with anaesthesia and invasive operations. In addition, although the surgery may correct or alleviate a physical abnormality in the brain, areas that play a key role in memory (such as the hippocampus and amygdala) may be traumatised. If brain trauma occurs during surgery, the person may experience post-operative cognitive decline (POCD). This condition commonly affects older people who have recently undergone a surgery. Common characteristics of POCD include impairment of memory, concentration, language comprehension and social integration (Phillips-Bute et al., 2006). If memory function is affected, the person's ability to learn new information (or form new short-term memories) or remember previously learnt information (access old long-term memories) may be impaired. These changes, particularly short-term memory loss, are usually subtle and most people recover quickly. However, in some cases the changes can be permanent and significantly detract from the person's normal daily functioning.

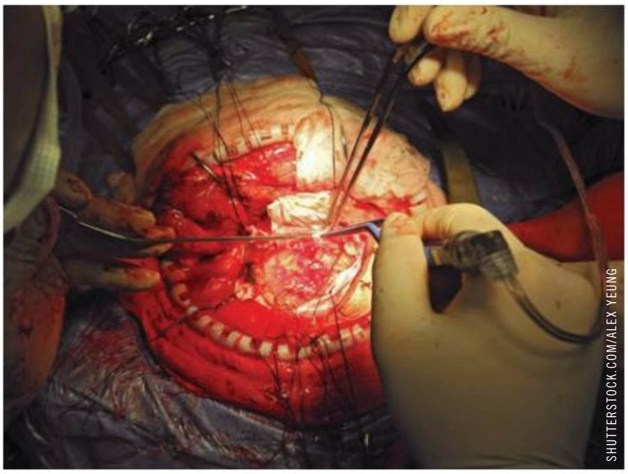

FIGURE 5.14 Brain surgery is a complex and invasive procedure that may traumatise the brain and cause post-operative cognitive decline (POCD) even though it corrects a physical abnormality.

Recently it has been suggested that general anaesthesia may be associated with cognitive decline, specifically with increasing the risk of dementia in the elderly, possibly by causing inflammation in the brain (Bekker & Weeks, 2003; Kline et al., 2012).

AMNESIA: WHERE HAVE THE MEMORIES GONE?

Amnesia refers to a temporary or permanent, partial or complete loss of memory. If brain injury results in amnesia, then the amnesia is said to have an organic cause.

Although different forms of brain injury or trauma can result in different amnesia symptoms, general symptoms include memory loss, confusion and the inability to recognise familiar faces, objects or places. For example, one type of brain injury may cause a 'gap' in memories preceding the amnesia-causing event (retrograde amnesia), while another injury may result in memory loss for events that follow the amnesia-causing event (anterograde amnesia).

Amnesia can also occur in the absence of physical injury; for example, because we are either consciously or unconsciously motivated to forget traumatic memories. When this occurs, the amnesia is said to have a psychological cause.

5.2 FOCUS ON RESEARCH

WHY ANAESTHETICS CAUSE PROLONGED MEMORY LOSS

Until now, scientists haven't understood why about a third of patients who undergo anaesthesia and surgery experience some kind of cognitive impairment – such as memory loss – after discharge from hospital. One-tenth of patients still suffer cognitive impairments three months later.

Anaesthetics activate memory-loss receptors in the brain, ensuring that patients don't remember traumatic events during surgery. Professor Beverley Orser and her team of researchers at the University of Toronto's Faculty of Medicine found that the activity of memory loss receptors remains high long after the drugs have left the patient's system, sometimes for days on end. Animal studies showed this chain reaction has long-term effects on the performance of memory-related tasks.

In the study healthy male mice were administered a low dose of anaesthetic for just 20 minutes. The results showed that memory-loss receptor activity was increased for a week afterwards. These results suggest the same

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effect can impact a patient's learning and memory during a time when they are receiving critical information about their care.

'There's a lot going on after surgery, which can alter our ability to think clearly. Loss of sleep, new environments and medications can all impact a patient's mental function. Anaesthetics likely compound these issues,' says Orser. The likelihood of a patient experiencing cognitive impairment depends on their age, health, type of surgery and the anaesthetic, with chances increasing for more intricate procedures. The incidence is highest in the elderly or those undergoing major surgery such as cardiopulmonary bypass. 'Anaesthetics don't put you to sleep – they induce a pharmacological coma. We shouldn't take these drugs lightly,' Professor Orser cautions.

Orser and her team are looking at drugs that can stop the receptors and restore memory loss. While they are still in the early stages of research, they say some of the drugs show very promising results in animal studies.

Source: Adapted from University of Toronto. (2014, November 3). Why anaesthetics cause prolonged memory loss. *ScienceDaily*.

QUESTIONS

1 What was the aim of this study?
2 Write a possible hypothesis for this study.
3 Identify the population of research interest.
4 What were the results of this study?
5 What conclusion(s) can be drawn from this study?

ANTEROGRADE AMNESIA: AN INABILITY TO FORM NEW LONG-TERM MEMORIES

The prefix 'antero' means 'forwards', so the memory loss experienced from **anterograde amnesia** occurs for events that happen *after* the amnesia-causing event (or forward in time). Sufferers of complete anterograde amnesia can retrieve memories from their LTM but they are unable to form new long-term memories, even though their STM still functions. However, those who suffer from partial anterograde amnesia do succeed in forming some new long-term memories. When recovering from anterograde amnesia, the most recent memories are often recalled before distant ones.

In 1985, neurologist Oliver Sacks wrote *The Man Who Mistook His Wife for a Hat*, a book of clinical case studies taken from his experience. One case study describes Sacks' patient Jimmie, a 49-year-old man who had an extreme form of anterograde amnesia that left him with no memory for events occurring after he received a brain injury in 1945. In 1975 when Sacks asked his age, Jimmie replied, 'Nineteen'. Sacks gave Jimmie a mirror and asked him if he saw a 19-year-old looking out from it. When Jimmie looked in the mirror he turned pale, gripped the chair, swore, and frantically asked, 'What's going on? What's happened to me?' However, when Jimmie's attention was diverted to some children playing outside, he forgot about the mirror and his panic ended.

Although his intellectual and perceptual powers were preserved, in many ways time had stopped for Jimmie. Jimmie's form of anterograde amnesia still allowed him to register a memory; however, distracting environmental stimuli made it difficult for him to consolidate memory traces and form new, lasting long-term memories.

Causes of amnesia

Normal memory function involves many parts of the brain and any event that traumatises or damages the brain can interfere with memory function. Anterograde amnesia is often the result of damage to the hippocampus or its surrounding areas in the medial temporal lobes. This can happen as a result of traumatic brain injury, and the degree of damage and location of the damage determines the severity of memory impairment. Because the hippocampus is involved in the formation of explicit declarative memories, if it is damaged no new information can enter memory, so no new short-term explicit memories can be formed. However, because the hippocampus does not process implicit procedural memories, the person can still learn new skills and retrieve old procedural memories. For instance, they are able to learn a new card game and remember events from their childhood, but they may not remember what they have eaten for lunch earlier that day. If the hippocampus remains intact but the person sustains damage to their amygdala, they will be able to form new explicit memories but these memories will lack emotional content.

Perhaps the worst case of amnesia ever recorded, is that of British composer and musician Clive Wearing,

craniotomy The surgical removal of part of the skull to expose the brain

amnesia A temporary or permanent, partial or total loss of memory

anterograde amnesia A form of memory loss for events that happen after an amnesia-causing event

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who suffered damage to his brain as a result of an encephalitis virus in 1985. Because the damage was to an area of his brain required to transfer memories from STM to LTM, he is completely unable to form lasting new long-term memories. Wearing's STM duration is limited to the extent that he will greet his wife like a long-lost friend even if she only left him 30 seconds ago. However, Wearing still recalls how to play the piano and conduct a choir, despite having no recollection of having received a musical education, because his implicit procedural memory was not damaged by the virus (Sacks, 2007).

Brain trauma can also result in retrograde amnesia, or memory loss for events occurring before the amnesia-causing event. The prefix retro means 'moving backwards', and sufferers of complete retrograde amnesia are unable to remember events before experiencing their amnesia-causing event. However, those who suffer from partial retrograde amnesia are able to access some long-term memories. The extent to which they are able to do so depends on the degree of their brain injury.

Individuals who suffer traumatic head injuries often experience partial retrograde amnesia and they are unable to recall events just before the injury. Because they often have good memory for old events and can form new memories, this amnesia form is generally attributed to an interruption to consolidation, the process whereby a short-term memory is formed into a long-term memory. Retrograde amnesia is often temporary, and memories of events leading up to the amnesia-causing event return gradually. The most distant memories are usually recalled first; however, recovery is usually incomplete. The person may never remember the last few seconds before the amnesia-causing event.

5.6 CHECK YOUR UNDERSTANDING >>

1 If an individual experiences a trauma that results in brain injury, they may be unable to recall anything from the moment of the injury or to retain memories of recent events. This is known as:
   - A anterograde amnesia.
   - B retrograde amnesia.
   - C total amnesia.
   - D post-event amnesia.

2 A key brain structure that is often damaged in patients with anterograde amnesia is the:
   - A cerebral cortex.
   - B amygdala.
   - C hippocampus.
   - D cerebellum.

3 What is a common side effect experienced by older people undergoing a craniotomy?
   - A Anterograde amnesia
   - B Retrograde amnesia
   - C Either A or B
   - D Neither A or B

4 Which of the following statements is true of retrograde amnesia?
   - A Memories from the distant past usually return before memories from the recent past.
   - B Memories from the recent past usually return before memories from the distant past.
   - C Sufferers have difficulty forming new long-term memories.
   - D Sufferers have difficulty forming new short-term memories.

5 What is amnesia and what can cause amnesia?

EFFECTS OF NEURODEGENERATIVE DISEASE

Like any brain injury, brain disease disrupts brain functioning, including memory processes. A range of neurodegenerative diseases can gradually and progressively kill nerve cells, causing nervous system dysfunction and permanent loss of ability. Neurodegenerative diseases can have a genetic cause but they can also be caused by chronic alcoholism, tumour, stroke, toxins, chemicals and viruses. They can affect balance, movement, talking, breathing, heart function and cognition. When the brain experiences neurodegenerative disease that affects cognition, the result may be dementia.

FIGURE 5.15 Retrograde and anterograde amnesia

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Dementia

Dementia, in itself, is not a disease and it is not the same as amnesia. Dementia often includes memory loss, but it also involves other significant cognitive problems that lead to a decline in the ability to carry out daily activities. With many types of dementia, some of the nerve cells in the brain stop functioning, lose connections with other cells, and die. Dementia is a general term describing the symptoms of a variety of illnesses that cause changes in the brain that lead to severe, progressive and permanent loss of intellectual capacity that severely interferes with a person's daily functioning. More than 342 800 Australians live with dementia. Dementia is the second leading cause of death in Australia and there is no cure (Alzheimer's Australia, 2015a).

Dementia affects a number of brain areas, and symptoms vary depending on the particular area of the brain affected. However, all forms of disease that result in dementia kill brain cells and cause brain dysfunction that leads to progressive, irreversible cognitive decline – usually accompanied by personality and behaviour changes – that severely impairs daily functioning. Characteristic dementia-related cognitive loss includes disrupted thinking, reasoning, communication, personality, cognitive speed and memory.

One of the main dementia symptoms is a persistent and progressive short-term and long-term memory loss that interferes with normal functioning (see Figure 5.16). Because dementia typically appears in later life, its symptoms have been mistakenly assumed to be indicators of old age. Although people who age normally usually experience some changes in attention and memory, this does not generally interfere with their everyday lives. An example of normal occasional memory loss is forgetting where we put the car keys. The person with dementia, however, may not only forget where they put the car keys but also forget what the keys are used for.

Other dementia symptoms include repeatedly asking the same question, confusion, increased anxiety or paranoia, personality changes, lack of initiative, difficulty learning new information or retrieving old memories, and loss of ability to perform everyday tasks. Common forms of dementia include vascular dementia, Lewy body disease, frontotemporal dementia and Alzheimer's disease. Table 5.2 shows the differences between normal memory loss and dementia-related memory loss.

FIGURE 5.16 Dementia causes people to slip into a slow mental decline that severely interferes with their daily functioning.

TABLE 5.2 Ageing: Dementia-related memory loss versus normal memory loss

DESCRIPTION	DEMENTIA-RELATED MEMORY LOSS	NORMAL MEMORY LOSS
Events	Forgets part or all of an event	Memory of events may sometimes be vague
Words or names for things or objects	Progressively forgets	Sometimes forgets; words or names are on the tip of the tongue
Attention	Increasingly unable to concentrate on TV programs, films, books or conversations	Able to follow
Written and verbal instructions	Increasingly unable to follow	Able to follow
Stored knowledge	Progressively loses information such as that relating to historical or political events	Recall may be slower but information is essentially retained
Everyday skills such as dressing and cooking	Progressively loses capacity to perform routine tasks	Retains ability, unless physically impaired

Source: Adapted from Alzheimer's Australia (2015b)

retrograde amnesia A form of memory loss for events occurring before an amnesia-causing event

neurodegenerative disease A disease that gradually and progressively kills nerve cells and results in nervous system dysfunction and permanent loss of ability

dementia A general term that describes the symptoms of a variety of brain illnesses that progressively kill brain cells and result in irreversible structural and chemical changes in the brain that lead to permanent and severe cognitive loss

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ALZHEIMER'S DISEASE

The most common form of dementia among older people is **Alzheimer's disease** – an irreversible, progressive and fatal neurodegenerative disease that attacks the brain and kills brain cells, causing severe cognitive and behavioural decline. Alzheimer's disease is the most common form of dementia, affecting up to 70 per cent of all people with dementia (Alzheimer's Australia, 2015c). Most people who age normally do not develop Alzheimer's disease, but the risk of developing it increases with age. Microscopic changes in the brain that signal the onset of Alzheimer's disease begin long before the first signs of memory loss. Usually symptoms appear after the age of 65; however, early onset can occur in one's 30s. Symptoms include loss of memory, confusion, mood swings and withdrawal.

Alzheimer's disease is named after the German neurologist Dr Alois Alzheimer. In 1906, Dr Alzheimer performed an autopsy on the brain of a 51-year-old woman, Auguste D., who had died of unusual mental illness (see Figure 5.17). Her symptoms included memory loss, language problems and unpredictable behaviour. During autopsy, Dr Alzheimer noticed that Auguste D.'s brain was very different from a normal brain. He found dramatic shrinkage, especially of the cortex. He also found dead and dying brain cells and recorded that Auguste D.'s brain tissue consisted of many abnormal clumps and tangled bundles of fibres around these cells. Today, these anatomical features are considered clear indicators of Alzheimer's disease.

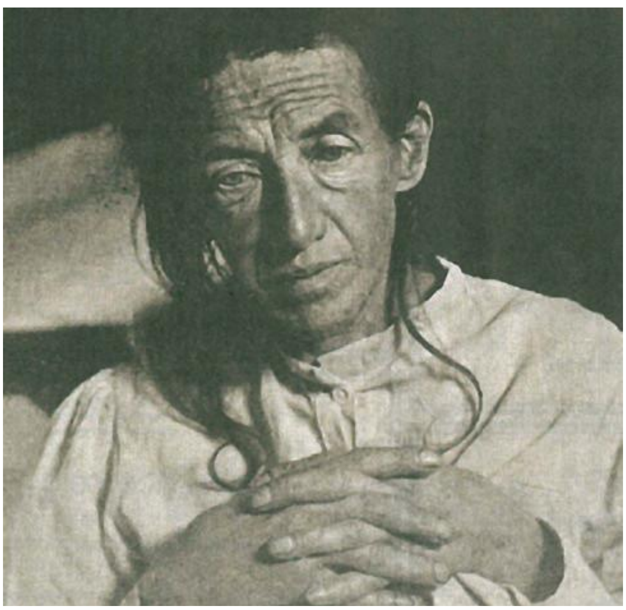

FIGURE 5.17 Auguste D., a patient of Dr Alois Alzheimer

Brain scans of Alzheimer sufferers indicate that the earliest damage occurs in the hippocampus. Typically, the first symptom of hippocampal damage (and Alzheimer's disease) is impaired memory formation, which progressively increases throughout stages of the disease. Initially, the person displays signs of anterograde amnesia and they have difficulty remembering recent events or newly learnt information. Implicit memory of learnt skills or habits and long-term semantic memory of facts remain relatively intact. However, as the disease progresses throughout the brain the onset of anterograde amnesia is slowly followed by the onset of retrograde amnesia. When this occurs, the person loses their ability to access long-term explicit memories. When the disease finally reaches their cerebellum, implicit memories are lost.

Causes of Alzheimer's disease

Neuroscientists believe age, genetics and environmental factors contribute to the disease. Although there is no single known cause of Alzheimer's disease, scans and autopsies reveal abnormal webs (known as amyloid plaques) and tangles (known as neurofibrillary tangles) in brain cells leading to and from the hippocampus (Ballard et al., 2011).

Plaques and tangles stop communication between nerve cells and cause them to die.

GETTY IMAGES/MAGGIE STEBER

FIGURE 5.18 A cross-section of a normal brain (top) and a brain affected by Alzheimer's disease (bottom). The gaps between the folds of brain tissue are much wider in the Alzheimer's-affected brain.

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Amyloid plaques are sticky, abnormal clusters of beta-amyloid protein fragments that collect on the outside of and between nerve cells. Beta-amyloid exists in normal brains, but when this normally harmless protein accumulates, it forms amyloid plaques, which destroy the synapses and disrupt the conduction of nerve impulses. Nerve cells are damaged when the amyloid reacts with the metals copper and iron, which are naturally abundant in the brain. This chemical reaction is similar to rusting and the affected neurons no longer transmit information properly.

The Alzheimer's brain also contains **neurofibrillary tangles**, which consist of bundles of twisted fibres of highly soluble tau protein. These tangles are found in the centre of dead and dying nerve cells. Tau proteins are involved in the structure of nerve cells and they are found throughout healthy nervous systems. When they are working properly, tau proteins help to stabilise nerve cells. However, if they become overexcited – as is believed to happen with Alzheimer's disease – they begin to assemble nerves in a chaotic and tangled form. Scientists suggest that plaques and tangles gradually disrupt the normal organisation of and communication between brain cells. The brain cells eventually die and brain volume shrinks. When the brain begins to atrophy (shrink), the neural systems critical for attention, memory, learning and higher cognitive abilities do not function effectively because they have far fewer nerve cells and synapses. As a result, there is interference in the way information is transmitted between the brain's neurons and in the activity of neurotransmitters that carry messages across the synaptic gap between neurons. Autopsies of atrophied brains also reveal that the amount of folds (gyri) of the Alzheimer's brain decrease and the fluid-filled spaces (ventricles) in the folds are grossly enlarged compared to a healthy brain (see Figure 5.18).

Although many people who age normally develop some brain plaques and tangles and they also suffer occasional memory loss, Alzheimer's sufferers have many more plaques and tangles than average and their memory loss is significant (see Figure 5.19). Alzheimer's sufferers also tend to develop plaques and tangles in a predictable pattern, beginning in areas important for memory before spreading to other regions.

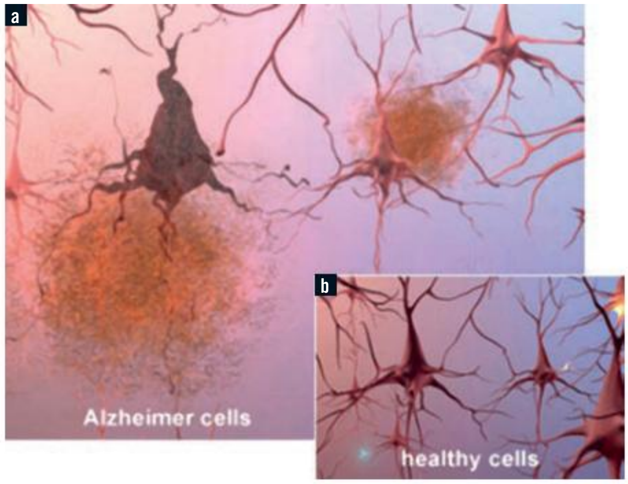

FIGURE 5.19 Tissue in an Alzheimer's-affected brain (a) contains fewer nerve cells and synapses than a healthy brain (b). Alzheimer's tissue is characterised by amyloid plaques and neurofibrillary tangles.

Tests show that the Alzheimer's brain also produces reduced levels of several neurotransmitters. In particular, there is a low level of **acetylcholine**, a neurotransmitter that carries information between the synapses of cells, because Alzheimer's disease systematically destroys the neurons that produce acetylcholine. The belief that acetylcholine plays a vital role in memory is supported by evidence that drugs that block the action of acetylcholine have been found to disrupt the formation of memory in healthy subjects.

As Alzheimer's disease affects different areas of the brain, specific functions or abilities are lost. Memory of recent events is often the first to be affected, but as the disease progresses, long-term memory is also lost. The disease also affects many of the brain's other functions and consequently language, attention, judgement and many other aspects of behaviour are affected.

Alzheimer's disease An irreversible and progressive neurodegenerative disease that gradually kills brain cells, causing severe cognitive and behavioural decline that eventually results in death

amyloid plaques Sticky, abnormal clusters of beta-amyloid fragments that collect on the outside of nerve cells, destroying the synapses and the conduction of nerve impulses

neurofibrillary tangles Twisted strands of tau protein found in the centre of dead and dying nerve cells

acetylcholine A neurotransmitter that carries information between the synapses of cells; involved in the activity of muscles and believed to be involved in learning, memory and mood

5.3

FOCUS ON RESEARCH

SHORTER SLEEP DURATION, POORER SLEEP QUALITY LINKED TO ALZHEIMER'S DISEASE

Alzheimer's disease is an irreversible, progressive brain disease that slowly destroys memory and thinking skills. According to the National Institutes of Health, as many as 5.1 million Americans may have the disease, with first symptoms appearing after age 60. Previous studies have linked disturbed sleep to cognitive impairment in older people.

According to a new study led by researchers at the Johns Hopkins Bloomberg School of Public Health, poor sleep quality may impact Alzheimer's disease onset and progression. Researchers examined the association between sleep variables and a biomarker for Alzheimer's disease in older adults. They found that reports of shorter sleep duration and poorer sleep quality were associated with a greater β-Amyloid burden, a characteristic of the disease.

'Our study found that among older adults, reports of shorter sleep duration and poorer sleep quality were associated with higher levels of β-Amyloid measured by PET scans of the brain,' said Adam Spira, lead author of the study. 'These results could have significant public health implications as Alzheimer's disease is the most common cause of dementia, and approximately half of older adults have insomnia symptoms.'

In a cross-sectional study of adults from the neuro-imagining sub-study of the Baltimore Longitudinal Study of Aging with an average age of 76, the researchers examined the association between self-reported sleep variables and β-Amyloid deposition. Study participants reported sleep that ranged from more than seven hours to no more than five hours. β-Amyloid deposition was measured by the Pittsburgh compound B tracer and PET (positron emission tomography) scans of the brain. Reports of shorter sleep duration and lower sleep quality were both associated with greater Aβ build-up.

'These findings are important in part because sleep disturbances can be treated in older people. To the degree that poor sleep promotes the development of Alzheimer's disease, treatments for poor sleep or efforts to maintain healthy sleep patterns may help prevent or slow the progression of Alzheimer disease,' said Spira. He added that the findings cannot demonstrate a causal link between poor sleep and Alzheimer's disease, and that longitudinal studies with objective sleep measures are needed to further examine whether poor sleep contributes to or accelerates Alzheimer's disease.

Source: Johns Hopkins Bloomberg School of Public Health. (2013, October 21). Shorter sleep duration, poorer sleep quality linked to Alzheimer's disease. *ScienceDaily*.

QUESTIONS

1 What was the aim of this study?
2 Write a possible hypothesis for this study.
3 Identify the independent variable (IV) and dependent variable (DV).
4 Identify the population and sample for this study.
5 Identify the data collection method used in this study and state one advantage and one disadvantage of this method.

5.7 CHECK YOUR UNDERSTANDING >>

1 Which of the following changes in memory performance is characteristic of the late stage of Alzheimer's disease?
   A Severe disruption to short-term memory but retaining the ability to consolidate new long-term memories
   B No disruption to short-term memory but severe disruption in laying down new long-term memories
   C Difficulty creating new long-term memories but no difficulty accessing old long-term memories
   D Forgetting how to do everyday things and an inability to form new long-term memories
2 Which of the following statements is not true of Alzheimer's disease?
   A Alzheimer's disease cannot be cured.
   B Alzheimer's disease affects both short-term and long-term memory function.
   C Alzheimer's disease only affects people over 65 years of age.
   D Alzheimer's disease is a form of dementia.
3 Neuroscientists researching the causes of Alzheimer's disease have identified which of the following as playing an important role in the formation of memory?
   A Acetylcholine
   B The amygdala
   C The hippocampus
   D All of the above
4 Which of the following statements is true of neurodegenerative diseases?
   A They become progressively worse.
   B There is no cure.
   C They are related to the death of brain cells.
   D All of the above
5 Which of the following is a characteristic of Alzheimer's disease?
   A Information is stopped from being transferred across the synapse by neurofibrillary tangles that form inside neurons.
   B Amyloid plaques that form inside neurons stop them from sending messages.
   C Information is stopped from being transferred across the synapse by neurofibrillary tangles that form around neurons.
   D Amyloid plaques that form around neurons stops them from sending messages.
6 Why is Alzheimer's disease considered to be a form of dementia and not a form of amnesia?
7 Explain the role of amyloid plaques, neurofibrillary tangles and acetylcholine in Alzheimer's disease.

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FACTORS INFLUENCING THE ABILITY TO REMEMBER

In addition to brain trauma, a variety of factors influence a person's ability and inability to remember information. These include *context* and *state-dependent cues*, *maintenance* and *elaborative rehearsal* and *serial position effect*.

RETRIEVAL CUES: CONTEXT- AND STATE-DEPENDENT CUES

We have already learnt the importance of cues when trying to retrieve information from memory. Psychologists suggest that one of the most effective ways of improving retrieval from LTM is to recreate the conditions – both physical and psychological – that were present when the memory was formed or encoded (see Figure 5.20). This is based on the belief that the best memory (retrieval) cues are those that were present during encoding (Lewis & Critchley, 2003).

Retrieval cues consist of any stimuli that assist in memory retrieval. They help you access memories stored in long-term memory and bring them to your conscious awareness.

Retrieval cues can be divided into two categories: context-dependent cues and state-dependent cues.

FIGURE 5.20 Actors are able to remember large amounts of complex information for many months while filming a movie, even when learning newer roles during this period. They remember their lines best when they are able to move and gesture in the same way they did when they were rehearsing. Their movements supply cues that aid recall.

Context-dependent cues: Where was I?

Retrieval cues can be external, such as the smell of a lit candle that reminds you of your grandmother's cinnamon apple pie. The physical surroundings (context) present when we learn something and form a new memory provide many useful external cues that may aid retrieval at a later time. These surroundings act as context-dependent cues. For example, if you are reading this textbook in your bedroom, the context would include the physical properties of your bedroom, such as your desk and bed, posters on your walls, the colour of the carpet and the aroma of a candle that you might have burning. **Context-dependent cues** aid retrieval because if you recall information in the same setting in which the information was learnt, physical landmarks, sounds and smells act as environmental cues for retrieving the memory. When we form a memory, it is stored in an organised manner; therefore, the physical surroundings help to put the memory in context. When we attempt to retrieve the memory in a different context, we lose the external cues related to memory formation that would help trigger the memory of that experience.

Research suggests context cues play a major role in retrieval of information from LTM and that memory is disrupted when testing occurs in the presence of stimuli that were not present during initial learning. In one famous experiment, Godden and Baddeley (1975) had scuba divers listen to a list of words in two different settings. Divers learnt their list either 3 metres underwater or sitting on the beach. As Figure 5.21 illustrates, the divers recalled more words when they were tested in the same setting they learnt the information. You have probably experienced similar

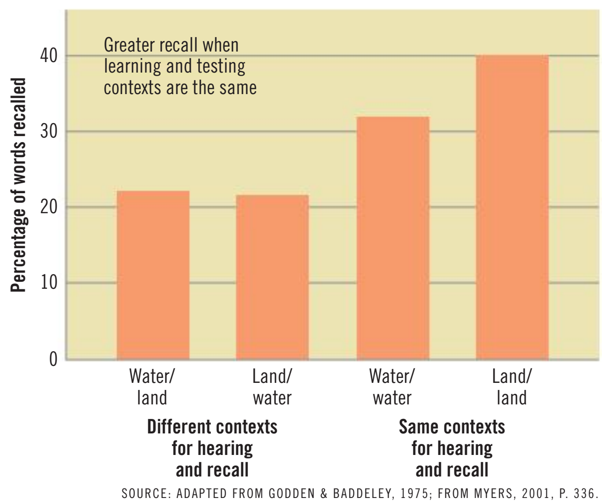

FIGURE 5.21 The effect of context-dependent cues on memory. Words that are heard underwater are best recalled underwater and words heard on land are best recalled on land.

retrieval cues Any stimuli that assists in retrieval of information

context-dependent cues Environmental cues in the specific context or environment where the memory was formed, which enhance the retrieval of memories formed in that context

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context effects. If you have ever revisited your primary school or the beach where you spent your favourite childhood holidays, you have probably been flooded with memories because of the retrieval cues present in the environment.

Obviously, when attempting to recall information, returning to the physical environment where the memory was formed is not always possible. However, if you use visual imagery in order to 'recreate' this physical environment many parts of the image will provide the context cues you need.

Apart from helping you to remember, context cues can also help you pass exams. For example, memory will be best if you study in the same room where you will be tested. Because this is often impossible, while you are studying try to visualise the room where you will be tested. Alternatively, when you are sitting your exam, try to visualise the setting you were in when you studied the exam material.

State-dependent cues: How did I feel?

Do you ever hear the joke that if people lost their keys or wallet when drinking, they will need to get drunk again if they are ever going to find them? Although this tale is often told for a laugh, it is not too far-fetched. The physical and psychological state that exists during learning can be a strong cue for later memory retrieval, an effect known as state-dependent learning. State-dependent cues are retrieval cues associated with your internal physiological and/or psychological state at the time the memory was formed. Therefore, it is easier to access a memory when you are in the same physiological and/or psychological state you were in when you learnt it.

Being very hot, for example, might prompt you to remember events that took place on another occasion when you were hot. Feeling hot is a physiological state, but a similar effect applies to emotional and psychological states. For example, Gordon Bower (1981) found that people who learnt a list of words while in a happy mood recalled the words better when they were happy again; people who learnt while they felt sad remembered best when they were sad. Similarly, if you are in a happy mood, you are more likely to remember recent happy events than if you are in a bad mood, when you will tend to recall unpleasant memories (Eich, Rachman, & Lopatka, 1990). Such links between emotional cues and memory retrieval could explain why couples who frequently quarrel often end up remembering – and rehashing – old arguments.

Research into the effects of drugs such as alcohol, caffeine, marijuana and nicotine also suggest that being under the influence of a particular drug aids recall of information stored when previously under the influence of that same drug (Roediger, 1992; Baddeley, 1990). Goodwin, Powell, Bremer, Hoine and Stern (1969) conducted a recall experiment using alcohol. Their results showed that heavy drinkers who hide alcohol or money when they are intoxicated experience more accurate recall of where the alcohol or money was hidden when they are intoxicated again, rather than when they are sober.

Context- and state-dependent cues can work well together. In an exam situation, for example, recreating (or imagining) the physical and psychological state in which you studied can enhance retrieval of the information you studied (Jerabek & Standing, 1992).

5.8 CHECK YOUR UNDERSTANDING >>

1 According to research into state- and context-dependent cues, which of the following techniques would most likely improve recall?
   - A Sitting an exam in the classroom you usually learn in
   - B Sitting an exam wearing your own clothes instead of a uniform
   - C Sitting an exam early in the morning because you are more alert
   - D Sitting an exam on your own because there are no distractions

2 Psychologists suggest that if you want to retrieve information correctly you should revisit the setting in which you learnt it. This is because __________ help you to remember.
   - A state-dependent cues
   - B episodic memories
   - C context-dependent cues
   - D semantic memories

3 When you form a mental picture of an item you wish to recall, this is known as visual:
   - A association.
   - B landscape.
   - C plotting.
   - D imagery.

4 Explain how retrieval cues help us to remember and how they contribute to forgetting.

5 When she was 18, Gizelle was ecstatic when she won first place in the women's freestyle event in her local swimming competition, which was held at a swimming pool 150 kilometres from where she lived. Now, Gizelle, who is 60 years old, can remember winning the competition, but she cannot remember details of the competition, such as who came second or what colour her bathing costume was. Explain how context- and state-dependent cues could help Gizelle retrieve her memory of the competition.

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REHEARSAL

It was noted earlier in this chapter, when information enters STM it is stored for approximately 18–20 seconds before it drops out – unless we do something with it. Consciously manipulating information to facilitate a longer duration in STM is known as rehearsal. By rehearsing information we not only increase the duration of STM beyond the usual 18–20 seconds, we also give it a greater chance of being transferred to LTM for relatively permanent storage. Rehearsal can take the form of either *maintenance* rehearsal or *elaborative* rehearsal.

Maintenance rehearsal: Repeat, repeat, repeat

Maintenance rehearsal involves repeating information a number of times so it can be held in STM for longer than the usual 18–20 seconds. Maintenance rehearsal can be implemented by silently or verbally repeating information, or by repeating a mental image of visual or spatial information. Research suggests that the more times information is rehearsed the stronger it becomes and, the longer it is held in STM, the higher its chances are of being stored in LTM (Barsalou, 1992).

You have probably used this method to remember a takeaway order for a short period of time before placing it. This mechanical repetition helps retain the list of dishes in STM long enough for you to place your order. Soon after, the list is lost from STM.

Maintenance rehearsal is very effective for storing meaningless information in STM for an extended period. However, it restricts the amount of new information entering from sensory memory and LTM. Additionally, maintenance rehearsal is very easily interrupted and, because it does not involve assigning meaning, it adds nothing to the understanding of information. Therefore, it is not a very effective way of transferring information to LTM. Table 5.3 outlines the advantages and limitations of maintenance rehearsal.

TABLE 5.3 Advantages and limitations of maintenance rehearsal

ADVANTAGES	LIMITATIONS
» Allows information to be stored in STM for longer than the usual 18–20 seconds » Good for remembering meaningless information	» Easily interrupted by information entering STM from sensory memory or LTM » Does not add to understanding » Restricts entry of new information into STM » Limited effectiveness in transferring information from STM to LTM

Elaborative rehearsal: Adding detail and meaning

Most psychologists agree that when information reaches LTM it is organised semantically – or according to its meaning – and stored in a hierarchical manner. This theory is known as the semantic network theory, which suggests that when you attempt to retrieve a specific memory from LTM you begin by conducting a memory search in one of the LTM stores using various memory cues as a trigger. By adding more detail to a memory during encoding you link bits of information in some meaningful way and, therefore, process it at a deeper level. This process is referred to as elaborative rehearsal. This creates more potential memory cues which can be used during retrieval to activate the memory.

Specifically, elaborative rehearsal involves linking new information in some meaningful way with information already stored in LTM, or with other pieces of new information, to hold it in STM for longer than the usual 18–20 seconds. This increases its chances of transfer to and retrieval from LTM. For example, if you are introduced to someone and you are interrupted, the person's name may slip out of your STM. If you make the effort to pay careful attention to the name and repeat it several times (maintenance rehearsal), you may remember it. But if you practise elaborative rehearsal and use the name in your next sentence or two, you are adding meaning to it and this will increase the chance of storing it in your LTM.

The elaborative rehearsal technique of self-referencing – linking new information to the self or to personal experience – also increases your chances of

visual imagery Forming a mental representation, or mental picture, of an item or scene

state-dependent cues Retrieval cues associated with your internal physiological or psychological state at the time the memory was formed, which enhance the retrieval of memories formed in that state

rehearsal The active manipulation of information in short-term memory in order to hold it for longer than the usual 18–20 seconds

maintenance rehearsal The rehearsal technique involving the repetition of information a number of times so it can be held in short-term memory for longer than the usual 18–20 seconds

semantic network theory The theory of how information in LTM is stored and organised in a hierarchical network of linked meaning

elaborative rehearsal The rehearsal technique involving linking new information in some meaningful way with information already stored in LTM, or with other pieces of new information, to hold it in short-term memory for longer than the usual 18–20 seconds

self-referencing An elaborative rehearsal technique involving linking new information to the self or to personal experience to hold it in short-term memory for longer than the usual 18–20 seconds and to increase its chances of transfer to and retrieval from LTM

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LTM retention. Information deemed 'relevant to me' is more likely to be processed deeply because it assumes a personal significance (Kesebir & Oishi, 2010) and deep processing increases the likelihood of such information being accessible for later retrieval.

Elaborative rehearsal takes longer than maintenance rehearsal, and it requires more of a conscious effort to recall information previously stored in LTM. Because it involves accessing information already in LTM, its effectiveness depends on how deeply you initially encoded the previously stored information and on your ability to quickly access this specific information. Table 5.4 outlines the advantages and limitations of elaborative rehearsal.

TABLE 5.4 Advantages and limitations of elaborative rehearsal

ADVANTAGES	LIMITATIONS
» Increases understanding because it requires deep processing » Adds more detail, which increases retrieval chances » Increases the possibility of long-term retention because it organises new information according to meaning » Makes information more accessible because it creates more potential retrieval cues	» Takes longer than maintenance rehearsal » Is difficult to practise in situations where information entering STM is rapidly changing » Relies on the ability to retrieve information previously stored in LTM » Requires more conscious effort than maintenance rehearsal

SERIAL POSITION EFFECT: WHERE IS IT IN THE LIST?

Rehearsal (particularly elaborative rehearsal) helps to move information from STM into LTM, and organising it semantically helps with its retrieval. The order in which we process information also affects how easily it can be retrieved. This is referred to as the **serial position effect** – a pattern of recall for list items, where recall is better for items at the beginning (primacy effect) or end of a list (recency effect), than for items in the middle. There are a number of explanations for the serial position effect, including the effects of rehearsal on STM and LTM (Baddeley, Eysenck, & Anderson, 2009). Many psychologists believe the serial position effect occurs because humans have both STM and LTM. They claim that its existence supports the theory that STM and LTM are indeed separate subsystems within the memory system.

Recency effect

When experimenters show participants a list of unrelated items (such as words, names or dates) and immediately ask them to recall the items in any order, participants are typically best able to remember items at the end of the list. Items at the beginning of the list are next most easily remembered, and participants have greatest difficulty recalling the items in the middle of the list. This is the serial position effect known as the **recency effect**: where recall is best for items at the end of a list, then for items at the beginning, then for items in the middle.

Try to memorise the following list, reading it only once. Then cover the list and immediately try to recall as many items as you can.

bread, apples, milk, ham, biscuits,
rice, sauce, butter, mustard, cheese, lettuce,
carrots, onions, soup, jam

If you are like most people, you will best recall items at the end of the list, then items at the beginning of the list. It will be hardest for you to recall items from the middle.

Psychologists believe the recency effect occurs because when recall immediately follows learning, the last few items on a list are able to be accessed because they are still stored in STM and still undergoing rehearsal. Therefore, they are readily available for recall. So, the recency effect can be explained in terms of maintenance rehearsal in STM.

Primacy effect

If recall of a list of items is delayed, attention shifts from the last items to the first items, causing the recency effect to be lost and replaced by the serial position effect known as the primacy effect. The **primacy effect** is the serial position effect where recall is best for the first items on the list, then for items at the end, then for items in the middle.

Try to memorise the following list, reading it only once. Then cover the list and do something else for 30 seconds (do not rehearse list items during that time). After 30 seconds, try to recall as many items as you can.

dog, horse, bear, cow, sheep, deer, lion, elephant,
giraffe, pig, cat, duck, donkey, tiger, chicken

If you are like most people, you will have better recall for items at the beginning of the list, then for items at the end of the list. It will be hardest for you to recall items from the middle.

The primacy effect is believed to occur because the first items on a list enter an 'empty' STM. As there is no other information in STM to interfere with them, they receive full attention and are able to be rehearsed, which increases their chances of being transferred to LTM (Medin & Ross, 1992).

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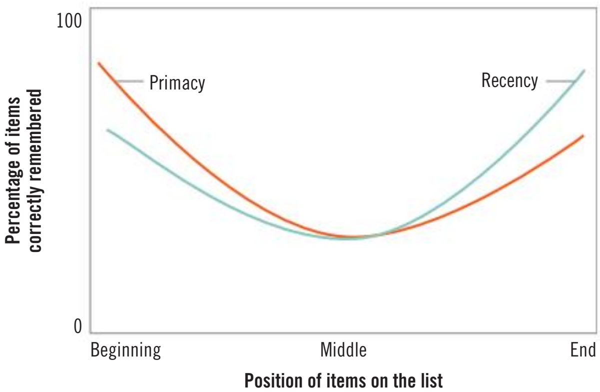

FIGURE 5.22 These curves show the general idea of the two types of serial position effect. The blue line shows the recency effect, where recall is likely to be best for items at the end of a list, then for items at the beginning, then for items in the middle. The red line shows the primacy effect, where recall is likely to be best for items at the beginning of a list, then for items at the end, then for items in the middle.

FIGURE 5.23 The names Queen Elizabeth II is most likely to forget are those of the people in the middle of the line.

Why do we have most difficulty remembering the middle items? By the time we get to the middle of the list there is already too much information in STM to allow effective rehearsal of new items. Without rehearsal, the middle-list words drop out of STM (see Figure 5.23). Whenever you have to learn something in order, be aware of the serial position effect. Give extra practice to the middle of a list, poem or speech.

5.9 CHECK YOUR UNDERSTANDING >>

1 The primacy effect is thought to occur because:
   A items at the end of a list are still in STM and can be accessed easily.
   B items at the beginning of the list were able to be rehearsed.
   C items at the end of the list are not pushed out of STM by incoming information.
   D items at the beginning of the list were pushed out of STM by items that followed them.

2 Remembering is better when a person's mood at encoding is similar to their mood at retrieval. This is an example of:
   A context-dependent memory.
   B state-dependent memory.
   C the primacy effect.
   D the recency effect.

3 Rehearsal is important for transferring information from:
   A sensory memory to LTM.
   B sensory memory to STM.
   C LTM to sensory memory.
   D STM to LTM.

4 When you arrive at the supermarket, you realise you left your shopping list at home. According to the serial position effect, the items on the list you are most likely to recall are:
   A items at the beginning of the list.
   B items in the middle of the list.
   C items at the end of the list.
   D items at the beginning, then end of the list.

5 When you are studying for your psychology exam, if you try to remember key concepts by associating each one with a personal event in your life, you would be practising:
   A the serial position effect.
   B maintenance rehearsal.
   C elaborative rehearsal.
   D imagery.

6 Conrad needs to memorise a number of important dates for his history exam. He decides that elaborative rehearsal is a better method of transferring the dates to his long-term memory than maintenance rehearsal. Outline two reasons why this would be true.

7 Explain how the serial position effect can be used to support the view that STM and LTM are different memory subsystems.

RECONSTRUCTING MEMORIES: HOW ACCURATE IS MEMORY?

A common belief about memory is that it is a copying process that results in an accurate memory of past events. This belief suggests that when we experience or witness an event, the human brain handles the

serial position effect A pattern of recall for list items, where recall is better for items at the beginning or end of a list than for items in the middle

recency effect The serial position effect where recall is best for items at the end of a list, then for items at the beginning, then for items in the middle of the list

primacy effect The serial position effect where recall is best for the first items on the list, then for items at the end of the list, then for items in the middle of the list

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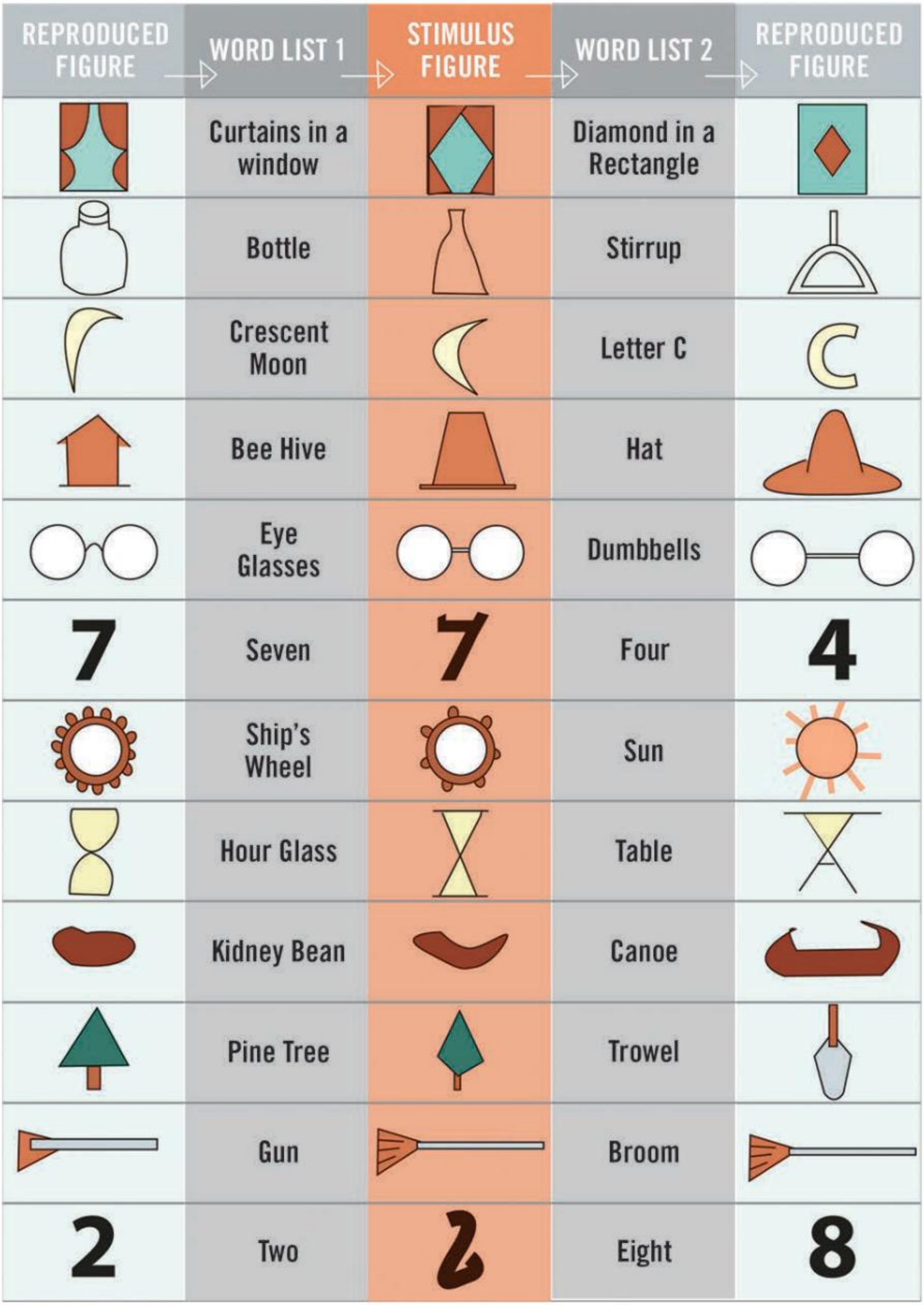

FIGURE 5.24 In an experiment by Carmichael, Hogan and Walter (1932) subjects were shown the stimulus figure (middle column) as the experimenter made remarks from one of the word lists (shown on either side of the middle column). The reproduced figures (shown in the outside columns) show that the remarks influenced the reconstructed memory.

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wealth of sensory information entering it from the external world in a similar way to tape recorders and cameras. However, psychologists know memories are not frozen in time and that, in fact, memory is fallible. They suggest that much of what we recall from LTM is not an accurate representation of information originally presented to us. For example, the *tip-of-the-tongue phenomenon* suggests that memories do not always survive intact – sometimes only fragments of a word can be retrieved. Memories of events may also be altered over time as new information and suggestions become incorporated into them, making the accuracy of the reconstructed memory questionable (see Figure 5.24). In addition, psychologists also suggest that memory reconstruction can be influenced by our expectations, beliefs, past experiences, ideals and mood, especially in times of high stress (Payne, Nadel, Allen, Thomas, & Jacobs, 2002).

THE EFFECT OF LEADING QUESTIONS ON EYEWITNESS TESTIMONY

Accuracy in memory retrieval is often taken for granted in everyday life, but it is particularly serious for eyewitness testimony. **Eyewitness testimony** requires people who have viewed an event (such as a crime or an accident) to give their personal account of the event at a later date. Police, judges, jurors and lawyers (among others) require that individuals' reconstructed accounts of events are accurate – but how accurate is eyewitness testimony?

Elizabeth Loftus, an American psychologist, has conducted much influential research in the field of memory reconstruction. Loftus was particularly interested in the effect of leading questions on memory reconstruction, particularly in how the choice of language used during police questioning of eye


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FIGURE 5.25 Eyewitness testimony is often relied on during investigations of crimes that occur in public places.


GETTY IMAGES/JODI HILTON

FIGURE 5.26 Elizabeth Loftus

witnesses affected eyewitness ability to accurately recall a past event. A **leading question** is a question posed to a witness of an event that is phrased in such a way that it prompts or suggests the desired answer to a question (Loftus & Palmer, 1974). 'Is this the gun you saw being used in the robbery?' is an example of a leading question because it assumes a gun was used in the robbery. If a witness to a robbery was asked, 'Was a gun used in the robbery?', this would not be a leading question. Leading questions are therefore a way of adding information after the event. Loftus suggests that during retrieval and reconstruction of a memory of an event, an opportunity for manipulation occurs because new information can be introduced at this stage. When the memory is finally retrieved and reconstructed, it is a new memory that includes the introduced information – and this memory may not be accurate.

Loftus suggests that eyewitness' memories of an event are fallible because of the reconstructive nature of memory. For example, witnesses might try to fit information contained in a leading question into a schema that results in distorted and inaccurate recall of an event. She believes that factors such as poor viewing conditions, brief exposure, stress, expectations, and personal stereotypes and biases can influence the accurate recall of a previously witnessed event.

In a series of experiments, Loftus demonstrated how memory can be altered by the use of specific language and the type of question an eyewitness is asked after the event. She showed new false memories

eyewitness testimony A statement (usually given in court) from an individual who has viewed an event that consists of their personal recollection of that event

leading question A question posed to a witness that is phrased in such a way that it prompts or suggests the desired answer to a question

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can be implanted and old ones unconsciously altered using leading questions. In one study Loftus (1975) asked participants to view a film of a car accident and then estimate the speed of the car that was involved. Half the participants were asked to estimate this speed as it 'passed the stop sign' and the other half were asked to estimate the speed as it 'passed the barn'. As there was no barn present at any time in the film, this question was viewed as a leading question, because it involved presenting incorrect information as a means to create false memories.

A week later, all of the subjects were given a test on their memory of the accident. Seventeen per cent of the subjects who were originally asked about the barn claimed they saw a barn in the accident. Only 3 per cent of participants who were not asked the leading question claimed to have seen a barn (Davies & Houghton, 1991).

In a similar piece of research into leading questions, Loftus showed participants a scene and then asked them questions about it. The experimental group was asked, 'Did you see children getting on the school bus?' and the control group was not asked about the bus. There was in fact no school bus in the scene at all. A week later, participants in the experimental group were three to four times more likely to say there was a bus as compared with the control group (Gleitman, Fridlund, & Reisberg, 1999).

Loftus also investigated the way in which questions were asked and the language used. She found that observers were three times more likely to say they saw an item when asked, 'Did you see the [item]?' as opposed to, 'Did you see a [item]?' (Eysenck & Eysenck, 1994). Findings also demonstrated that when the cars in an accident were described as 'smashing' into each other, and participants were asked if there was broken glass in the scene, 32 per cent of witnesses claimed they saw broken glass. When the cars were described as 'hitting' each other, only 14 per cent reported seeing broken glass when asked. Of course there was no broken glass at the scene at all (Eysenck & Eysenck, 1994).

Earlier in this chapter we discussed the influence of distracters on recognition tasks. This is highlighted in eyewitness testimonies and police line-ups, in that it is important to include in police line-ups people who look similar to each other and the suspect.

Because of the effect of leading questions on our construction of memory, it is easy to see why leading questions are not permissible in court cases. Such questions allow for a false memory to be implanted in the minds of jury members.

5.10 CHECK YOUR UNDERSTANDING >>

1 Research involving eyewitness testimony suggests that:
   - A eyewitness testimony is easily distorted.
   - B eyewitness testimony is unreliable.
   - C eyewitness testimony consists of subjective reconstructions of an event that are influenced by personal biases.
   - D All of the above

2 Which of the following statements about eyewitness testimony is correct?
   - A The memory accounts of witnesses improve over time.
   - B Leading questions are more likely to lead to inaccurate recall.
   - C Memories are not changed once they are formed.
   - D Eyewitness testimony is always accurate.

3 According to research on eyewitness testimony, leading questions can:
   - A intimidate the witness.
   - B confuse the witness.
   - C increase the chance of reconstructive errors.
   - D help jog the witness's memory.

4 Which of the following questions would be considered a 'leading question'?
   - A Did she touch the child?
   - B How hard did she smack the child?
   - C Can you describe what happened to the child?
   - D Where did this incident occur?

5 Outline two factors that might influence the accuracy of eyewitness testimony.

6 Explain how leading questions can affect eyewitness testimony.

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CHAPTER SUMMARY

Memory

- Memory is an active information-processing system that receives, stores, organises and recovers information.
- Memory involves the major processes of encoding, storage and retrieval of information.

Atkinson and Shiffrin's multi-store model of memory

- This model visualises memory as a system consisting of multiple memory stores (sensory memory, STM and LTM) through which a stream of data flows for processing.
- Sensory memory stores an unlimited amount of sensory information in its original form for up to several seconds, which is long enough for it to be attended to, encoded and transferred to STM. STM receives a limited amount of information from sensory memory and LTM, which it holds for approximately 18–20 seconds without rehearsal.

Brain areas involved in LTM memory storage of implicit and explicit memories

- Long-term memories can be divided into explicit (declarative) memories that can be consciously retrieved and can be expressed in words or symbols. Explicit memories are further divided into semantic and episodic memories. Semantic memories are memories of impersonal facts and events. Episodic memories are memories of personally significant events related to time and place. Implicit (procedural) memories are memories of learnt actions and skills that are retrieved unconsciously and expressed through action.
- Memories are not stored in one area of the brain; they are stored across the brain. Interactions between the cerebral cortex, hippocampus, amygdala and cerebellum play a major role in forming and storing long-term memories.

Methods to demonstrate the storage of information in LTM

- To demonstrate that information has been stored in LTM, information can be retrieved from LTM and brought back to consciousness by a variety of methods, including recall (free recall, serial recall and cued recall), recognition and relearning. The reconstruction of a memory at a later date also demonstrates that information was stored in LTM; however, reconstruction can produce a faulty or inaccurate memory.

The effects of physical brain trauma on memory

- If the brain is injured or physically traumatised, some degree of dysfunction will result. This dysfunction can be caused by brain surgery or neurological disease. Memory dysfunction is a common result of brain trauma. This commonly occurs in the form of anterograde amnesia, a form of amnesia that prevents the person from forming new long-term memories.
- Alzheimer's disease is an irreversible, progressive and fatal neurodegenerative disease that attacks the brain and kills brain cells, causing severe behavioural and cognitive decline, including a decline in memory.

Factors that influence a person's ability to remember

- Retrieval cues help us to remember because they provide information associated with the memory at the time it was formed. During remembering, accessing context-dependent cues supplies information about the physical surroundings (context) present when we learned something and formed a new memory. Accessing state-dependent cues supplies information about the physical and psychological state we were in when forming the memory.
- Whether we were able to rehearse the information when we were learning also affects our ability to remember. The longer we hold information in STM and the more potential retrieval cues we create, the stronger the information, and the higher the likelihood it will transfer to LTM. Maintenance rehearsal holds information in STM for longer than the usual 18–20 seconds but does not add meaning, so it does not increase retrieval chances. Elaborative rehearsal adds meaning to information so it creates links and increases retrieval chances.
- Serial position effect also impacts on memory because, when learning information, the position of information in an ordered list affects retrieval. When recall immediately follows learning, the items at the end of the list are remembered best (recency effect). When recall is delayed, the items at the beginning of the list are remembered best (primacy effect).

Reconstructing memories

- When we remember, we reconstruct a memory from information stored in LTM. Because memory is able to be manipulated, the reconstructed memory is not always accurate. Elizabeth Loftus is well known for demonstrating how memory can be manipulated by introducing leading questions to eyewitnesses of an event.

APPLY YOUR KNOWLEDGE AND SKILLS

SECTION A: MULTIPLE-CHOICE QUESTIONS

Answer the following questions by writing the correct letter in your workbook. Only one answer is correct for each question.

1 Which of the following statements about sensory, short-term and long-term memory is most accurate?

A Information first enters sensory memory and, after rehearsal, transfers to short-term memory and then passes into long-term memory.

B Information entering sensory memory can be rehearsed through elaborative rehearsal before being transferred to short-term and long-term memory.

C Information first enters short-term memory, and if attended to, is transferred to sensory and long term-term memory.

D Information first enters our sensory memory and, if attended to, transfers to short-term memory and may later pass to long-term memory.

2 Sensory information must be converted into a form (code) that can be used in the memory system. This conversion process is known as:

A storage.
C encoding.
B duration.
D retrieval.

3 The three major memory processes that occur in order are:

A retrieval, storage, encoding.
B encoding, storage, retrieval.
C storage, encoding, retrieval.
D storage, retrieval, encoding.

4 Research into the physiological basis of memory suggests that:

A the hippocampus is the brain structure responsible for memory formation and storage.

B memory formation begins at specific synapses in the brain.

C the temporal lobes are the brain areas responsible for all memory formation and storage.

D memory formation begins with the formation of plaques and tangles in the brain.

5 A distinction is made in memory research between __________ memory and __________ memory. The former refers to __________, whereas the latter refers to __________.

A Semantic; procedural; memory for general knowledge; memory for personally meaningful events

B semantic; episodic; memory for general knowledge; memory for personally meaningful events

C semantic; short term; memory for personally meaningful events; memory held in temporary storage

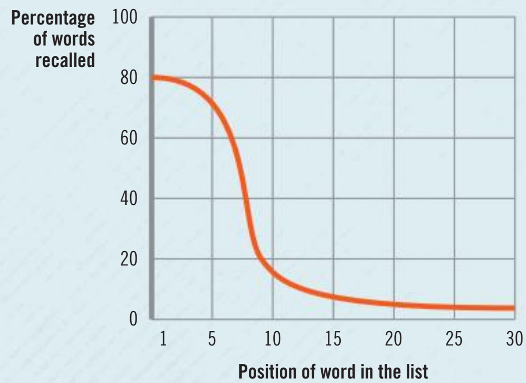
D episodic; autobiographical; memory for personally meaningful events; memory for general knowledge

6 If material is unrehearsed, it usually fades from STM after:

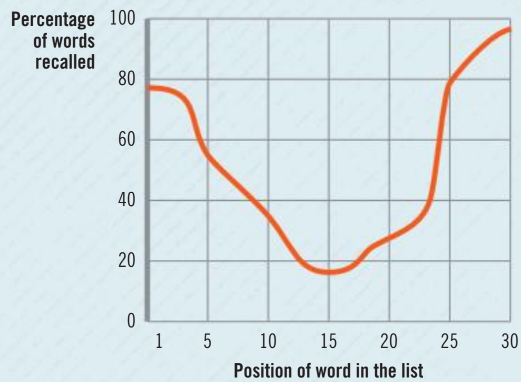
A approximately 3–4 seconds.
B approximately 7 seconds (+ or – 2 seconds).
C approximately 12–18 seconds.
D approximately 18–20 seconds.

7 Which of the following graphs best represents serial position effect?

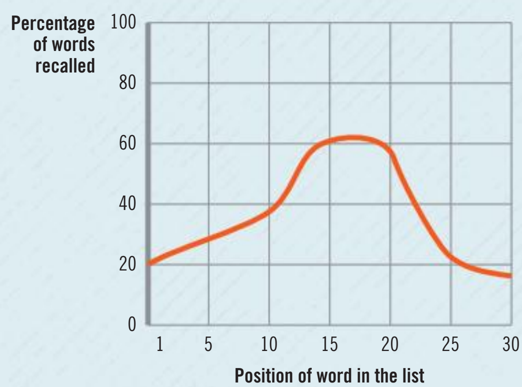
A



B



C



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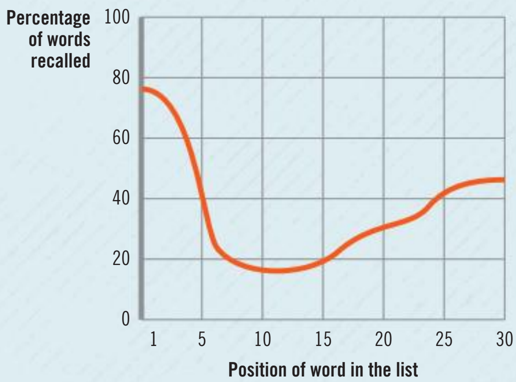
D



8 Which of the following is the most effective way to transfer information from STM to LTM?

A Chunking
B Serial position
C Elaborative rehearsal
D Maintenance rehearsal

9 Visual sensory memory is assumed to hold:

A seven pieces of information for less than one second.
B an unknown number of information items for less than one second.
C seven pieces of information for up to one minute.
D an unknown number of information items for up to one minute.

10 Which of the following statements about storage in LTM is true?

A LTM's storage capacity is limited.
B LTM's storage capacity is unlimited.
C LTMs are stored according to the similarity of their structural features.
D LTMs are stored phonemically.

11 In recognition tasks, the presence of distracters can often lead to:

A more accurate recognition.
B less accurate recognition.
C slower recognition.
D faster recognition.

12 Sammy remembered the names of a number of people he met at a party last week. A few days later, while at the supermarket, Sammy saw a girl he felt he met at the party but he couldn't remember her name. When he thought about various details of the party, he was able to remember her name. This was because thinking about the party:

A provided Sammy with useful context-dependent cues.
B provided Sammy with useful state-dependent cues.
C allowed Sammy to practise elaborative rehearsal.
D allowed Sammy to practise maintenance rehearsal.

13 George is an active, healthy 85-year-old. Yesterday he was visited by a friend. He also went bowling, a sport he has played since he was young and he went shopping at his local supermarket. While George's memory ability is generally good, at times he has difficulty remembering some things. Which of the following correctly categorises George's memories of yesterday's events?

	BEING VISITED BY A FRIEND	NAMES OF ITEMS ON THE SUPERMARKET SHELF	HOW TO BOWL
A	episodic	semantic	procedural
B	procedural	episodic	semantic
C	semantic	procedural	episodic
D	semantic	episodic	procedural

14 In Loftus' research, what was the impact of leading questions on accurate recall?

A Leading questions led to inaccurate recall in every subject.
B Leading questions led to a slight, but insignificant increase in inaccurate recall.
C Leading questions significantly increased the number of false memories.
D Leading questions did not appear to influence subjects to any degree of significance.

15 Leading questions appear to influence people to reconstruct their memory in a way that makes the details of the memory more:

A interesting.
B detailed.
C consistent.
D contradictory.

SECTION B: SHORT-ANSWER QUESTIONS

1 What does the term 'encoding' mean?

2 What is the difference in duration and capacity of sensory memory and short-term memory?

3 How does interaction between the hippocampus and amygdala contribute to memory formation?

4 Explain the difference between maintenance rehearsal and elaborative rehearsal.

5 Identify two reasons why Alzheimer's disease is linked to memory loss.

6 On the first meeting of his scout group, Mr Smith asked the 20 group members to introduce themselves by calling out their names one at a time. As soon as the last member called out his name, Mr Smith attempted to recall as many of the names as he could. Which names would Mr Smith be most likely to recall, and why?

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7 Explain the difference between episodic memory and semantic memory. Use an example to illustrate your answer.

8 With reference to the serial position effect, explain why items at the end of a list are more likely to be remembered than items in the middle of a list.

9 What are leading questions? Provide an example of a leading question that could be asked of an eyewitness to a house fire.

10 After Connie had witnessed a car accident, the attending police officer asked her to write a statement about what she had seen. One year later, Connie appeared in court to give evidence about the accident. On this occasion, her description was far more detailed and colourful than her original statement. How does Loftus' theory of reconstructed memory explain why Connie's account of the accident in court differed from the original written statement she had given to the police a year earlier?

SECTION C: EXTENDED-RESPONSE QUESTION

Researchers at Brownbank University Hospital wanted to investigate whether anaesthesia contributed to cognitive dysfunction in the elderly. They asked 100 patients over the age of 65 who were scheduled for surgery if they would participate in a computerised test of cognitive abilities. These tests consisted of verbal tasks and visuospatial tasks. All patients agreed to be tested the day before undergoing general anaesthesia and surgery, 8 days after their surgery, and again 4 months later. Their performance on the tests was compared to 100 patients over the age of 65 who attended the hospital but did not undergo surgery that required general anaesthesia and who completed the same tests on the same day as the patients undergoing surgery. Results showed that patients who did not have surgery achieved scores on both tests that varied 2–3 points over the testing period, and patients who did have surgery achieved progressively lower scores on both types of tests over the testing period.

Write a discussion section for a research report on this investigation. Your report must follow the usual convention for report writing and should include the following:

- the aim of the study
- a description of the results
- a statement that explains whether the results support the hypothesis
- identification of the independent variable and a statement about its effect on the dependent variable
- at least one potential limitation of this study and how it might be overcome in the future
- at least two ethical considerations that apply to this study.

This question is worth 10 marks.

SECTION D: ASSESSMENT TASK

VISUAL PRESENTATION

For this presentation you will need a poster-sized piece of cardboard. Your task is to create a poster that explains the key concepts of Atkinson and Shiffrin's multi-store model of memory. Your poster should:

- identify the memory stores that information passes through during processing
- distinguish these stores in terms of function, capacity and duration
- explain how chunking and rehearsal can affect short-term memory
- provide an everyday example of how information is encoded, stored and retrieved.

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UNIT 4

HOW IS WELLBEING DEVELOPED AND MAINTAINED?

AREA OF STUDY 1:
HOW DO LEVELS OF CONSCIOUSNESS AFFECT MENTAL PROCESSES AND BEHAVIOUR?

AREA OF STUDY 2:
WHAT INFLUENCES MENTAL WELLBEING?

AREA OF STUDY 3:
PRACTICAL INVESTIGATION

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CHAPTER 06

CONSCIOUSNESS

KEY KNOWLEDGE INCLUDES:

- consciousness as a psychological construct that varies along a continuum, broadly categorised into normal waking consciousness and altered states of consciousness (naturally occurring and induced)
- the measurement of physiological responses to indicate different states of consciousness, including electroencephalograph (EEG), electromyograph (EMG), electro-oculograph (EOG) and other techniques to investigate consciousness (measurement of speed and accuracy on cognitive tasks, subjective reporting of consciousness, including sleep diaries, and video monitoring)
- changes in a person's psychological state due to levels of awareness, controlled and automatic processes, content limitations, perceptual and cognitive distortions, emotional awareness, self-control and time orientation
- changes in levels of alertness as indicated by brainwaves patterns (beta, alpha, theta, delta) due to drug-induced altered states of consciousness (stimulants and depressants)
- the effects on consciousness (cognition, concentration and mood) of one night of full sleep deprivation as a comparison with effects of legal blood-alcohol concentrations.

Psychology Area of Study Key knowledge points derived from *VCE Psychology Study Design 2016*, pp. 28-9; © The Victorian Curriculum and Assessment Authority (VCAA). Used with permission.

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WHAT IS CONSCIOUSNESS?

As you read this paragraph, you are aware of the words on the page. If you stop reading and pay attention to your body, you may notice that you are hungry or that you have sore eyes. If you pay attention to the environment around you, you may notice the sound of the heater or the buzzing of the light overhead, and if you listen hard enough you may hear voices coming from another room. As you listen, you may remember that tonight you have to study for tomorrow's maths test. You might then change your focus to the air entering your lungs or to the sensation created by the feel of the watchband on your wrist. Before your attention was directed to these sensations, do you think you were aware of them?

The awareness of our internal and external environments is an ever-changing array of thoughts, feelings and sensations known as consciousness. Your consciousness consists of all the thoughts, feelings, sensations, perceptions and memories you are aware of at any given moment.

You can manipulate your consciousness very easily. For example, try to remember your last birthday. What did you do? What did you eat? What day of the week was it? Now try to remember the best holiday you have been on (see Figure 6.1). Where did you go? With whom did you go? By triggering these memories and bringing them into your thoughts, you have manipulated your consciousness.

FIGURE 6.1 Remembering where you went and the experiences you had on your favourite holiday requires manipulation of your consciousness.

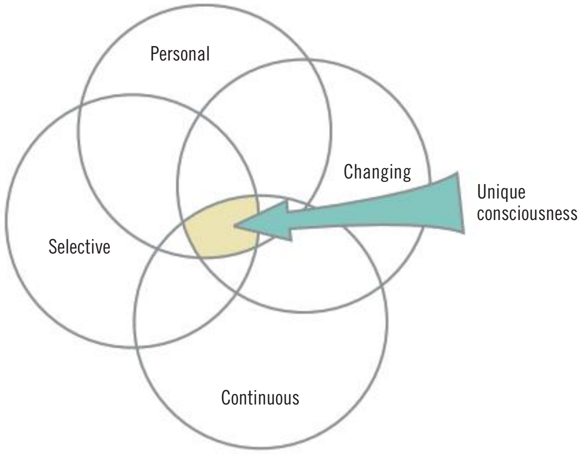

FIGURE 6.2 Each individual's consciousness is unique because it is personal, selective, continuous and changing.

Human consciousness has been described as being personal, selective, continuous and changing (see Figure 6.2).

Consciousness is personal because it consists of your understanding and perceptions of the world around you. It is unique for each individual.

Consciousness is selective because you pay attention to some things in the environment and ignore others. For example, while reading an interesting novel you are completely focused on it, so you don't notice the TV on in the background or the birds chirping outside your window.

Consciousness is continuous because its contents are blended into one another with no specific beginning or end. Your consciousness is never empty; that is, there is never a time when you are not thinking.

Finally, consciousness is changing, as your thoughts are constantly moving from topic to topic. For example, one moment you may be thinking about how hungry you are, then your consciousness is filled with thoughts of what you are planning to cook for dinner, then you suddenly start thinking about the assignment that is due tomorrow.

Sometimes our consciousness is filled with personal thoughts and feelings, while at other times it is filled with sensations from the external environment. So, as you can see, although we all experience consciousness, the actual consciousness that we experience is unique to each individual. Try it yourself 6.1 contains an exercise to help you explore your own consciousness.

consciousness Our awareness of internal and external environments at any given moment in time

6.1 TRY IT YOURSELF >>

EXPLORING YOUR CONSCIOUSNESS

If our consciousness is constantly changing, can we keep up with our own thoughts?

For five minutes, record everything that comes into your mind. Use a pen and paper, and a timer. Try to record all your thoughts, even if they occur at the same time – each time a new thought emerges, try to record it even if you haven't 'finished' with your previous train of thought.

QUESTIONS

1 How did you go? Could you keep up?
2 Look at what you have written.
   a What types of things are recorded?
   b Can you identify emotions, plans, and information about the internal and external environments?
3 If you had to define what consciousness is, how would you describe it?

INVESTIGATING CONSCIOUSNESS

Studying consciousness is a difficult thing to do because it cannot be directly observed. We know whether a person is male or female, has blue or green eyes or is short or tall just by looking at them. Unfortunately, we cannot directly measure what a person is thinking or what state of consciousness they are in just by observing them. For this reason, consciousness is referred to as a **psychological construct**.

A psychological construct is a concept used to describe an entity that we believe to exist, because we can measure its effects, but we cannot directly observe or measure the entity itself. Behaviours can be measured objectively or subjectively. **Subjective data** are measurements that are collected through personal observations of behaviour. These are often influenced by researcher or observational biases, or may be influenced by the participant's biased view of their own behaviour. In terms of consciousness, a researcher may make an assumption about a participant's level of awareness of the things going on around them, or whether they are showing a reasonable amount of self-control. These data are subjective as they are based on opinion and observation of the individual's behaviour, but are not scientifically measured. **Objective data** are measurements of behaviour collected under controlled conditions. They are easy to measure scientifically and can be compared to other data. Objective measures minimise many biases encountered in research and represent a more scientific, accurate and reliable method of data collection that allows experiments to be replicated independently.

Something that cannot be seen and is unique to every individual is very difficult to conceptualise. However, this has not stopped people theorising about what consciousness actually is. One man who is well known for his views on consciousness is René Descartes. Descartes was born in 1596 in the town of La Haye in the south of France. He was well known in the fields of science and mathematics for his work on geometry and algebra. However, many believe that his most important works were his philosophical writings. In the process of trying to discover what, if anything, could be said to exist with certainty, Descartes came to the conclusion that the only thing he could be sure of was that he existed – he coined the Latin phrase *cogito ergo sum*, which means 'I think, therefore I am'. Descartes therefore described himself as a 'thinking thing' (*cos regitans*). In a sense, what he was describing was his capacity for conscious thought, or what we call our self-consciousness.

Descartes was the first philosopher to clearly link the mind with consciousness and to identify it as a non-physical thing separate from the brain (Descartes, 1641). The resulting school of thought, which hosts a variety of views about the relationship between mind and matter, is known as dualism. Dualism claims that mental phenomena such as consciousness are in some respects non-physical (Hart, 1995).

American psychologist William James (1842–1910) adopted the philosophy of dualism as the underpinning of psychology (Mishlove, 1975). In the late 19th century, James was the first person to offer a course in Psychology at an American university. Throughout his career, James also taught anatomy, physiology and philosophy, but he is arguably best known for his views on human consciousness. He thought that the most appropriate way of defining human consciousness was to compare it to a stream, because, similar to a stream, consciousness is constant and continuously changing (see Figure 6.3). Consciousness consists of a random flow of thoughts, feelings, memories and sensations that pass fleetingly through our mind. James suggested that this flow is endless and that there is never a gap between the end of one thought and the beginning of another, which again parallels the movement of a flowing stream. Consciousness helps us to survive by allowing us to learn about, adapt to and deal with the environment around us.

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FIGURE 6.3 William James likened human consciousness to a stream that was constant and continuously changing.

STATES OF CONSCIOUSNESS

As consciousness varies throughout the day, so does the state of consciousness we experience. Your state of consciousness refers to your level of awareness of stimuli, both internal and external. There are no distinct boundaries to indicate where one state of consciousness begins and another ends.

Many psychologists believe that the best way to describe the different states of consciousness is to place them on a continuum (range) from complete lack of awareness (unconsciousness) to total awareness (focused attention). There are many different states of consciousness between the two extremes of the continuum. At the high end of the continuum (total awareness), your attention is focused and selective, and you are able to concentrate on specific tasks (such as exams) and ignore other, less important information (such as birds chirping outside). This tends to occur when someone is highly attentive to a situation; for example, when learning a new concept such as mathematical problem-solving, or learning a skill such as driving a car. At the low end of the continuum (lack of awareness), you may be unaware of thoughts, feelings and sensations. This may occur when you are fatigued, meditating, under the influence of drugs or alcohol, hypnotised, sleeping or anaesthetised. Figure 6.4 shows the continuum from complete lack of awareness to total awareness.

To aid our understanding of the various levels of consciousness, psychologists use two broad categories: *normal waking consciousness* and *altered states of consciousness*. We will examine these next.

6.1 CHECK YOUR UNDERSTANDING >>

1 Describe why consciousness is considered to be personal, selective, continuous and changing.

2 Describe why consciousness is often considered a psychological construct. Use an example to support your response.

3 William James likened our consciousness to a stream because:
   - A consciousness stops and starts at different times.
   - B consciousness is always winding and turning in new directions.
   - C consciousness is continuously changing.
   - D consciousness is often on its way downhill.

4 Which of the following is not a term used to describe consciousness?
   - A Selective
   - B Stagnant
   - C Flowing
   - D Personal

5 Which of the following states is on the higher end of the consciousness continuum?
   - A Comatose
   - B Sleeping
   - C Meditative state
   - D Selective attention

6 In which of the following states of consciousness will a person have the highest level of attention?
   - A Daydreaming
   - B Anaesthetised
   - C Selective attention
   - D Sleep

psychological construct A concept used to describe something that is believed to exist, because we can measure its effects, but we cannot directly observe or measure it

subjective data Data collected through personal observations, interpretations, emotions and judgement

objective data Measurements of behaviour collected under controlled conditions, which allow data to be directly observed or measured

state of consciousness An individual's level of awareness of internal and external stimuli at any given moment

attention A voluntary or involuntary tendency to orient towards or focus on a particular stimulus and ignore other stimuli

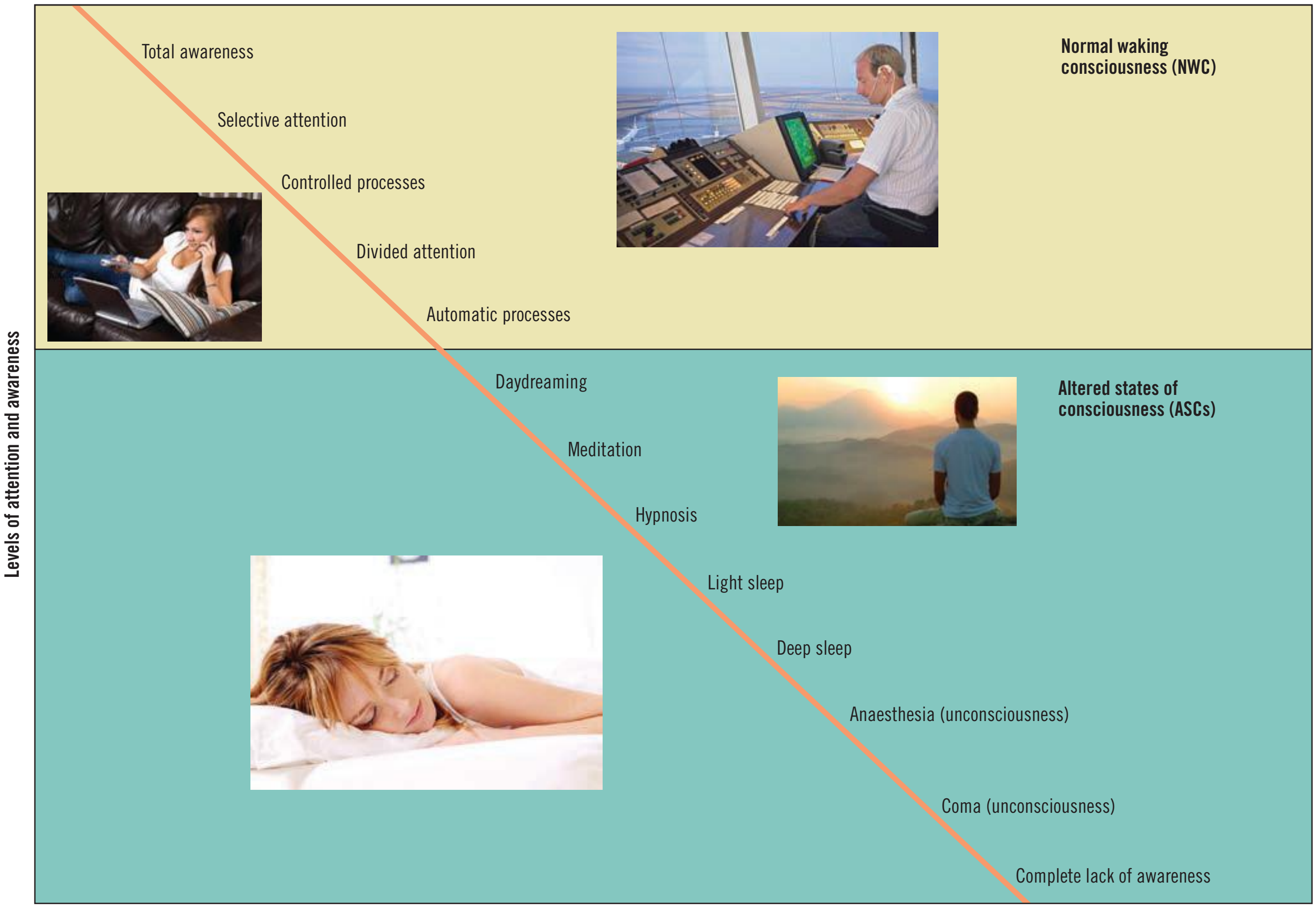

FIGURE 6.4 States of consciousness can be placed on a continuum from complete lack of awareness (unconsciousness) to total awareness (selective attention).

NORMAL WAKING CONSCIOUSNESS

Each state of consciousness brings with it a different level of awareness of our internal and external environments. We spend most of our lives in **normal waking consciousness (NWC)**, which is a state of clear, organised alertness to internal and external stimuli. We would experience NWC when reading a book, playing sport or talking with our friends (see Figure 6.5). Not surprisingly, we spend two-thirds of every day in NWC. This state of consciousness is at the high end of the continuum, where we perceive time, places and events as real, meaningful and familiar.

Although everyone has an individual consciousness that is personal and unique, there are a number of common psychological characteristics that are shown when an individual is experiencing normal waking consciousness. These include:

- moderate to high levels of awareness
- good memory and cognitive abilities
- focused attention on specific tasks
- an accurate perception of reality
- appropriate emotions
- a degree of self-control
- an accurate perception of time and sensations.

FIGURE 6.5 During normal waking consciousness we have clear, organised alertness to internal and external stimuli, which allows us to engage in a task such as having a conversation with friends.

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ALTERED STATES OF CONSCIOUSNESS

If we spend approximately two-thirds of our day in normal waking consciousness, then the other third is spent in an altered state of consciousness (ASC). An ASC is any state of consciousness that is distinctly different from normal waking consciousness. An ASC may differ from NWC in a variety of ways, including the level of awareness and the quality or intensity of sensations, perceptions, thoughts and emotions. Characteristics of an altered state of consciousness may include:

- low levels of awareness
- memory difficulties and reduced cognitive abilities
- difficulty paying attention to specific tasks
- distorted perception of reality, such as delusions
- inappropriate or uncharacteristic emotions
- a lack of self-control
- difficulty in accurately perceiving time and sensations.

There are many different types of altered states of consciousness and all are varied in terms of awareness and experience. ASCs can occur naturally, or they can be induced.

FIGURE 6.6 A patient under anaesthesia experiences an altered state of consciousness due to their lack of awareness of the internal and external environments.

NATURALLY OCCURRING ASCs

Naturally occurring ASCs involve physiological and psychological changes that occur automatically and are produced spontaneously beyond our conscious control. Naturally occurring ASCs include sleep, dreaming, daydreaming and even psychosis. The onset of naturally occurring ASCs can be due to a range of occurrences such as sleep deprivation, fever, trauma, sensory deprivation or overload, or a neurochemical imbalance.

One example of a naturally occurring ASC is daydreaming. Daydreaming is characterised by a shift in concentration from external stimuli to internal thoughts, feelings, memories and images. We are awake when we are daydreaming, but we are so focused on our internal state that we are unaware of everything going on around us. Daydreaming is a naturally occurring ASC because it is produced spontaneously without any conscious effort or decision-making and may be caused by sensory deprivation or overload. We all daydream many times each day. In fact, it is believed that teenagers spend approximately one-third of their waking day daydreaming.

INDUCED ASCs

An induced ASC involves physiological and psychological changes that have been intentionally produced. For example, a person makes a conscious decision to drink alcohol or take drugs and therefore will experience physiological and psychological changes because of this consumption. Other examples of induced ASCs include being hypnotised, practising meditation and being anaesthetised.

Some physiological changes a person will experience when drinking alcohol or taking drugs include a loss of self-control, slower reaction times and an inability to accurately perceive and judge the world around you. Psychological changes induced when practising meditation include a lowered awareness of external stimuli, and psychological changes associated with hypnotism include distortions in a person's perceptions and cognition, such as a reduced experience of pain.

normal waking consciousness (NWC) A state of consciousness characterised by clear and organised alertness to internal and external stimuli

altered state of consciousness (ASC) A state of consciousness that is characteristically different from normal waking consciousness in terms of awareness, sensation and perception

naturally occurring ASC An ASC that is produced spontaneously without any conscious effort or decision-making (e.g. daydreaming)

induced ASC An ASC that is intentionally produced (e.g. being under the influence of drugs or alcohol)

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PHYSIOLOGICAL RESPONSES INDICATING STATE OF CONSCIOUSNESS

As discussed earlier in this chapter, the state of consciousness someone is in is a psychological construct. A number of psychological characteristics provide subjective indications that may help determine whether somebody may be experiencing an ASC. However, it is also possible to objectively measure physiological changes that indicate an ASC. Some physiological changes are typically associated with ASCs, so measuring these physiological changes may provide evidence to more accurately determine the state of consciousness and level of awareness someone is in.

Objective data measure behaviour collected under controlled conditions, therefore they are free of bias. This is why researchers investigating consciousness generally use objective measurements. There are a number of physiological measures that objectively measure the electrical activity of a body part to gauge levels of alertness and, therefore, whether an individual is experiencing an ASC. These measurements include the *electroencephalograph (EEG)*, *electrooculograph (EOG)* and *electromyograph (EMG)*.

MEASURING THE BRAIN'S ELECTRICAL ACTIVITY: ELECTROENCEPHALOGRAPH (EEG)

The human brain is always active. As we have learnt, consciousness is likened to a stream that continually flows. The brain is aware of our thoughts, feelings and sensations at all times. Our brain is made up of billions of neurons that use electricity to communicate and send signals to each other. As millions of signals are sent throughout the brain, this generates an enormous amount of electrical activity. The electroencephalograph (EEG) is a device used by researchers to detect, amplify and record the brain's electrical activity, measured in the form of brainwaves. By knowing the particular electrical activity of the brain, we can determine a person's level of awareness of their environment. An EEG recording shows the frequency and amplitude of brainwave activity and it provides a visual of distinctive brainwave patterns that are characteristic of various levels of consciousness.

The frequency of activity refers to the number of brainwaves per second. A pattern of high frequency refers to greater brain activity, meaning more brainwaves per second. A pattern of reduced frequency refers to slow brain activity, meaning fewer brainwaves per second.

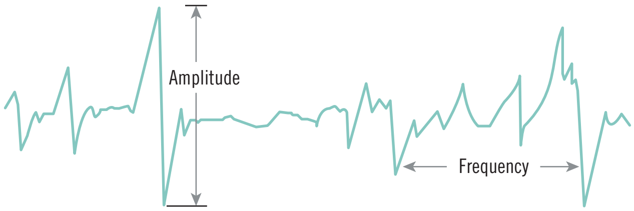


FIGURE 6.7 The frequency of the brainwave refers to the number of waves per second, whereas amplitude is a measure of intensity.

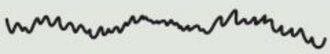
Brain activity is also measured by amplitude, or intensity. Amplitude is measured by the size of the peaks and troughs in brain activity compared to a baseline of zero activity, as displayed on the EEG machine. High amplitude brainwaves have large peaks and troughs, and low amplitude brainwaves have small peaks and troughs. Different combinations of frequency and amplitude in an EEG recording indicate different types of brainwave activity, and thus varying states of consciousness (see Figure 6.7).

There are four types of brainwaves, known as beta, alpha, theta and delta waves. All have different combinations of frequency and amplitude, and all are named after letters of the Greek alphabet. When beta brainwaves are present, a person's brain is alert and active, which is indicative of NWC. Any other brainwave pattern indicates a person is in an ASC. See Table 6.1 for a summary of each brainwave.

MEASURING THE EYE'S ELECTRICAL ACTIVITY: ELECTROOCULOGRAPH (EOG)

The electrooculograph (EOG) is a device that detects, amplifies and records the electrical activity of the muscles surrounding the eyes as they move or rotate in their sockets. It records the activity through small electrodes that are attached to the skin around the eyes. When we are awake and alert during NWC, we are able to track moving objects; that is, move our eyes in all directions and either converge or fixate them. The speed of our eye movements and, therefore, the electrical activity generated by the muscles controlling their movement, will vary according to the activity we are engaged in at the time. However, during an ASC our ability to control eye movement and the variations in the speed of eye movement do not occur

TABLE 6.1 Overview of brainwaves

BRAINWAVE	EEG RECORDING	AMPLITUDE ON EEG	FREQUENCY ON EEG	WHEN DOES IT OCCUR?
Beta		Low	High	» Normal waking consciousness (e.g. awake and alert) » Beta-like waves can be experienced during REM sleep (discussed later), which is an altered state of consciousness
Alpha		Low–medium (higher than beta waves)	Medium–high (lower than beta waves)	Deeply relaxed or meditative state
Theta		Medium–high (higher than alpha waves)	Low–medium (lower than alpha waves)	Early or light sleep
Delta		High (highest of all brainwave types)	Low (lowest of all brainwave types)	Deep sleep

to the same degree. Therefore, by demonstrating the level of electrical activity of muscles that control eye movement, the EOG can help determine a person's state of consciousness.

Electrooculograph readings are particularly helpful in determining whether someone is awake or asleep and, if asleep, which stage of sleep they are in. Sleep can be broadly categorised into two distinct stages – rapid eye movement sleep (REM) and non-rapid eye movement sleep (NREM). When in REM sleep, the EOG will detect a high amount of electrical activity because the eyes are moving rapidly beneath the eyelids. When in NREM sleep, the EOG will detect low electrical activity because the muscles surrounding the eyes will have little to no movement (see Figure 6.8).

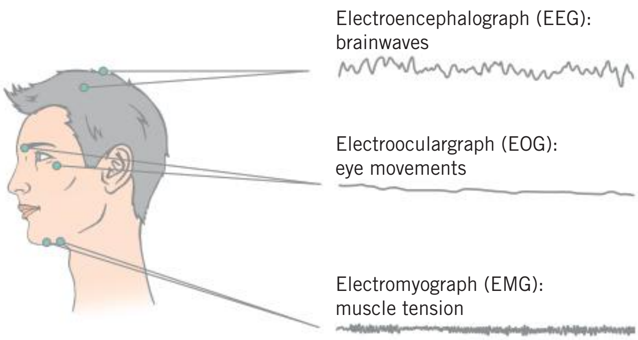


FIGURE 6.8 EEG, EMG and EOG recordings tend to be made simultaneously on continuously moving chart paper.

MEASURING THE MUSCLES' ELECTRICAL ACTIVITY: ELECTROMYOGRAPH (EMG)

An electromyograph (EMG) is a device that detects, amplifies and records the electrical activity created by active, skeletal muscles on a continuously moving chart paper (see Figure 6.8). During normal waking consciousness our skeletal muscles are tense enough to maintain normal posture. We can contract or relax these muscles on command, so we can stay upright and stabilised during movement. When we are in NWC, an EMG will show a pattern of electrical activity that is moderate to high. However, as we enter some ASCs, for example sleep, this pattern changes as skeletal muscles gradually relax and our ability to stay upright or control voluntary movement diminishes. Because an EMG detects and amplifies the electrical activity created by active muscles, it is able to record the degree of tension

electroencephalograph (EEG) A machine used to detect, amplify and record the brain's electrical activity, measured in the form of brainwaves

frequency (of brainwaves) The number of brainwaves per second

amplitude (of brainwaves) The strength of a brainwave as measured by the size of the peaks and troughs from a baseline of zero activity

beta waves Brainwaves characteristic of normal waking consciousness, with a low amplitude and high frequency

alpha waves Brainwaves experienced during a deeply relaxed state, with a low–medium amplitude and medium–high frequency

theta waves Brainwaves experienced during the early stages of sleep, with a mix of medium–high amplitude and a low–medium frequency

delta waves Brainwaves experienced during the deepest stages of sleep, with high amplitude and low frequency

electrooculograph (EOG) A machine used to detect, amplify and record the electrical activity of muscles that control eye movement

electromyograph (EMG) A machine used to detect, amplify and record the electrical activity of voluntary muscles

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TABLE 6.2 Summary of the objective methods used to measure physiological changes when in an ASC such as sleep

DEVICE	WHAT IT MEASURES	HOW MIGHT IT DEMONSTRATE STATE OF CONSCIOUSNESS?
Electroencephalograph (EEG)	The electrical activity of the brain (brainwaves)	Brainwaves (alpha, theta and delta waves) can indicate an altered state of consciousness. Alpha waves may indicate a meditative or deeply relaxed state, whereas beta waves indicate a high level of alertness.
Electrooculograph (EOG)	The electrical activity of the muscles surrounding the eyes	The EOG gives us an indication of which stage of sleep a person is in and therefore their state of consciousness. When in REM sleep, the EOG will detect a high amount of activity because the eyes are moving rapidly beneath the eyelids. When in NREM sleep, the EOG will detect low activity because the muscles surrounding the eyes will display little to no movement.
Electromyograph (EMG)	The electrical activity created by active muscles	The EMG gives us an indication of which stage of sleep a person is in and therefore their state of consciousness. When in REM sleep, a person's muscles will not be moving at all. When in a light stage of sleep, muscles may twitch.

or relaxation in the muscles. When this information is combined with EEG and EOG readings, we can gather fairly accurate information about the level of consciousness a person is experiencing.

When an EMG is used, electrodes are attached to the skin's surface, overlying muscle. EMG electrodes are typically placed under the chin, arms and legs, because muscles in this area show changes that are associated with different levels of consciousness. For example, during sleep, our muscle tension changes as we move through the various sleep stages. EMG measurements show a gradual decrease in muscle tension as we enter the sleep cycle, from the moderate muscle activity detected during sleep experienced early in the sleep cycle to the atonia (muscle paralysis) present during REM sleep. Figure 6.8 shows EEG, EOG and EMG recordings of a young adult.

6.2 CHECK YOUR UNDERSTANDING >>

1 Distinguish between NWC and ASC with reference to the characteristics of each state.

2 Using examples, explain the difference between a naturally occurring ASC and an induced ASC.

3 What does the EEG measure and how does it indicate different levels of consciousness?

4 What do the terms 'frequency' and 'amplitude' refer to with respect to brainwave patterns?

5 __________ brainwaves are characterised by high frequency and low amplitude, while __________ are characterised by low frequency and high amplitude.
   A Beta; theta
   B Beta; delta
   C Delta; alpha
   D Delta; theta

6 The role of the EOG is to:
   A detect and record the electrical activity of the muscles surrounding the eyes.
   B detect and amplify the electrical activity of the eyes.
   C detect, amplify and record the electrical activity of the eyeballs.
   D detect, amplify and record the electrical activity of the muscles surrounding the eyes.

7 What does the EMG measure and how is this device used?

OTHER TECHNIQUES FOR INVESTIGATING CONSCIOUSNESS

As previously discussed, consciousness is often measured using devices such as the EEG, EMG and EOG, which record physiological responsiveness. These devices are not the only way to gauge consciousness – there are also cognitive measures such as measuring the speed and accuracy of tasks, subjective reporting and video monitoring.

SPEED AND ACCURACY ON COGNITIVE TASKS

A common way to measure speed and accuracy on cognitive tasks when a person is in an ASC is through the use of a **psychometric vigilance test (PVT)**. The PVT is the most widely used test to measure behavioural alertness. It requires participants to respond to a visual stimulus and measures their speed and accuracy. For example, participants may be required to watch a computer screen that displays a box with fast-counting numbers in it. The participant will be provided with a particular number they must look out for. When this number appears on the screen, the

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person must press the box as quickly and accurately as possible.

Research has shown that some ASCs (for example, an alcohol-induced state) are associated with slower reaction times, therefore performance on a task such as this may lead to an increase in response errors on the PVT. Research has also suggested that other states of consciousness, such as sleep deprivation, lead to decreased reaction times and an increase in response errors (Bianchi, 2014).

SUBJECTIVE REPORTING OF CONSCIOUSNESS: THE USE OF SLEEP DIARIES

Subjective reporting, or self-reports, are an effective way to measure different states of consciousness. **Self-reports** involve an individual keeping a record of their own subjective experiences (thoughts, feelings and behaviours). An advantage of using self-reports to measure consciousness is that they provide researchers some insight to covert thoughts that can't be directly observed or measured through observational studies or physiological recording devices. A self-report may provide information about an individual's thoughts. For example, if their comments on the self-report are coherent and linked to reality, this may indicate that a person is in a NWC; if their comments are incoherent, incomplete or unrelated to reality, this may indicate an ASC.

One example of a self-report is a sleep diary. To establish a person's sleeping patterns over time, sleep scientists will often ask people who are experiencing sleep disturbances to keep a sleep diary. A **sleep diary** is a log of subjective behavioural and psychological experiences surrounding a person's sleep. Some examples of experiences that may be logged in a sleep diary include general activities before bedtime; any consumption of food and drinks before bedtime; the amount of time it took to fall asleep; any sleep disturbances throughout the night, including the number of times the person woke; and their feelings on waking in the morning. See Try it yourself 6.2 for an example of a sleep diary.

Sleep diaries are a cheap and simple way for researchers to gain an insight into when sleep patterns are uncharacteristic, the degree to which they are affecting an individual's daily routine, and all the psychological and behavioural factors that can contribute to sleep disturbances. Subjective reporting to measure consciousness has some limitations. One is the accuracy of the recordings. Often people don't remember all the things they did during the day or they forget to write them down, so when they try to remember later, their recollections may be incomplete or distorted. Also, we don't recall what we do when we sleep, so estimations of how much sleep was experienced may be unreliable. People may also neglect to record things out of fear or embarrassment because they may be worried about how it will be interpreted and may only want to record what they believe the experimenter or sleep scientist will want to read.

VIDEO MONITORING

Video monitoring involves using infrared cameras to videotape a person while they are sleeping to record and then analyse any observable disturbances in their sleep. People who experience sleep disturbances may attend a sleep laboratory so their sleeping behaviour can be videotaped because they may not be aware of any disturbances and therefore will not report them in their sleep diary. For example, the recording may show frequent waking, such as in the case of a nocturnal sleep-related eating disorder, where sufferers wake several times during the night and visit the kitchen to eat whatever they can find. In this condition the part of the brain that controls urges and decision-making is not fully functional, so sufferers can report eating anything in this state, even frozen pizza. Video recordings are extremely useful in the diagnosis of sleep conditions, so much so that there are specialised services in Australia where you can order sleep equipment for your own home and then send the recordings online for an assessment. However, to accurately assess and diagnose sleep problems and disorders, video recordings must be used in conjunction with self-reports.

Some advantages of using video monitoring to measure consciousness include that the footage can be viewed at any time after a period of sleep,

psychometric vigilance test (PVT) A test used to measure behavioural alertness, where participants respond to a visual stimulus and their speed and accuracy of the task are measured

self-report Involves an individual keeping a record of their own subjective experiences (thoughts, feelings and behaviours)

sleep diary A log of subjective behavioural and psychological experiences surrounding a person's sleep

video monitoring Videotaping a person while they are sleeping to record and then analyse any observable disturbances in their sleep

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it can be given to a number of people to interpret, and it can be shown to the participants to increase their awareness and understanding of their sleep behaviour. Some limitations of using video monitoring include that results may sometimes be inconclusive, interpretation may be subjective, and if video recording have taken place in a sleep lab the artificial environment may affect the person's ability to sleep normally.

FIGURE 6.9 Sleep scientists analysing video-monitored data of a patient spending a night in a sleep laboratory

6.3 CHECK YOUR UNDERSTANDING >>

1 What is a psychometric vigilance test and why is it used?

2 When in an ASC, accuracy and performance on a PVT may be:
   A the same.
   B enhanced.
   C impaired.
   D no different.

3 Why are sleep diaries an example of a subjective reporting of consciousness?

4 Which of the following would not be included in a person's sleep diary self-report?
   A Activities before bedtime
   B Caffeine consumption throughout the day
   C The EEG recording
   D The number of times the person wakes throughout the night

5 What are some limitations of using sleep diaries to measure consciousness?

6 Why might a person need to be videotaped while sleeping?

6.2 TRY IT YOURSELF >>

SUBJECTIVE REPORTING OF CONSCIOUSNESS

Over a 7-day period spend some time subjectively reporting your consciousness through the use of a sleep diary. Copy the table below into your notebook. Fill it out every morning to identify any changes in your sleep patterns over the 7-day period. Then at the end of the 7-day period complete the analysis questions.

DAY	TIME YOU WENT TO BED THE PREVIOUS NIGHT	TIME YOU WOKE UP	APPROXIMATELY HOW LONG IT TOOK YOU TO FALL ASLEEP	NUMBER OF HOURS SLEPT	ANY SLEEP DISTURBANCES OR AWAKENINGS	RATE YOUR STRESS LEVELS FROM THE PREVIOUS DAY (1–10)	WHAT ACTIVITIES DID YOU DO BEFORE BED? (E.G. EXERCISE, SCREEN TIME, CAFFEINE INTAKE)
Monday							
Tuesday							
Wednesday							
Thursday							
Friday							
Saturday							
Sunday							

QUESTIONS

1 Calculate the total amount of sleep you accumulated during the week.

2 The recommended sleep for teenagers is 9–10 hours per night. Did you get your recommended 63–70 hours of sleep during the week?

3 Did you notice any relationship between the activities you did before you went to bed and the amount of time it took you to fall asleep? Explain.

4 Did you notice any relationship between your stress levels and the amount of time it took you to fall asleep or sleep disturbances? Explain.

5 What evidence did you find that stimulants such as caffeine affected your sleep?

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CHANGES IN A PERSON'S PSYCHOLOGICAL AND PHYSIOLOGICAL STATE

There are distinct differences in behaviour and experiences in normal waking consciousness compared to behaviour and experiences in an altered state of consciousness. These characteristics may help us to make a decision about which state of consciousness an individual may be experiencing. They include levels of awareness, ability to engage in controlled and automatic processes, content limitations, experience of perceptual and cognitive distortions, emotional awareness, self-control and the perception of time.

AWARENESS

As shown on the states of consciousness continuum (Figure 6.4), some activities require higher levels of concentration and attention than others. For example, someone reading a difficult chemistry textbook will devote a higher level of attention to their reading than someone who is reading a comic strip in a newspaper.

During NWC, you have a high level of awareness of internal and external stimuli. However, during an ASC, awareness is greatly reduced. During meditation or sleep, for example, your awareness of the outside world decreases. You may be watching the football on TV while someone sleeps on the couch in the same room, yet the sound of the screaming and cheering will not disturb the person's slumber.

You can also be less aware of internal stimuli while in an ASC. This is why states such as meditation, hypnosis and, of course, going under anaesthetic are used to reduce the experience of pain – they make you less aware of internal sensations. Because of this reduced awareness, it is difficult to focus your attention on a task that requires a high level of awareness when you are experiencing an ASC.

Activities that do require a high level of awareness include anything to which a person must devote attention in order to understand them, such as solving a difficult maths problem, learning a new dance-step or learning to snorkel. All these tasks need to be undertaken during NWC so that they can be efficiently processed and understood.

Activities that require an individual to be in NWC are known as **controlled processes**. Controlled processes are actions that require high levels of attention, awareness and concentration in order to actively achieve a particular goal. When completing controlled processes, attention is focused completely on the task, with little or no awareness directed towards other, less important activities. This is known as **selective attention**. We can shift our attention quickly and intentionally between stimuli, such as when choosing to listen closely to a teacher giving hints about an upcoming exam, but listening less intently when that teacher describes a concept you already know about. Attention can also shift unintentionally. For example, if a mobile phone rings, our attention automatically shifts from what we were doing to focus on answering the phone call. Thus, it can be seen that attention is very selective in nature, making it difficult to pay full attention to more than one thing at a time.

Controlled processes are experienced in all areas of life. A good example of a controlled process is when someone is learning to drive a manual car. Here, the person needs to concentrate on controlling the steering wheel; coordinating the brake, clutch and accelerator when changing gears; and using the indicator when turning (not to mention the windscreen wipers when it is raining!). To top off this extraordinary process, the car needs to be navigated through highly variable traffic, road and weather conditions at all different times of the day and night (see Figure 6.10).

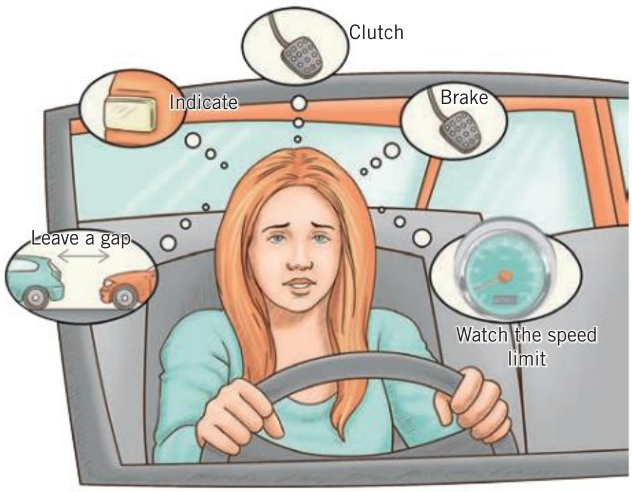

FIGURE 6.10 Learning to drive a car is a controlled process because it requires a high level of mental effort and selective attention.

controlled processes Actions that require a high level of conscious awareness, attention and mental effort

selective attention Attending to a particular stimulus while ignoring others; it requires a high level of awareness

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TABLE 6.3 The differences between controlled and automatic processes

TYPE OF PROCESS	EXPLANATION	EXAMPLE	EFFECT ON COMPLETION OF OTHER TASKS
Controlled process	An action that requires a high level of conscious awareness, attention and mental effort	» Completing homework » Learning a new task	» Performance on other controlled processes is compromised » Performance on automatic processes may or may not be affected
Automatic process	An action that requires little conscious awareness or mental effort	» Knitting » Watching TV	» Performance on controlled processes may or may not be affected » Performance on other automatic processes is unaffected

After some practice, driving a car requires much less concentration and awareness than when initially learning the skill. Experienced drivers are capable of simultaneously driving, holding a conversation, changing a radio station or finding their way around an unfamiliar suburb. As with many other complex skills, driving a car can become automatic with practice. When this happens, actions shift from being controlled processes to automatic processes. An **automatic process** is a set of actions that require little conscious effort or awareness, and do not interfere with performance on other activities. For example, it is possible to type out an essay while listening to music.

When a behaviour is an automatic process, we are able to perform more than one activity at a time. Being able to distribute your attention in this way is known as divided attention. **Divided attention** is when an individual focuses on two or more stimuli simultaneously. Research into divided attention suggests that we are capable of processing some information that is outside human consciousness. To illustrate this, think about whether you have ever been asked a question by your mother while you were watching television. Initially, you may not have heard the question because you were focusing your attention on your favourite show. You may have asked your mother to repeat the question, but before she finished repeating it, you answered her. The question was not directly in your consciousness, yet you still knew what she had previously asked, and were able to respond to it.

The ability to divide attention between two tasks depends on the types of tasks being performed. For you to be able to successfully divide your attention, both tasks must be automatic processes, such as watching TV and eating a meal. Alternatively, one may be a controlled process and the other an automatic process, such as doing maths homework while listening to music. It is difficult, however, to complete two controlled processes simultaneously, as they both require high levels of attention.

The ability to complete two tasks simultaneously is also influenced by the similarity of tasks. Two similar tasks are much more difficult to complete at the same time than two different ones.

Table 6.3 compares the features of controlled and automatic processes.

6.4 CHECK YOUR UNDERSTANDING >>

1 Describe the difference between a controlled and an automatic process using an example that is not included in the text.

2 Describe the difference between selective attention and divided attention.

3 To be able to successfully divide your attention between two tasks, the tasks should be:
- A automatic processes that are different.
- B automatic processes that are similar.
- C controlled processes that are different.
- D controlled processes that are similar.

4 __________ is an example of a controlled process, whereas __________ is an example of an automatic process.
- A Learning to ride a bike; solving a simultaneous equation
- B Strolling in the park; performing a gymnastic routine on the beam
- C Knitting a jumper you have knitted before; strolling in the park
- D Solving a simultaneous equation; stirring soup in a pot

5 __________ requires selective attention, whereas __________ can be achieved using divided attention.
- A Talking to your friend on the phone; learning to drive a car
- B Learning to ride a bike; watching TV
- C Listening to music; playing the piano
- D Watching TV; doing your homework

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CONTENT LIMITATIONS

During NWC, our thoughts are usually controlled and limited to reality. Although our consciousness is ever-changing and flowing, the content is usually 'normal'. Wildly bizarre thoughts do not often pop into consciousness, and we are usually able to control the themes of our thinking with relative ease. For example, we are often able to block or stop thoughts that make us feel embarrassed, upset, distressed, afraid or hurt. This is very useful, as it allows us to significantly control the content of our thoughts. This is not always the case during an experience of an ASC. Hypnosis is often used to try to bring uncomfortable or distressing thoughts into conscious awareness as a means of accessing 'hidden memories'. Additionally, while dreaming we have little control over which thoughts surface in our conscious awareness. As a result, we say that our content limitations are reduced when experiencing an ASC.

As well as being 'controlled', the content of thoughts in NWC is usually logical and organised. In NWC, we do not usually think about all our teeth falling out or about walking naked down the street; yet we may imagine these situations in a dream.

We also know that during NWC we can process a lot of information at one time; however, during an ASC the amount of information (or content) that can be processed is limited. Because of a reduced awareness of our surroundings and reduced cognitive functioning, there are limitations on how much content can be processed in an ASC.

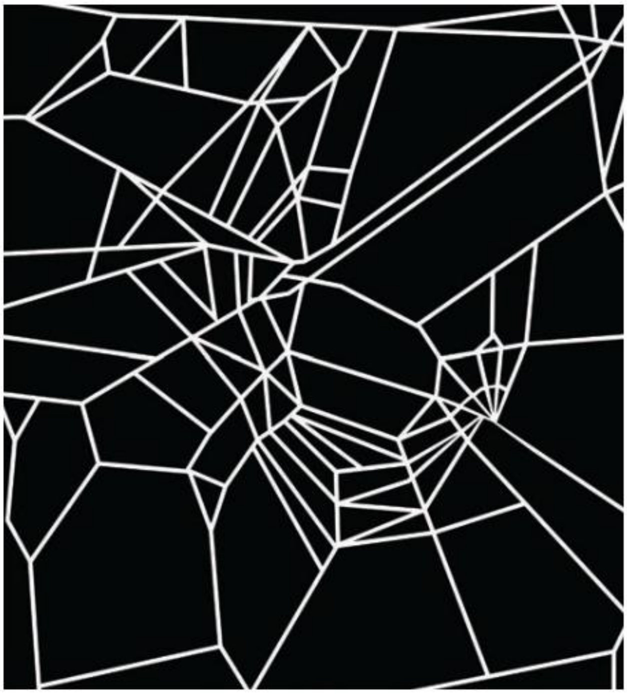
PERCEPTUAL DISTORTIONS

Perceptual distortions refer to mistakes that we make when internally processing our external environment. During NWC we can accurately perceive the world around us. We feel pain when we are hurt and we see images and hear sounds that exist. However, the experience of sensation and perception in ASCs is often very different. In an ASC, sensations and perceptions can be dulled or blunted, or they can be sharpened.

Sensation and perceptions are dulled by pain medication, hypnosis, meditation or daydreaming. We discussed earlier how hypnosis can reduce the experience of pain by focusing attention away from the source of the pain. There are other states of consciousness where the experience of pain is further reduced. Being placed under anaesthetic not only dulls the experience of pain but completely blocks any sensation to the area that is being anaesthetised. This is obviously a useful tool in treatment of physical ailments.

Hallucinatory drugs such as LSD (lysergic acid diethylamide, an illegal hallucinogenic drug) or crystal meth (methamphetamine, an illegal amphetamine) can heighten and sharpen sensations and perceptions. Individuals in a drug-induced state may see images or hear voices that do not exist or are not real. This is known as a **hallucination**. Hallucinations can also be experienced during extreme sleep deprivation where the onset of these symptoms clearly indicates that an individual is in an ASC.

An individual's perception of reality is also compromised during an ASC. An individual may believe they are being followed by the government or may be suspicious of people around them. These false beliefs are known as **delusions** and they can also be characteristic of an individual experiencing a drug-induced state.



SCIENCE PHOTO LIBRARY/NASA

FIGURE 6.11 A computer graphic image of a web created by a spider under the influence of drugs (in a drug-induced ASC), in an experiment by NASA. Notice that the web lacks logical order.

automatic processes Actions that require little conscious awareness or mental effort, and do not interfere with performance on other activities

divided attention When an individual simultaneously focuses on two or more stimuli, or simultaneously undertakes two or more tasks

hallucination A sensory experience (e.g. seeing or hearing something) that does not actually exist

delusion A belief or thought that is not supported by or connected to reality

COGNITIVE DISTORTIONS

The brain is bombarded with large amounts of sensory information from the internal and external environments. One of the brain's many roles is to decide which information is useful, necessary or relevant. The brain then actively stores and retrieves this information in the form of memories.

In NWC, an effective memory system is required in order to function. For example, you need to remember how to use the washing machine, which roads will lead you home, which channel your favourite TV show is on, or how to make an omelette. To understand this textbook as you read it, you need to remember the last few sentences you read, in order for the next few sentences to make sense.

During an ASC, memory is often disrupted, and everyday tasks can be difficult to perform. Memory tends to be less accurate, with people storing less information and experiencing more difficulty in retrieving it. For example, when you have a dream at night, you may remember it in detail for a few seconds after you wake up, but forget most of it very quickly.

Memory is just one example of a cognitive function. Others are thinking, reasoning and problem-solving. During NWC, cognition is organised and logical. In ASCs, cognition is often disorganised, illogical, fragmented and lacking sequence. For example, have you ever tried to have a logical conversation with someone who is drunk? It is often very difficult to make sense of their arguments and reasoning. People who binge-drink alcohol (that is, who sporadically drink large amounts) often have trouble remembering what happened when they were intoxicated.

EMOTIONAL AWARENESS

The way people experience emotions is unique to every individual; however, we can say that during NWC the emotions are generally appropriate to the situation in terms of experience and intensity. In an ASC, emotions can be intensified, blunted or totally inappropriate to the situation. For example, people often become more emotional when they have been drinking alcohol, and usually cheerful people may report feeling sad or depressed after consuming it. Similarly, many people express their emotions more openly after a few drinks. Some people even become more aggressive when they are drunk; many bar fights between drunken patrons over minor disagreements would have not occurred if the patrons had been sober.

On the other hand, during an ASC some people report that they are emotionless and feel empty. They have no feelings in situations that would produce intense emotional reactions in NWC. For example, it is normally upsetting to experience the death of a close friend, yet someone who has smoked a lot of marijuana might not experience these feelings in this situation.

During ASCs some people have inappropriate emotions or reactions. They may laugh at a funeral, cry when given a present, or become angry and violent when someone smiles at them.

SELF-CONTROL

Self-control is characterised by a good sense of management of physical responses – such as coordination – and also as a demonstration of good judgement and physical restraint. During NWC we exhibit fine motor control and can coordinate very complex movements. We are also able to make decisions that consider the likely outcomes and implications of a particular behaviour and as a result we are less likely to engage in risk-taking behaviours. During an ASC, however, self-control is often compromised. For example, during some stages of sleep we move around a lot, and may even sleep-talk. We are unable to control these behaviours, no matter how much we may want to. One test for sobriety is to walk along a straight line; during an alcohol-induced state our ability to coordinate movements is compromised (see Figure 6.12).

Alcohol can also reduce people's inhibitions. Someone who is drunk is more likely to engage in extreme risk-taking activities – such as drink-driving, unprotected sex or drug use – because their self-control has been reduced.


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FIGURE 6.12 In altered states of consciousness we are unable to coordinate complex movements such as walking in a straight line.

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PERCEPTION OF TIME

In NWC, people's perceptions of time are generally accurate. This means that if a task takes an hour to complete, it also 'feels' as if it takes an hour. If you drop off a prescription at your local pharmacy and the pharmacist tells you to come back in 10 minutes, you are usually able to accurately guess roughly how long that is without having to look at a clock.

In ASCs, perception of time is often distorted. Time feels like it is passing either more quickly or more slowly than normal. For example, when people are intoxicated with alcohol and at a party, they are often surprised by the time when they look at their watch – it may feel like 10 or 11 p.m. when it is actually 3 a.m. In other ASCs, time seems to pass more slowly than usual. Have you ever fallen asleep and woken feeling as if you have been asleep for hours, only to find you have only been asleep for a few minutes? Or have you been woken by your alarm in the morning and felt as if you have been asleep only a few hours, when really you have had a full night's sleep? Table 6.4 shows a comparison between the characteristics experienced in an ASC compared to NWC.

6.5 CHECK YOUR UNDERSTANDING >>

1 With reference to content limitations, what content do we tend to 'block' when in NWC, which we have less control over compared to when in an ASC?

2 Distinguish between perceptual and cognitive distortions using an example of each.

3 Which of the following are more likely to be displayed during an ASC?
   - A Inappropriate or uncharacteristic emotions
   - B No emotions
   - C Exacerbated or intensified emotions
   - D All of the above

4 Which of the following characteristics of self-control is likely when in an ASC?
   - A Unable to walk in a straight line
   - B Able to walk in a straight line
   - C Being able to drive a car safely
   - D Being able to perform an acrobatic routine on a balance beam

5 Use an example to describe when you have experienced a distorted perception of time when in an ASC. Was time perceived to be going faster or slower?

6 Which of the following is not an example of a cognitive distortion that may be experienced when in ASC?
   - A Decreased memory ability
   - B Difficulty undertaking problem-solving tasks
   - C Illogical thought patterns
   - D Decreased perception of pain

TABLE 6.4 Differences in characteristics and behaviours between normal waking and altered states of consciousness

	NORMAL WAKING CONSCIOUSNESS	ALTERED STATES OF CONSCIOUSNESS
Awareness	High awareness of internal and external environments Able to complete controlled and automatic processes	Low level of awareness of internal and external environments Limited ability to complete controlled processes and some automatic processes are impaired
Attention	Selective attention on specific stimuli Able to divide attention between two tasks	Low level of ability to attend to stimuli
Content limitations	Able to control thoughts Able to process many different pieces of information at the same time	Unable to block unacceptable or undesirable thoughts from entering consciousness The amount of information processed is limited
Sensations and perception	Able to accurately perceive the world Experience sensations that are real	Experience distorted perceptions of the world; may experience hallucinations or delusions Reduces or heightens the experience of pain
Cognition	Able to think logically and clearly Able to memorise and recall information accurately	Experience illogical thoughts that are fragmented Unable to remember information accurately
Emotions	Experience emotions that are appropriate	Emotions may be dulled or heightened or may not be appropriately expressed
Self-control	Able to coordinate a sequence of movements and include fine motor skills	Unable to coordinate actions and behaviours Loss of inhibitions
Perception of time	Able to fairly accurately perceive the amount of time that has passed	Unable to accurately perceive time; may feel as if time passes faster or slower

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6.3 TRY IT YOURSELF >>

PROGRESSIVE MUSCLE RELAXATION TASK

For this task you will try to achieve an ASC through a common meditative technique known as progressive muscle relaxation. The aim of this activity is for you to deliberately focus on and notice the difference between tension and relaxation, as you work through different parts of your body. Progressive muscle relaxation is an effective technique to reduce stress, anxiety and muscle tension.

Lay down or sit in a comfortable position with your eyes closed and let your body hang loose. Have your teacher or a friend read through the following script, guiding you through the exercise.

> *Take a deep breath in through your nose ... hold your breath for a few seconds ... and now breathe out ... take another deep breath through your nose ... Now pay attention to your body and how it feels ... Starting with your right foot ... squeeze all the muscles in your right foot. Curl your toes as tight as you can, now hold it ... hold it ... good ... now relax and exhale ... let your foot go limp ... notice the difference between the tension and relaxation ... feel the tension flow out of your foot like water ... (then repeat with right lower leg and foot, entire right leg, then entire left side etc. ...)* (Anxiety BC, n.d.)

QUESTIONS

1 Do you believe you entered an ASC when completing this activity? How would you know?

2 Did you experience any of the following characteristics when completing the activity?
- Disturbed sense of time
- Perceptual distortions
- Cognitive distortions
- Lower level of awareness of external stimuli

3 Why might achieving this state of ASC be an effective way to reduce stress?

6.1 FOCUS ON RESEARCH

THE CASE OF TERRI SCHIAVO


GETTY IMAGES/GETTY IMAGES NEWS

FIGURE 6.13 Terri Schiavo with her mother, Mary

On 25 February 1990 in Florida, United States, a 26-year-old woman named Terri Schiavo collapsed in her home after suffering cardiac arrest. The cause of her cardiac arrest is still unknown; however, she sustained severe brain damage because of the loss of oxygen supply to the brain.

She was admitted to hospital and was in a coma and placed on life support. After several weeks she was taken off mechanical life support and was breathing on her own, but her conscious awareness did not improve and after several months she was diagnosed as being in a persistent vegetative state (PVS).

A PVS is characterised by a lack of responsiveness and awareness of the self or the environment. Sufferers of PVS have little to no activity in their brain's cortex; however, their brain stem (keeping their autonomic physiological responses regulated) remains active. People in a PVS may remain awake or drift in and out of periods of sleep. When they are awake they show no evidence of voluntary motor responses, language comprehension or expressions, and suffer bladder and bowel incontinence. They may at times groan or blink when startled or display facial expressions such as smiling, but these are usually without apparent reason (Nicolussi, 2015).

There is much controversy around the diagnosis of PVS because consciousness is so subjective. This was certainly the case with Terri Schiavo. Following her diagnosis, her husband Michael Schiavo believed it would be Terri's wish to remove her feeding tube, which was the only thing keeping her alive. This was not well received by Terri's parents, Robert and Mary Schindler, because they believed their daughter was still conscious and wanted to try therapies to help rehabilitate her. After a gruelling 15 years of lawsuits, including the decision to remove Terri's feeding tube in 2001, which was granted and removed for 60 hours, then appealed and reinserted, in 2005 the court made a final decision to disconnect her feeding tube. The tube was disconnected on 18 March 2005 and Terri died 13 days later on 31 March 2005. This case sparked much controversy and publicity about the diagnosis and prognosis of PVS and end-of-life decisions by ethical, political and religious activists.

In 2008, a team of researchers reviewed all the media coverage surrounding the case of Terri Schiavo (Racine, Amaram, Seidler, Karczewska, & Illes, 2008). They disseminated the 1141 relevant newspaper articles published in 1990–2005 about the case and found that most articles (31 per cent) described the legal aspects surrounding the case followed by end-of-life issues (25 per cent) and also political (22 per cent) aspects of the case. Some articles denied Schiavo was even in a PVS (6 per cent) and others claimed removing her feeding tube was murder (9 per cent). Surprisingly, less than 1 per cent of articles actually described the characteristics of PVS and other chronic disorders of consciousness. Overall the review found many articles printed in the media were conflicting, few provided information about the medical diagnosis and prognosis of PVS, and many gave the readers a false hope for Terri's recovery. Research evidence suggests that after 1 year in a PVS, sufferers seldom recover. From this analysis it was concluded that considering the media has such a powerful role in changing society's perceptions and beliefs more should be done to accurately educate society regarding health issues such as PVS. It was suggested the need for greater communication between health professionals, patient communities and families and strategies will lead to greater internal agreement regarding the diagnosis of PVS (Racine et al., 2008).

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QUESTIONS

1 In terms of levels of awareness, why is Terri's condition an example of an ASC?
2 What other characteristics of ASC were relevant to Terri's case?
3 Following the review of literature surrounding Terri's case, what did the results suggest?
4 In your opinion, do you believe Terri should have had her feeding tube removed? Explain.

DRUG-INDUCED ASCs

As discussed earlier, one example of an induced ASC is being under the influence of drugs. Drugs are widely used by Australians to alter consciousness by changing a person's moods, thoughts, perceptions, levels of alertness and behaviours. People use consciousness-altering drugs for a variety of reasons – to help them wake up in the morning, to feel more comfortable when socialising at a party, to be relieved of pain or to help them sleep at night. Some of these drugs are legal and used responsibly, others are illegal and often used recklessly. The type of drugs that affect consciousness are called psychoactive drugs. Psychoactive drugs are any class of drug that alters the brain's chemistry and subsequently changes a person's perceptions, thoughts and behaviours. Psychoactive drugs are effective at altering consciousness because they cross the blood–brain barrier. The blood–brain barrier is a mechanism that prevents or slows the passage of potentially harmful molecules in the blood from entering the brain but allows other non-threatening molecules to enter. Psychoactive drugs enter the brain and therefore affect neural transmission. Some psychoactive drugs alter brain chemistry by mimicking the activity of neurotransmitters, others block neurotransmitters by binding to receptor sites.

Two characteristics of using psychoactive drugs is that they often produce effects of tolerance and dependence. *Tolerance* occurs when a person builds up a resistance to the effects of a specific drug and needs to take a higher dose in order to feel the drug's effects. This tends to occur when a person has been abusing a drug or using a drug for an extended period of time. Extended drug use can also lead to *dependence* where the person's drug use has become part of their bodily functions and if discontinued, symptoms of withdrawal may be experienced. Psychoactive drugs can be categorised as either stimulants or depressants.

STIMULANTS

Stimulants are a group of drugs that elevate mood, increase alertness and reduce fatigue. They do this by exciting neural activity in the brain, which increases bodily functions. Drugs in this category tend to increase blood pressure and heart rate, constrict blood vessels and increase blood glucose. Historically, because stimulants help asthma sufferers breathe by opening their airways, stimulants were medically used to treat asthma patients by providing temporary relief of respiratory difficulties. The medical use of stimulants today also includes sufferers of attention deficit hyperactivity disorder (ADHD) and narcolepsy (a sleep disorder discussed in Chapter 8). However, medical use of these drugs has diminished over the years as various dependence and addictive properties have been discovered. Medicinal drugs are not the only examples of stimulants, so are other commonly used substances such as caffeine and nicotine, as well as dangerous and illegal substances such as methamphetamines and cocaine.

Caffeine

Caffeine, which is found naturally in the seeds, nuts or leaves of a number of plants native to South America and East Asia, is a stimulant drug that affects the central nervous system. Caffeine can be found in coffee, tea, cocoa, cola soft drinks, energy drinks and chocolate bars. When using caffeine, people can build up tolerance and, like any other psychoactive drug, they will need to consume more in order to feel the same effects of the drug, such as higher levels of alertness and increased focus. Excessive amounts of caffeine can lead to anxiety, sleeplessness, rapid heart palpitations and trembling. However, these extreme symptoms will usually not be experienced unless the recommended daily intake of caffeine is exceeded. Generally, 400 milligrams is considered to be an acceptable dose of caffeine per day, although individual differences such as

psychoactive drugs Any class of drug that alters the brain's chemistry, which subsequently changes a person's perceptions, thoughts and behaviours

blood–brain barrier A mechanism that prevents or slows the passage of potentially harmful molecules in the blood from entering the brain but allows other molecules to enter

stimulants A group of drugs that elevate mood, increase alertness and reduce fatigue by exciting neural activity in the brain, which increases bodily functions; they include caffeine, nicotine, amphetamine, methamphetamine and cocaine

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metabolism, body mass and an individual's state of health need to be considered when consuming caffeine (see Table 6.5).

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SHUTTERSTOCK.COM/CHONES
SHUTTERSTOCK.COM/LIFESTYLE GRAPHIC

FIGURE 6.14 Different types of caffeinated beverages

TABLE 6.5 Approximate caffeine levels per serve

CAFFEINATED DRINK	AMOUNT OF CAFFEINE
Instant coffee	60–100 mg
Espresso coffee	90–200 mg
Decaffeinated coffee	3 mg
Energy drinks (e.g. Red Bull)	80–90 mg
Tea (depending on the type and brew)	30–100 mg
Cola drinks	35 mg

Source: Victoria. Better Health Channel (2015b)

Nicotine

Nicotine is a stimulant drug that is the main chemical found in tobacco. When inhaled, nicotine-rich smoke surges through the lungs and into the brain where it activates several brain chemicals, which cause a range of effects such as feelings of euphoria, increased heart rate, and increased levels of arousal and alertness. When nicotine reaches the brain, messages are sent to the adrenal glands to release adrenaline, which brings the body into a state of arousal and alertness. Simultaneously, another chemical in the brain, dopamine, is released and this results in the feelings of pleasure associated with smoking. In addition, another chemical, acetylcholine (associated with memory and learning), is released, which enhances the smoker's concentration. Because smokers enjoy the effects of nicotine, it is relatively easy for them to become addicted to this drug. Many smokers say they would like to quit but find it extremely difficult to do so. Nicotine addiction is just as strong as heroin addiction and as a result addicts can suffer withdrawal symptoms as they build up tolerance to the drug. Some of the withdrawal symptoms include irritability, anxiety, loss of concentration and moodiness. When nicotine is


SHUTTERSTOCK.COM/IVAN VOLOZHANIN

FIGURE 6.15 Nicotine is the addictive stimulant found in the tobacco of cigarettes.

introduced into the body in small controlled amounts, such as in the form of patches, gum or lozenges, it works by slowly releasing nicotine into the system. This helps the addict overcome their nicotine addiction without inhaling any of the harmful chemicals found in cigarettes.

Amphetamines and methamphetamines

Amphetamines and methamphetamines are another class of stimulant drug. Although they sound similar and have similar effects on consciousness, they are different in terms of the way each drug is manufactured, their use and their potency. Both amphetamines and methamphetamines increase your ability to stay awake and alert, and they increase your focus and attention. Amphetamines and methamphetamines affect the brain by stimulating the production of the brain chemicals noradrenaline and dopamine. These brain chemicals play a role in heightened activity and euphoria, which is why users often experience increased mood and energy levels.

Amphetamines were first developed in the late 1800s and, during the early 1900s, they began being used to treat illnesses such as asthma. Amphetamines were also used by soldiers in World War II to beat fatigue and increase alertness. These days, medical professionals use amphetamines to help sufferers of ADHD and narcolepsy. Although amphetamines can be useful, when administered incorrectly or abused they can have addictive qualities and serious side effects.

Methamphetamines derive from amphetamines. The difference between their chemical compositions is determined by how they are manufactured. Methamphetamines are more potent, so they have a stronger and quicker effect on the body than amphetamines. Street names for one type of methamphetamine include 'ice' or 'crystal meth' (a crystallised form usually smoked or injected by users).

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This drug has been highly publicised in the Australian media because of its addictive nature and debilitating effects. It is reported that 2.1 per cent of Australians aged 14 years and over used methamphetamines in 2013. Of these people, 50.4 per cent report crystal meth or ice as the main form of the drug used (Australian Institute of Health and Welfare, 2014). As well as increased attention, alertness and a sense of euphoria, other short-term effects of methamphetamine use include a dry mouth, decreased appetite, increased talkativeness and an increase in nervousness. Long-term effects of methamphetimine use include aggression, depression, anxiety, sleep disturbances and psychotic symptoms such as paranoia and hallucinations. Because of its potency and addictive and harmful side effects, methamphetamine is severely damaging to a person's physical and mental health, and it is not prescribed by medical professionals. Methamphetamine addiction and drug dependence can tear families apart because users may lose their homes, jobs and close relationships as their behaviour becomes consumed by receiving their next 'hit'.

FIGURE 6.16 These images show a woman at the start (left) and after years (right) of methamphetamine addiction. The effects of her addiction are physically evident in the image on the right.

Cocaine

Cocaine is a stimulant drug extracted from the leaves of a coca bush found in South America. Indigenous people from South America used to chew the leaves of the bush or use them to make tea to experience a suppressed appetite (Weiss, Mirin, & Bartel, 1994). Cocaine comes in several forms. The most common form of cocaine used in Australia is a white powder called cocaine hydrochloride. This form of cocaine is often 'cut' (mixed) with other chemicals, such as glucose or lactose, to boost the drug dealers' profits. Cocaine is generally inhaled (snorted) or injected by users or rubbed onto their gums to produce an intense and rapid 'rush' of euphoria. This euphoric feeling can be experienced for 15–30 minutes, and is then followed by a powerful, devastating 'crash'. Some of the feelings and symptoms associated with the rush include:

- feelings of exhilaration or euphoria
- greater self-confidence
- an accelerated heart rate
- an increased urge in sexual activity
- loss of appetite
- dilated pupils
- increased energy.

The experience of the rush is due to the brain's reward system being activated and abused. The neurotransmitters dopamine, serotonin and noradrenaline all have common mood-lifting properties. When they are released into the synapse, cocaine binds to the pre-synaptic neuron transporter inhibiting the process of re-uptake (the reabsorption of a neurotransmitter by a transporter of a pre-synaptic neuron after it has performed its function of transmitting a neural impulse). As a result these neurotransmitters remain in the synapse, intensifying their normal mood-elevating effects and this is what causes the euphoric rush (see Figure 6.17). The crash is produced when cocaine wears off, leading to an absence of these neurotransmitters in the synapse. When this occurs a person can experience:

- depression and anxiety
- bursts of anger
- nausea
- tremors
- total exhaustion.

Other long-term effects of cocaine include hallucinations, eating disorders, hypertension, paranoia and symptoms of psychosis. One recent study published also found a significant link between cocaine use and sudden cardiovascular-related deaths (Norentin, Ballesteros, Callado, & Meana, 2014).

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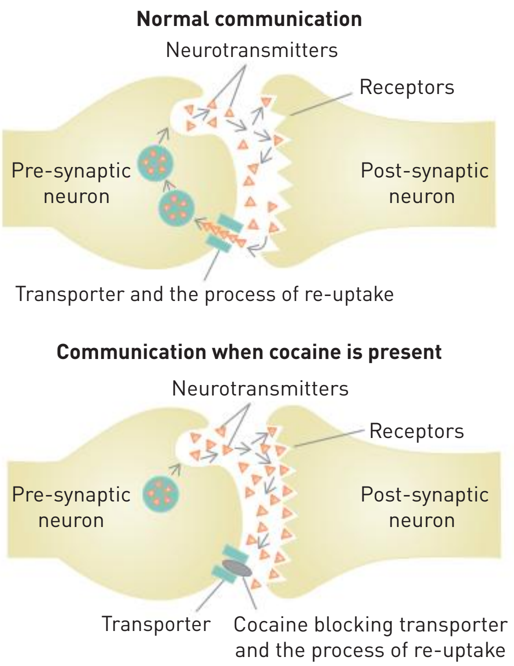

FIGURE 6.17 The top image shows normal neural transmission at the synapse; the bottom image shows how cocaine influences normal neural transmission.

6.6 CHECK YOUR UNDERSTANDING >>

1 How do psychoactive drugs enter the brain and alter a person's consciousness?
2 What do the terms 'tolerance' and 'dependence' refer to with reference to psychoactive drug use?
3 Describe some of the effects stimulants have on consciousness as well as examples of this class of drug.
4 What is considered to be an excessive amount of caffeine consumption and what are the associated effects?
5 What are some of the chemicals in the brain that are released when a smoker inhales nicotine?
   A Adrenaline, dopamine and acetylcholine
   B Adrenaline, dopamine and GABA
   C Cortisol, dopamine and acetylcholine
   D Adrenaline, dopamine and cortisol
6 What are the differences and similarities between amphetamines and methamphetamines?
7 Describe the cause of the euphoric rush experience by cocaine users.

CHANGES IN LEVELS OF ALERTNESS DUE TO STIMULANT USE

One device that is often used to measure levels of alertness in drug-induced ASCs is the EEG. As previously discussed, the EEG detects, amplifies and records the electrical activity of the brain in the form of brainwave patterns. Beta, alpha, theta and delta brainwaves are all displayed on the EEG monitor to indicate levels of alertness. Brainwaves are detected by measuring the frequency and amplitude of peaks and troughs in brain activity. Generally, research has found stimulant drug use to be associated with higher levels of beta brainwaves, with some stimulants also associated with increased levels of alpha brainwaves.

Beta brainwave patterns are associated with NWC and are those most present during the day when we are awake. German psychiatrist Han Berger (1873–1941), the creator of the EEG, first discovered the presence of beta brainwaves when patients were concentrating. Beta brainwaves are present any time you are conscious and alert and engaged in activities such as reading a book, solving a difficult maths equation or completing a puzzle. When people think logically, they tend to show beta brainwave activity. When we experience excessive levels of beta brainwave we can experience feelings of stress and anxiety, which are also side effects of excessive stimulant drug use.

Alpha brainwaves are associated with a more relaxed and calm state. When we are peacefully relaxing, or in an ASC related to meditating or daydreaming, alpha brainwaves may be present. Alpha brainwaves have also been associated with creative states of consciousness; for example, when painting a portrait there may be an increase in alpha brainwaves. When you are stressed, alpha brainwaves diminish. Simply closing your eyes and taking a deep breath can start to increase the activity of alpha brainwaves. People who are addicted to nicotine often report a feeling of calmness and reduction in stress and anxiety when smoking cigarettes; this is due to the effects of alpha brainwaves present when inhaling nicotine. As well as reducing stress, alpha brainwaves can help balance our moods and emotions, leaving us in a positive state of consciousness.

Below is a brief summary of some of the research evidence to support the presence of beta and alpha brainwaves when affected by different stimulant drugs.

- *Caffeine*: After drinking a caffeinated drink such as coffee or a Red Bull energy drink, you will often report feeling more awake, alert and attentive. For this reason caffeine is associated with beta brainwave activity.
- *Nicotine*: Nicotine alters electrical brain activity. When inhaled, delta and theta brainwaves immediately decrease and alpha and beta increase. One research study compared two groups of participants: one who would smoke a real cigarette and the other who smoke a pseudo-cigarette (containing no nicotine).

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When comparing brainwave patterns, those who inhaled the real cigarettes showed increased levels of alpha brainwave activity (Dominoa et al., 2009).

- *Amphetamines and methamphetamines*: Research has shown that use of these types of drugs is linked with increased beta activity, which is why people have increased levels of attention and reduced fatigue (Salinsky et al., 2002). Children who suffer from ADHD have increased levels of theta brainwaves opposed to beta brainwaves. When taking an amphetamine-based medication, this helps restore the balance to increase beta brainwaves.
- *Cocaine*: Research has found that cocaine use is linked to increased levels of beta and alpha brainwaves, with higher doses of the drug more associated with beta brainwave activity (Ceballos, Bauer, & Houston, 2009; Salinsky et al., 2002). Symptoms of the drug include an adrenaline rush, and increased heart rate and energy, which are associated with beta brainwaves; whereas symptoms such as an elevated positive mood may be associated with alpha brainwaves.

DEPRESSANTS

Depressants are a class of drug that calm neural activity and slow down bodily functions. Depressant drugs are sometimes referred to as 'downers' because they reduce arousal when taken. For this reason, depressants have been used by medical practitioners to treat seizures and are still used to treat disorders such as insomnia and anxiety. Some of the effects of depressants include increased fatigue and drowsiness, lowered heart rate, reduced anxiety and calm nerves. Depressant drugs can be purchased legally or illegally. Some types include alcohol, barbiturates, benzodiazepines, opioids and cannabis.

Alcohol

Alcohol is the most widely used drug in Australia and it can be legally purchased by anyone over the age of 18 years. Many people do not consider it as a drug because it is widely accepted in social settings, despite alcohol being related to more problems in Australian society than any other drug. For example, alcohol was the reason for the majority of drug-related ambulance attendances in 2012–13, with 11 159 attendances compared to 3159 for benzodiazepines, 1901 for heroin, and 1112 for crystal methamphetamine (ice) (Lloyd, Matthews, & Gao, 2014) (see Figure 6.18).

FIGURE 6.18 Paramedics tending to a drunk, semi-conscious woman

Because alcohol is a depressant, it slows down messages between the brain and the body. Alcohol enters the bloodstream through the stomach and intestines. Its effects slow down if a person has a full stomach; however, someone who has just eaten will still experience the effects of the drug. Some of the effects of moderate alcohol consumption on consciousness include reduced inhibitions and feeling relaxed, calmer and more confident. People under the influence of alcohol may also experience a loss of self-control, impaired mobility and coordination, and slower reaction times. Excessive alcohol consumption or 'binge drinking' can lead to more severe characteristics on consciousness, including:

- blurred vision
- nausea and vomiting
- aggression
- confusion
- memory loss
- unconsciousness (passing out, which can lead to coma or in some instances even death).

There is no safe level of drinking as alcohol affects different people in different ways depending on a person's weight, health, gender and amount of food in their stomach. The amount of alcohol in our bloodstream is measured as a blood alcohol concentration (BAC). The only way our BAC drops is when our liver metabolises the alcohol, which takes time – the liver metabolises approximately three-quarters of a standard drink in one hour. Drinking

depressants A group of drugs that calm neural activity and slow down bodily functions; include alcohol, benzodiazepines, barbiturates, opioids and cannabis black coffee, vomiting, taking a powernap or having a cold shower do not speed up this metabolic process despite what some people may believe.

Barbiturates and benzodiazepines

Barbiturates and benzodiazepines are both prescription drugs that depress the central nervous system functions. For this reason both classes of drugs are known as tranquilisers because they produce a calming effect on the body, including drowsiness, feelings of wellbeing or euphoria, reduced tension and decreased anxiety. Today, benzodiazepines are commonly used to treat people who suffer from anxiety disorders and sleep disorders such as insomnia. Medical practitioners will usually prescribe benzodiazepines before barbiturates for these types of disorders, because benzodiazepines have less addictive properties. Barbiturates are now more commonly used as an anaesthetic.

Benzodiazepines work by binding to the receptor site of post-synaptic neurons to increase the functioning of GABA (gamma-amino butyric acid), the major inhibitory neurotransmitter found in the central nervous system (see Figure 6.19). GABA works by blocking neural transmission, therefore producing a calming effect on the body. People who experience anxiety disorders may have a dysfunctional GABA system, resulting in heightened arousal due to insufficient amounts of GABA being produced.

If people misuse barbiturates and benzodiazepines that have been acquired illegally they may develop a tolerance towards the drugs and experience symptoms of withdrawal when their supply runs out. Some people abuse the drugs to help with the 'come-down' experienced when the effects of stimulant drugs such as cocaine or methamphetamines wear off. Abuse of barbiturates and benzodiazepines can have serious side effects such as confusion, dizziness, impaired motor coordination, blurred vision and feelings of depression. If these drugs are mixed with alcohol, the combined depressant effects on a person can be lethal.

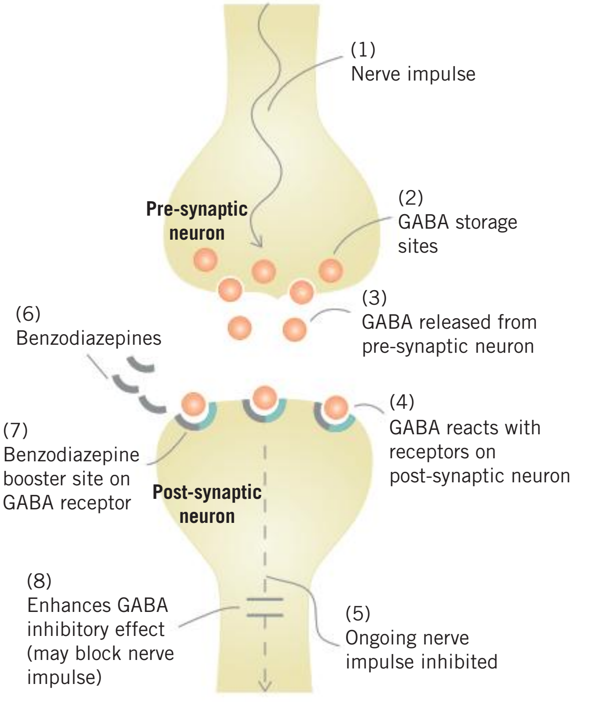

FIGURE 6.19 The effects of benzodiazepines on neural transmission. Benzodiazepines bind to the receptor sites on the post-synaptic neuron, enhancing GABA's inhibitory effect by blocking neural transmission.

6.7 CHECK YOUR UNDERSTANDING >>

1 Beta brainwaves are present when you are __________ and alpha brainwaves are present when you are __________.
   - A painting a portrait; sleeping
   - B reading a book; solving a maths equation
   - C meditating; closing your eyes
   - D completing a logic puzzle; deeply relaxed

2 Summarise the research findings about stimulant drug use and associated brainwave patterns.

3 Identify three effects depressants have on consciousness and provide three examples of this class of drug.

4 Which depressant drug is the most widely used drug in Australia?
   - A Ice
   - B Nicotine
   - C Alcohol
   - D Benzodiazepines

5 Compare some of the effects of moderate versus excessive alcohol consumption.

6 Describe how GABA is manipulated in the brain of someone taking benzodiazepines.

Opioids

Opioids are a group of depressant drugs that slow down CNS functions such as heart rate, breathing rate and thought processes. Opioids are derived from opium, which is found in a poppy plant. Opium poppy plants are primarily found in Afghanistan, but they are also found on a smaller scale in Pakistan and South-East Asia (see Figure 6.20). Because opioids also severely distort the perception of pain, ancient civilisations used opium for its pain-relieving properties. Currently, legal forms of opioids such as morphine and codeine are also used for this purpose.

LEGAL OPIOIDS: MORPHINE AND CODEINE

Taken as prescribed, opioids can be extremely useful to effectively reduce pain. Morphine is often prescribed to help a person deal with severe pain (such as someone who is recovering after an operation), whereas codeine is often prescribed to help manage mild to moderate pain (such as having your wisdom teeth removed). Both codeine and morphine change the perception of pain in an individual so can make them feel more relaxed and pain free. However, because they both slow down a person's breathing rate they must be avoided by people who suffer from respiratory illness such as asthma because they can cause them to stop breathing.

ILLEGAL OPIOIDS: HEROIN

Heroin is a far more potent and addictive opioid than morphine. Because its effects are so dangerous that they can lead to death, heroin is illegal. When a person takes heroin, their CNS becomes depressed and this causes a drop in their breathing rate, blood pressure, body temperature and heart rate. Sometimes, a person's breathing may stop altogether, causing a coma, unconsciousness or even death. Other effects of the drug include an immediate rush of pleasure and diminished perception of pain, narrowing of the pupils, feelings of nausea and decreased sex drive. As a user's brain gets used to the drug's pleasurable effects, the brain is tricked into not producing dopamine, the neurotransmitter that delivers pleasurable sensations and contributes to voluntary movement. Because heroin is highly addictive, when the production of dopamine stops in the brain of a heroin addict they experience symptoms of withdrawal that are often excruciating.

FIGURE 6.20 Afghan farmers harvesting a poppy field to source opium

Cannabis

Cannabis is a psychoactive drug that comes from the plant *Cannabis sativa*. These plants can be grown indoors or outdoors, given the correct conditions. People who use cannabis typically inhale the dried buds of the plant through smoking it. Cannabis is often difficult to classify because of the mixed effects of the drug. In smaller doses it is classified as a depressant; however, when taken in larger doses, cannabis has hallucinogenic properties. In smaller doses the effects of cannabis may include relaxation, drowsiness, spontaneous laughter and excitement, and an increased appetite. Larger doses of the drug often result in blurred vision, bloodshot eyes, hallucinations, delusions and paranoia. These later effects are known as psychotic symptoms, because they are experienced by people suffering from psychotic disorders such as schizophrenia. Research has shown that cannabis drug abuse during early age can lead to the development of a psychotic illness later in life. See Focus on research 6.2 for more on this issue.

CHANGES IN LEVELS OF ALERTNESS DUE TO DEPRESSANT USE

One way to measure how the brain and our state of consciousness is affected by depressants is through the use of the EEG. Because depressants slow down neural activity in the brain and calm the body, they have generally been found to be associated with the onset of alpha, theta and delta waves. Alpha waves have also been linked with stimulants (for example, nicotine) but they are also present when depressants (for example, alcohol) are consumed. Atypically, some depressants (such as benzodiazepines) can have a reverse effect on the brain, producing beta brainwaves on the EEG recording.

Theta brainwaves are often present when in deep relaxation such as meditation practices and also in the early stages of sleep. They are characterised by medium–high amplitude and low–medium frequency. When theta brainwaves are present, our consciousness of the external world is shut off and we become focused on internal signals. We may experience vivid imagery and be in a highly creative or deeply relaxed state of consciousness when theta waves are present. Theta waves can also make us more suggestible and can be experienced when under hypnosis. Stimulation of theta brainwaves has been associated with reduced anxiety levels, which is also experienced by many who are under the influence of stimulant drugs (Le Scouarnec, Poirier, Owens, Gauthier, Taylor, & Foresman, 2001).

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Delta brainwaves are the slowest frequency brainwaves and they are mostly associated with the deeper stages of sleep (Stages 3 and 4 NREM) that help restore and rejuvenate our body and mind. Typically, children experience more delta brainwaves during sleep than adults do, and the elderly experience fewer delta brainwaves during sleep compared to younger adults. In addition to the restorative effects of delta waves, they are also associated with increasing empathy and a decrease in the stress hormone cortisol, which in turn helps boost our immune system. Delta waves are also associated with depressant drug use because of their relaxing properties.

Below is a brief summary of some of the research evidence to support the presence of alpha, theta and delta brainwaves when affected by different depressant drugs.

- *Alcohol*: People often turn to alcohol when stressed or tensed because it helps them relax. It does this by boosting alpha brainwaves. Increases in alpha brainwave patterns are associated with alcohol consumption (Kaufman, 2001; Salinsky et al., 2002). It also helps to explain how alcoholics become dependent on alcohol. Alcoholics continue consuming alcohol to leave the normal, waking, alert beta brainwave state to return to this relaxed and tranquil alpha brainwave state.
- *Benzodiazepines and barbiturates*: Low doses of barbiturates produce an increase in fast brainwave frequencies; however, in high doses brain frequencies slow dramatically (Salinsky et al., 2002). Barbiturates are often used as an anaesthetic. This causes total unawareness from the external environment, creating similar levels of awareness to deep stages of sleep. Therefore, brainwave patterns are also similar when in a deep stage of sleep and under the influence of a high-dose barbiturate medication. Both produce an increase in delta brainwave activity on the EEG (Saletu, Anderer, & Saletu-Zyhlarz, 2006).

  Although benzodiazepines are sedatives, ironically they have the opposite effect on the brain and they are associated with an increase in beta brainwaves. This is known as a pharmacological dissociation (Jongsma et al., 2000; Lier, Drinkenburg, van Eeten, & Coenen, 2004).
- *Opioids*: Research has shown that opioid use can increase slow brainwave activity, which is a combination of theta and delta brainwaves (Phillips, Herning, & London, 1994; Volavka, Zaks, Roubicek, & Fink, 1970).
- *Cannabis*: Research has shown changes in EEG patterns for cannabis users consistent with the effects of the drug. Cannabis users report feeling carefree and calm when under the influence of the drug and therefore experience an increase in alpha brainwave activity (Iversen, 2003; Salinsky et al., 2002).

TABLE 6.6 Summary of psychoactive drugs, their effects on consciousness and brainwave patterns

PSYCHOACTIVE DRUG	EFFECT ON CONSCIOUSNESS	TYPES OF DRUG	BRAINWAVE PATTERNS
Stimulants	» Elevate mood » Increase alertness » Reduce fatigue » Reduce appetite » Increase energy levels	Caffeine	Increases beta brainwaves
		Nicotine	Increases alpha brainwaves
		Amphetamines and methamphetamines	Increase beta brainwaves
		Cocaine	Increases beta and alpha brainwaves
Depressants	» Increase fatigue » Induce calmness » Reduce anxiety	Alcohol	Increases alpha brainwaves
		Barbiturates and benzodiazepines	Barbiturates in high doses increase delta brainwaves Benzodiazepines increase beta brainwaves
		Opioids	Increase theta and delta brainwaves
		Cannabis (hallucinogen)	Increases alpha brainwaves

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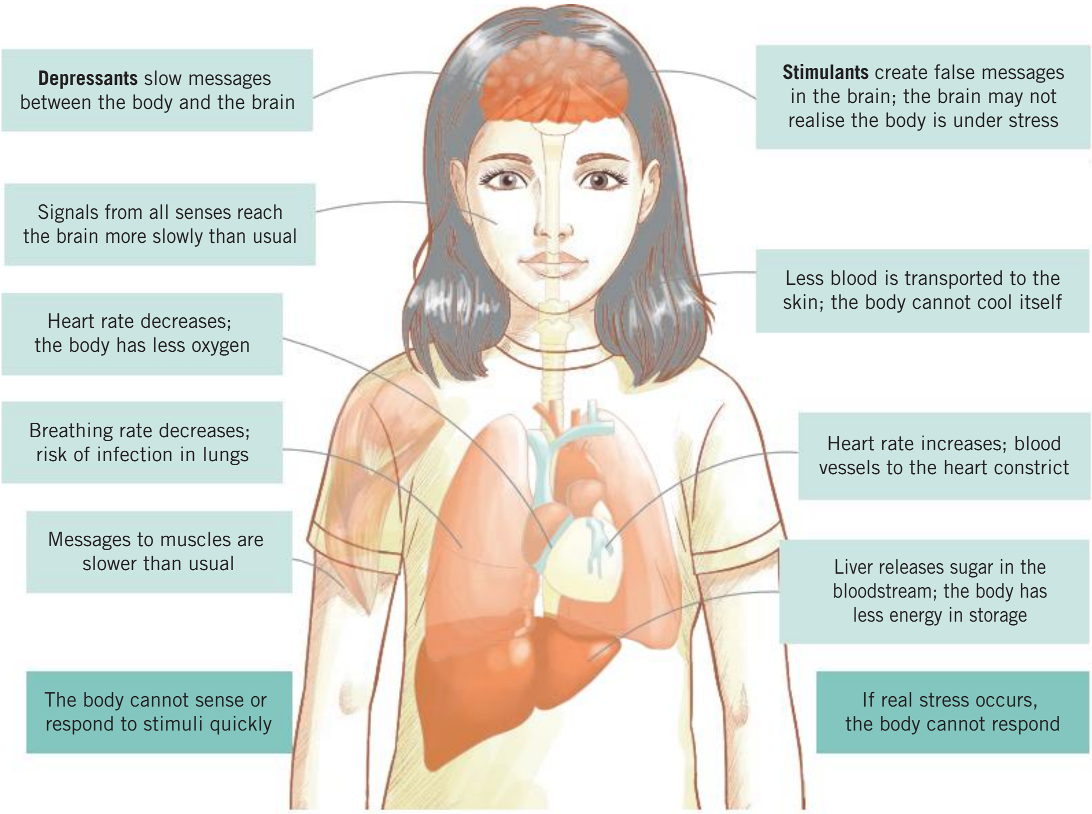

FIGURE 6.21 The effects of depressants and stimulants on the body

6.8 CHECK YOUR UNDERSTANDING >>

1 Opioids can be useful and helpful when:
   A administered to relieve pain.
   B administered as heroin.
   C taken with other stimulant drugs.
   D taken with other depressant drugs.

2 Why is heroin such a dangerous drug?

3 Why is cannabis considered a depressant and a hallucinogenic drug?

4 Theta brainwaves are present when you are __________, and delta brainwaves are present when you are __________.
   A meditating; reading a book
   B under hypnosis; in a deep stage of sleep
   C in a deep stage of sleep; painting a portrait
   D solving a maths equation; in a deep stage of sleep

5 Summarise the research findings about depressant drug use and associated brainwave patterns.

6 __________ are examples of depressant drugs, whereas __________ are examples of stimulant drugs.
   A Methamphetamine and alcohol; cocaine and opioids
   B Alcohol and opioids; amphetamine and cocaine
   C Opioids and cocaine; methamphetamine and alcohol
   D Alcohol and nicotine; caffeine and benzodiazepines

FOCUS ON RESEARCH 6.2

OUTCOMES OF OCCASIONAL CANNABIS USE IN ADOLESCENCE

Cannabis was the most widely used illicit drug among 12 to 17-year-olds in Australia in 2011 (White & Bariola, 2012). Many adolescents engage in this risky drug-taking behaviour completely unaware of the long-term effects of the drug. Decades of research have supported the link between excessive cannabis use during adolescence and the onset of drug-induced psychosis such as schizophrenia. Symptoms of psychosis are characterised by someone who loses touch with reality. They may experience delusions (strongly held false beliefs) and hallucinations (visual – seeing things that aren't really there – or auditory – hearing voices). One recent research study looked at the effects of cannabis use and early onset psychosis. This research found strong evidence that reducing cannabis use can delay the onset of psychosis or, in some cases, even prevent the illness altogether (Large, Sharma, Compton, Slade, & Nielssen, 2011).

One study conducted in Victoria investigated the effects of occasional cannabis use in adolescents and the potential psychosocial problems and subsequent drug use presented later in life. Much research had been done in the area around frequent cannabis use; researchers were interested in whether occasional use carried similar risks. The 1943 participants were Victorian mid-secondary

→

school students (around Year 9) who were selected as a representative sample. The experiment was conducted over a 10-year period (1992–2003), where the groups of participants were contacted over different phases of the experiment at various ages. For example, participants were interviewed at four 6-monthly intervals during their teens, with two follow-ups in young adulthood, at 20–21 years and 24–25 years. Adolescent cannabis use was categorised as either 'no use', 'occasional use (less than weekly)' or 'weekly/daily use'. Some of the key findings of the study include:

» Weekly/daily adolescent users were less likely to have parents with low education, and were more likely to have attended a metropolitan school, than non-users.
» Depression/anxiety symptoms, alcohol use and cigarette smoking were more likely among both occasional and weekly/daily adolescent cannabis users compared with non-users.
» Of the 331 adolescent occasional users, 28 abstained at 20 years of age, 236 persisted with that level of use, and 67 escalated to weekly or daily use.
» Adolescent cannabis users were less likely than non-users to have gained post-school qualifications by 24 years.
» Both alcohol and nicotine dependence at 24 years occurred more often among adolescent cannabis users, with occasional users intermediate in risk level between non-users and weekly/daily users.

From these findings researchers concluded that even occasional use of cannabis in adolescence can cause psychosocial and drug dependence problems in adulthood (Degenhardt, Coffey, Carlin, Swift, Moore, & Patton, 2010).

QUESTIONS

1 Describe some of the symptoms of psychosis. Who is at risk of developing a psychotic illness?
2 What was the aim of this research study?
3 Summarise the key findings of occasional adolescent cannabis use.
4 What are some of the problems researchers may have faced carrying out a longitudinal study such as this one?

SLEEP DEPRIVATION AND CONSCIOUSNESS

Sleep deprivation refers to going without or not getting sufficient amounts of sleep. **Partial sleep deprivation** occurs when a person does not get the recommended hours of sleep per night for their age group. For example, adults require approximately 8 hours of sleep per night, so the effects of partial sleep deprivation may be experienced when an adult only gets 4 hours of sleep per night. **Total sleep deprivation** occurs when a person goes without sleep altogether. This can be one full night or in some cases, such as those discussed below, this can be several nights without sleep.

In 1959, to raise money for charity, American DJ Peter Tripp (see Figure 6.22a) agreed to forgo sleep for 201 hours. After 100 hours, he began to have hallucinations: he saw cobwebs in his shoes, and he watched in terror as a tweed coat became a suit of 'furry worms'. When Tripp went to a hotel to change his clothes, a dressing-table drawer seemed to burst into flames. After 170 hours, Tripp was in agony. He struggled with simple thoughts and reasoning, and had memory problems. His brainwave patterns looked like those of someone asleep, and he was no longer sure who he was. By the end of 201 hours, Tripp was unable to distinguish between his waking nightmares, hallucinations and reality (Luce, 1965).

Surprisingly there are more extreme cases of sleep deprivation. The world record is held by Californian Randy Gardner (see Figure 6.22b), who, at 17 years of age in 1964, went 264 hours (11 days) without sleep. At various times, Gardner experienced irritability, memory lapses, difficulty concentrating and difficulty in naming common objects. Surprisingly, Gardner needed only 14 hours of sleep to recover (Coren, 1996).

Gardner's experience highlights that, to recover from sleep deprivation, it is not necessary to completely replace lost sleep as most symptoms of sleep deprivation are reversed by a single night's uninterrupted sleep. People who have been sleep deprived may report sleeping for a longer period of time than normal in the few nights following deprivation, but they did not need to replace the total amount of sleep lost to recover. This may be because during periods of total sleep deprivation they were briefly refreshed by what is known as a microsleep. **Microsleeps** are short periods where the individual appears to be awake – their eyes may even be open – however, brainwave patterns indicate that they are asleep. Microsleeps are especially prevalent when people who are sleep deprived complete monotonous tasks. That is why drivers who feel tired are encouraged to take a break or a 15-minute powernap. It is also likely that when sleep-deprived individuals sleep the subsequent night, they experience **REM rebound**. REM rebound is when a person who has been deprived of REM sleep later 'compensates' by having extra amounts of REM sleep than what they normally would in a typical night's sleep.

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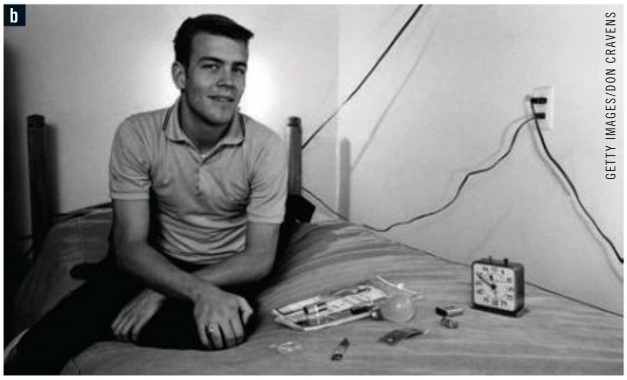

FIGURE 6.22 (a) Peter Tripp deprived himself of sleep for 201 hours. (b) Record holder Randy Gardner deprived himself of sleep for 264 hours.

The need for sufficient amounts of sleep is clearly evident when looking at the psychological and physiological effects of sleep deprivation. The most typical physical reactions to sleep deprivation are trembling hands, droopy eyelids, increased pain sensitivity, headaches and general discomfort. Individuals who experience one night of full sleep deprivation are subject to a decrease in cognitive functions such as memory and concentration, a slowing of reaction times and changes to mood and emotional behaviour.

EFFECTS OF SLEEP DEPRIVATION ON COGNITION

One full night of sleep deprivation can affect a person's cognitive abilities. Some cognitive capabilities that can be adversely affected during sleep deprivation include working memory, attention and executive functions such as planning, decision-making and problem-solving.

Working memory is a part of our memory system that temporarily stores and manipulates a limited amount of information needed to perform cognitive tasks. According to Baddeley and Hitch (1974) who developed the working memory model, working memory holds all the information needed for cognitive activities, such as thinking, planning and analysis. One key component of working memory is controlling and directing attention. The functions of both working memory and attention have been associated with frontal lobe activity. Research has shown that sleep deprivation dampens frontal lobe activity, and thus the capacity of working memory and attention systems. Specific attentional systems impaired include vigilance, auditory and visuospatial attention, serial addition and subtraction tasks, and different reaction time tasks as measured by the PVT (Alhola & Polo-Kantola, 2007).

Our long-term memory system is also thought to be affected by sleep deprivation, particularly our ability to process declarative memories. As discussed in Chapter 5, the encoding of declarative memories is highly dependent on the functioning of the hippocampus and medial temporal lobe brain structures. Research has found that during long-term memory tasks people who are sleep deprived show significantly reduced activity within the medial temporal regions compared to rested, wakeful people completing the same memory task (Killgore, 2010).

In one recent research study a group of participants were sleep deprived for one full night and then presented with a series of scenic photographs to encode (remember) while undergoing an fMRI. A second group of non-sleep deprived participants underwent the same task. Following two nights of normal sleep at home participants' memory retention was measured. Neuroimaging technologies showed that when the sleep-deprived groups were trying to remember the photos, there was significantly less activation in parts of their hippocampus, resulting in worse retention of photos compared to non-sleep-deprived participants (Yoo, Hu, Gujar,

sleep deprivation Going without sleep or not getting sufficient amounts of sleep to support optimal daytime functioning

partial sleep deprivation Getting some sleep in a 24-hour period but less than normally required for optimal daytime functioning

total sleep deprivation Getting no sleep at all in a 24-hour period

microsleep A short period of sleep where the individual appears to be awake, but brain activity indicates that they are asleep; occurs because of sleep deprivation

REM rebound The process whereby an individual experiences extra amounts of REM sleep after being deprived of it

working memory Part of our memory system that temporarily stores and manipulates a limited amount of information needed to perform cognitive tasks

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Jolesz, & Walker, 2007). These studies support the large growing body of literature that suggests sleep helps consolidate learning and memory processes.

Executive functions are also impaired after one full night of sleep deprivation. These include the ability to make decisions that are logical and consistent, the ability to solve a problem such as a maths equation or to complete a sudoku puzzle. The ability to make plans can also be diminished.

EFFECTS OF SLEEP DEPRIVATION ON CONCENTRATION

As already discussed earlier in the chapter, when attempting to determine the level of someone's consciousness, the speed and accuracy of cognitive tasks is often measured using a PVT. Concentration of tasks when sleep deprived is measured the same way, and research has shown that concentration generally deteriorates the more sleep deprived we are with concentration deteriorating after just one full night of sleep deprivation. Simple and routine tasks seem to be more difficult for the sleep deprived, and in these tasks most people experience problems with concentration, attention and accuracy. This is particularly important to note for vehicle drivers, pilots or machine operators because, for these people, making a mistake when conducting simple or routine tasks may prove fatal. If a task is monotonous (such as factory work), no amount of sleep deprivation is safe because accuracy is impaired (Gillberg & Akerstedt, 1998).

Coincidentally, concentration levels and performance on complex tasks seem to be less affected when sleep deprived. One study found that people who have not slept for 2 or 3 days and who may be experiencing an ASC show little impairment on relatively interesting or complex mental tasks (Binks, Waters, & Hurry, 1999). A subsequent study supported these findings and reported that, even after 24 hours of sleep deprivation, performance on a complex task was better preserved compared to performance on a simpler task (Chee & Choo, 2004).

High concentration levels are also paramount for many employees who do shift work, such as emergency service workers, doctors, nurses, police officers and taxi drivers. Shift workers are often required to work throughout the night and, if they are unable to sleep during the day, they may suffer from one full night's sleep deprivation. If their concentration is impaired as a result of sleep deprivation, the consequences can be disastrous because their safety and the safety of others may be in jeopardy. For this reason most emergency service workers are legally obligated to have a 10-hour break between rostered shifts. This gives them adequate time for a full night's sleep between shifts so concentration while on the job is not impaired.

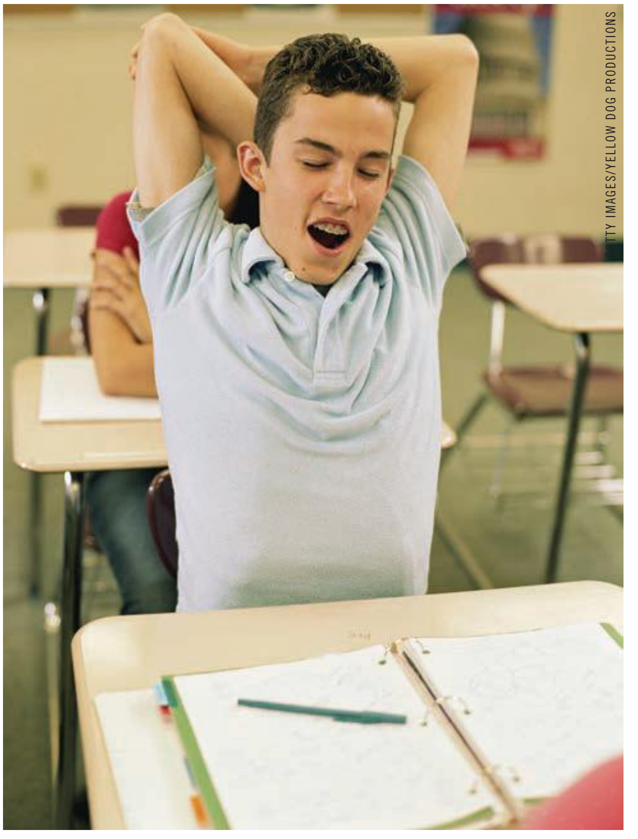
TTY IMAGES/YELLOW DOG PRODUCTIONS

FIGURE 6.23 This student is finding it difficult to concentrate in class because of the effects of sleep deprivation.

You may have done an 'all-nighter' before and be able relate to what you felt like the next day in terms of your concentration levels, particularly if you had to go to school. Your concentration may be impaired and you may find it more difficult to listen to the teacher's instructions, complete learning activities or even read the words in this textbook (see Figure 6.23).

EFFECTS OF SLEEP DEPRIVATION ON MOOD

The effects of sleep deprivation are also clearly evident on a person's mood. You may recall that after a sleepless night you may feel more irritable, short-tempered and impatient. Research has shown that after just one night of sleep deprivation a person's positive mood decreases while negative moods increase. Increased negative moods include feeling angry, hostile and argumentative, while positive moods include empathy, excitement and friendliness. Mood also affects emotional reactivity and

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interpretation. In one study conducted by Tempesta et al. (2010) well-rested participants' interpretations of photographs based on their emotional quality were compared with participants who had just experienced one full night of total sleep deprivation. All participants were shown a series of neutral, pleasant and unpleasant photos and were asked to rate these according to their emotional qualities. It was found that there were no differences in the ratings of the pleasant and unpleasant photos; however, sleep-deprived participants rated neutral images significantly more negatively compared to non-sleep-deprived participants. The study concluded that sleep deprivation alters emotional perception of neutral stimuli, biasing towards greater negativity (Tempesta et al., 2010).

The effect of increased negative mood as a result of sleep deprivation also affects one's vulnerability to stress, which can lead to feelings of anxiety and depression. Extensive research into the effects of sleep deprivation has established a positive relationship between sleep deprivation and mood and anxiety disorders. For example, one study found that chronic insomnia sufferers were more likely to develop depression and anxiety disorders (Neckelmann, Mykletun, & Dahl, 2007). People who suffer from depression often report sleeping difficulties, and sleeping difficulties are now considered to be one of the key symptoms of this disorder.

6.9 CHECK YOUR UNDERSTANDING >>

1 Total sleep deprivation involves __________, whereas partial sleep deprivation involves __________.
   - A not getting the required amount of sleep; going without sleep completely
   - B going without sleep completely; not getting the required amount of sleep
   - C not getting the required amount of sleep; changes in sleeping habits and patterns
   - D going without sleep completely; changes in sleeping habits and patterns

2 Describe the two longest recorded cases of sleep deprivation. What are some of the effects they both experienced?

3 When a person is sleep deprived they may move into periods of __________ where they temporarily fall into brief periods of sleep.
   - A REM rebound
   - B sleep paralysis
   - C tranquilised state
   - D microsleep

4 Which of the following is a physical effect of sleep deprivation?
   - A Droopy eyelids
   - B Irritability
   - C Reduced attentions and alertness
   - D Increase in stress and anxiety

5 Describe the effect sleep deprivation has on working and long-term memory with reference to changes in areas of the brain.

6 When sleep deprived, concentration:
   - A is better.
   - B is impaired.
   - C is the same as when not sleep deprived.
   - D depends on how much sleep has been deprived.

7 Describe the link between sleep deprivation and mood disorders.

LEGAL BLOOD ALCOHOL CONCENTRATIONS AND CONSCIOUSNESS

Driving a car safely is a task that requires a high level of conscious awareness. When you're behind the wheel you need to make important decisions on the road that require total concentration, rapid reflexes, good coordination and the ability to make good judgements. However, when a person is under the influence of alcohol their consciousness is impaired.

As discussed earlier, alcohol is a depressant that slows the activity of the CNS, and if a person drinks enough alcohol they may enter an alcohol-induced ASC. They may experience a lack of self-control, disturbed sense of time, distorted perceptions and cognition, and emotional instability, all of which are detrimental to their ability to safely drive a motor vehicle. When police need to determine whether a driver's consciousness has been impaired by alcohol, they measure the amount of alcohol present in the bloodstream by determining their **blood alcohol concentration (BAC)**. A breathalyser or saliva or urine sample will provide a BAC, with breathalysers being the most commonly used in Victoria. In Victoria the legal BAC when driving is under 0.05 for drivers with a full licence and 0.00 for probationary drivers and professional drivers (for example, heavy truck drivers, taxi drivers and bus drivers). A BAC of 0.05 indicates that every 100 millilitres of your blood

blood alcohol concentration (BAC) The amount of alcohol present in the bloodstream contains 0.05 grams of alcohol. The Transport Accident Commission (TAC) reported that one in four drivers and riders killed in the years 2008–12 had a BAC greater than 0.05. Some workplaces also impose a BAC on their employees. Pilots, machine operators and police officers, for example, are all required to have a BAC of 0.00 when working.

EFFECTS OF ALCOHOL ON COGNITION, CONCENTRATION AND MOOD

When a person has a BAC over 0.05 their consciousness is impaired. The effects of alcohol on cognition, concentration and mood include:

- *Cognition* – Various aspects of a person's cognition can be impaired with high BAC levels. These include an inability to problem solve or make decisions, impaired logic and reasoning, and impaired memory ability. When driving, these effects may result in not knowing when to give way to other drivers, not remembering basic road rules, and difficulty judging distance between surrounding cars.
- *Concentration* – A BAC over 0.05 causes a decline in concentration because a person may not be able to concentrate on the multifaceted aspects of driving a car, such as maintaining the speed limit or noticing the changing of traffic lights.
- *Mood* – When a person is under the influence of alcohol their emotions and mood may be exaggerated and intensified. A person may be overly emotional, displaying inappropriate emotions or experience a lack of emotions. A person's moods may fluctuate or they may have little control over their moods and these mood changes may affect their ability to make safe decisions on the road. For example, thrill-seeking emotions may be exacerbated in a driver with a high BAC, causing their propensity for reckless driving to intensify.

When a person's BAC increases, so does the severity of symptoms experienced. See Table 6.7 for a summary of different BAC levels and the effects on consciousness and behaviour.

TABLE 6.7 Levels of legal blood alcohol concentrations and their effects on consciousness and behaviour

BLOOD ALCOHOL CONCENTRATION	EFFECTS ON CONSCIOUSNESS AND BEHAVIOUR
0.05	Lowered alertness and judgement, lowered inhibitions, minor impairment of memory and reasoning; emotions may be intensified and exaggerated
0.10	Significant impairment in motor coordination and reaction times; less cautious
0.15	Reaction times further deteriorated, speech may be slurred, balance and vision have declined, anxiety and restlessness are common
0.20	Feeling dazed, disorientated, confused, depressed; may not be able to feel pain; may experience nausea and vomiting
0.25	All mental, physical and sensory functions are severely impaired; increased risk of asphyxiation (suffocation) from excessive vomiting
0.30	Stupor, no awareness or comprehension of the external environment
0.35	Unconsciousness or coma is likely; this is the equivalent level of surgical anaesthesia, a lethal dose for some adults
0.40	A lethal dose of alcohol for approximately 50% of adults

SLEEP DEPRIVATION AND LEGAL BAC

Going without sleep and drinking alcohol can both severely impair a person's ability to perform higher-order cognitive functions such as driving a car. While there are laws imposed to prevent drivers from driving on the road when they have been affected by alcohol, no such laws exist for people who are sleep deprived. According to the TAC, approximately 20 per cent of fatal road accidents are due to driver fatigue. Over many years the TAC has attempted to curb the road toll by mounting campaigns that encourage drivers to stay off the road when sleep deprived and to remind drivers of the deadly effects of sleep deprivation.

Many research studies that have investigated the effects of sleep deprivation on driving ability have found that sleep deprivation has similar effects to those experienced by drivers over the legal BAC. One well-known study conducted by Williamson & Feyer (2000) involved investigating the

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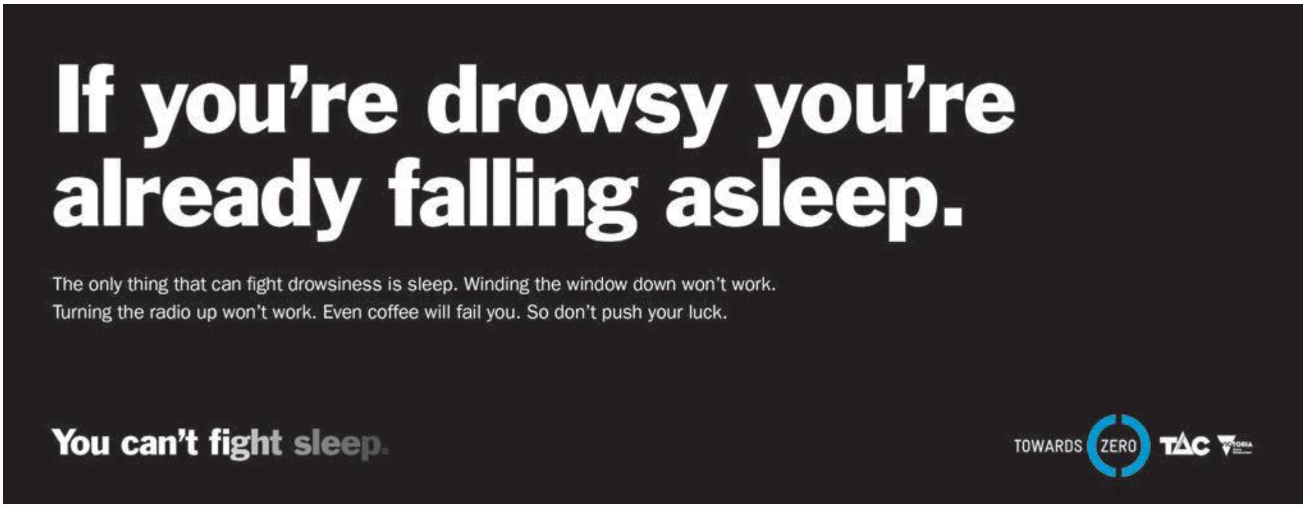

FIGURE 6.24 TAC fatigue campaigns are used to remind drivers of the dangerous consequences of driving when sleep deprived.

difference between the effects of sleep deprivation and equivalent BACs. They tested the abilities of sleep-deprived and alcohol-induced subjects using several performance tests such as a response speed test, a hand–eye coordination task, a divided attention task, a perceptual coding test and various memory tests. The results of the study found that going without sleep for 17–19 hours is the equivalent of having a BAC reading of 0.05. The study showed that, compared to drivers who were well rested, sleep-deprived drivers are twice as likely to have an accident because their reaction times are 50 per cent slower, with research showing 24–28 hours of sleep deprivation is the equivalent of a BAC reading of 0.10. These drivers are seven times more likely to have an accident on the road (Williamson & Feyer, 2000). Focus on research 6.3 provides more statistics on BACs and road accidents.

6.3

FOCUS ON RESEARCH

THE EFFECT OF ALCOHOL

Because alcohol consumption results in an altered state of consciousness, much research has been conducted on the effects of alcohol when driving. Road trauma is the most common cause of premature death among young adults in Australia. Figure 6.25 shows a graph of the number of drivers and motorcyclists killed on Victorian roads who recorded a BAC of 0.05 g/100 mL or higher between 1987 and 2012.

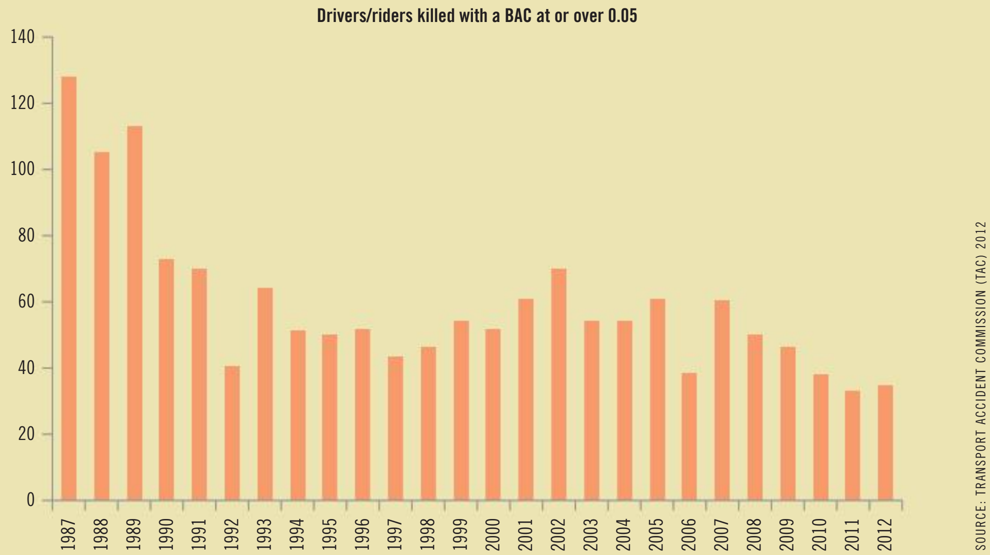

FIGURE 6.25 The number of drivers and motorcyclists killed in Victoria with a BAC over 0.05, 1987–2012

Some reported TAC alcohol road statistics are summarised below (TAC, 2015).

- The proportion of drivers and motorcycle riders killed with a BAC greater than 0.05 g/100 mL declined from 38 per cent in 1987 to 24 per cent in 2012.
- Close to one in four drivers and riders killed in 2008–12 had a BAC greater than 0.05.
- Drink-driving offenders are predominantly male (84 per cent).
- The age demographic of drink-driving offenders follows a linear pattern downwards from 21–29 onwards. In other words, the older the person, the less likely they are to be caught offending.
- Since 1997, Victoria Police have breathalysed more than 20 million drivers and riders during Booze Bus operations, catching close to 70 000 drivers and riders with an illegal BAC over this period.

QUESTIONS

1. Write a possible hypothesis that may investigate the effect of alcohol on driving ability.
2. What types of statistics are provided in this piece of research and what is the purpose of using these types of statistics?
3. What possible conclusion could be made from the data shown in Figure 6.25?
4. Suggest some of the reasons why the number of drink-drivers and riders with a BAC of 0.05 who were killed on Victorian roads has decreased since 1987.

6.10 CHECK YOUR UNDERSTANDING

1. What is a BAC and how is it measured?
2. What is the legal BAC for different types of drivers in Victoria?
3. When a person is experiencing vomiting because of consumption of alcohol, what is their likely BAC?
   - A 0.00
   - B 0.05
   - C 0.10
   - D 0.20
4. Being deprived of 17–19 hours of sleep is equivalent to what BAC?
   - A 0.00
   - B 0.03
   - C 0.05
   - D 0.10
5. What was the aim of the study conducted by Williamson and Feyer (2000)?
6. Write a possible hypothesis for the study conducted by Williamson and Feyer (2000).
7. Summarise the results of the study conducted by Williamson and Feyer (2000).

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CHAPTER SUMMARY

Consciousness

- Human consciousness is defined as all the perceptions, sensations, memories, thoughts and feelings one is aware of at any given moment.
- Human consciousness is divided into two main levels of consciousness: normal waking consciousness (NWC) and altered states of consciousness (ASCs).

Measuring consciousness

- Human consciousness is a psychological construct, which means it cannot be directly observed or measured. Thus, it has to be indirectly measured.
- Consciousness is measured indirectly using a variety of physiological devices, such as the electroencephalograph (EEG), electromyograph (EMG) and electrooculograph (EOG).
- An EEG detects, amplifies and records the brain's electrical activity and tells us which brainwaves are prominent at any given moment. The four types of brainwaves are beta, alpha, theta and delta waves. These brainwaves differ in their amplitude and frequency. Delta waves indicate deep sleep; beta-like waves indicate an awake and alert state.
- The EMG detects, amplifies and records the electrical activity of active muscles in the body.
- The EOG detects, amplifies and records the electrical activity of the muscles around the eyes. It can be used to detect whether an individual is experiencing NREM or REM sleep.
- Sleep research is typically conducted in a sleep laboratory. It is a controlled environment that uses participants' self-reports, video recordings and electronic recording devices to measure sleep.
- A psychometric vigilance test (PVT) may also be used to measure the speed and accuracy on cognitive tasks when a person is in an ASC such as a sleep-deprived state.

Difference between NWC and an ASC

- Examples of ASCs include states of hypnosis, meditation, daydreaming, sleep, anaesthesia, coma and being under the influence of alcohol or drugs.
- An ASC can occur naturally without any conscious effort or decision-making (e.g. daydreaming) or can be intentionally induced (e.g. being under the influence of drugs or alcohol).
- NWC is characterised by selective attention, controlled processes, automatic processes and divided attention.
- During NWC, humans have high levels of attention and awareness; high content limitations; a reliable memory; logical, controlled and rational thoughts; reliable emotional awareness; good self-control; good awareness of sensations and a realistic sense of time.
- During ASCs, humans may have lower attention and awareness of internal and external stimuli; reduced content limitations; poor memory; illogical and bizarre thoughts; heightened, blunted or inappropriate emotional experiences; poor self-control; blunted or sharpened sensations; and an inaccurate sense of time.

Stimulants and depressants, and how they affect brainwave patterns

- Psychoactive drugs are any class of drug that alters the brain's chemistry, which subsequently changes a person's perceptions, thoughts and behaviours. Two classes of psychoactive drugs include stimulants and depressants.
- Stimulants are a group of drugs that elevate mood, increase alertness and reduce fatigue. They do this by exciting neural activity in the brain, which increases bodily functions. Commonly used stimulants include caffeine and nicotine. Dangerous and illegal stimulants include amphetamines, methamphetamines and cocaine.
- Stimulant drug use affects brainwaves patterns. Caffeine increases beta brainwave activity; nicotine increases levels of alpha brainwave activity; amphetamines and methamphetamines increase beta activity; and cocaine increases levels of beta and alpha brainwaves, with higher doses of the drug more associated with beta brainwave activity.
- Depressants are a class of drugs that calm neural activity and slow down bodily functions. Some of the effects of depressants include increased fatigue and drowsiness, lowered heart rate, reduced anxiety and calm nerves. Some types of depressant drugs include alcohol, barbiturates, benzodiazepines, opioids and cannabis.
- Depressant drug use affects brainwave patterns. Alcohol increases alpha brainwaves; barbiturates in high doses increase delta brainwaves; benzodiazepines increase beta brainwaves; opioids increase theta and delta brainwaves; and cannabis increases alpha brainwaves.

Sleep deprivation effects and comparison with legal BACs

- Partial sleep deprivation is when one does not get the recommended hours of sleep per night, whereas total sleep deprivation is when a person goes without sleep altogether. Both total and partial sleep deprivation can affect a person's cognitive abilities, concentration levels and mood.
- Cognitive capabilities such as working memory and attention are adversely affected during sleep deprivation. Concentration on tasks when sleep

deprived deteriorates the more sleep deprived we are, with simple and routine tasks being more difficult for the sleep deprived. Negative moods such as anger and hostility increase when sleep deprived.

- Blood alcohol concentration (BAC) refers to the amount of alcohol present in the bloodstream, which can affect a person's cognitive abilities, concentration levels and mood, therefore affecting their driving ability.
- When experiencing a high BAC, cognitive impairments include an inability to make decisions, impaired logic and reasoning, and impaired memory ability. Concentration declines and moods can become exaggerated and intensified, possibly causing reckless driving.
- Going without sleep for 17–19 hours is the equivalent of having a BAC reading of 0.05, while going without sleep for 24–28 hours is the equivalent of a BAC reading of 0.10.

APPLY YOUR KNOWLEDGE AND SKILLS

SECTION A: MULTIPLE-CHOICE QUESTIONS

Answer the following questions by writing the correct letter in your workbook. Only one answer is correct for each question.

1 Which of the following is not an ASC?

A Reading
B Sleeping
C Daydreaming
D Being under the influence of marijuana

2 Beta waves are found during:

A deep sleep.
B light sleep.
C hypnosis.
D normal waking consciousness.

3 NWC is different from an ASC because:

A in NWC, thoughts are logical and controlled, but in an ASC thoughts are rational and illogical.
B in an ASC, memory is often good but in NWC memory is often impaired.
C in NWC, hallucinations may occur, but in an ASC this is unlikely.
D in NWC, thoughts are logical and rational, but in an ASC thoughts may be illogical.

4 Which of the following is the best example of selective attention?

A Driving a car while talking and changing the radio
B Playing a difficult computer game
C Watching cartoons on television
D Having a shower and washing your hair

5 Lauren underwent a hypnosis treatment. Afterwards, she was surprised to learn that she had been hypnotised for 40 minutes, yet it seemed to her that only 5 minutes had passed. Lauren had most likely experienced:

A a state of NWC.
B an ASC.
C stream of consciousness.
D an automatic process.

6 Stimulant drug use typically increases __________ and __________ brainwaves.

A alpha; theta
B theta; delta
C beta; delta
D beta; alpha

7 The task of learning how to drive a car can be considered a controlled process because:

A it is likely to interfere with performance of other tasks.
B the level of mental effort required is much less than for other skilled performance tasks.
C the driver must use the controls at all times.
D it allows the driver to have more control of their life.

8 Which of the following drugs is an example of a depressant drug?

A Opioid
B Cocaine
C Methamphetamine
D Amphetamine

9 Craig was having problems sleeping, and spent a night in a sleep laboratory on his doctor's suggestion, so that his brainwaves could be measured. Craig took a long time getting to sleep, but he finally fell into a deep sleep. The doctor used a device called an __________ to determine Craig's brainwave activity. When Craig was in the deep sleep, his brainwaves became __________ and were __________ waves.

A EEG; faster; delta
B EEG; slower; beta
C EEG; slower; delta
D ECG; faster; beta

10 The sleep scientist asked Craig to subjectively report his sleeping experiences. Craig might do this through the use of __________.

A a sleep diary
B an EMG
C an EOG
D a psychometric vigilance test

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11 Craig had electrodes placed around his eyes when he was in the sleep laboratory. What device would this have been?

A EEG
B EOG
C EMG
D ECG

12 Which of the following drugs slows down neural activity, making us feel sedated and calm?

A Cocaine
B Caffeine
C Nicotine
D Cannabis

13 What is the lethal BAC for most adults?

A 0.20
B 0.40
C 0.60
D 0.80

14 One of the effects of sleep deprivation is:

A increased positive mood.
B increased negative mood.
C increased concentration.
D faster reaction times.

15 Going without sleep for 24 hours is the equivalent of what BAC reading?

A 0.00
B 0.05
C 0.10
D 0.15

SECTION B: SHORT-ANSWER QUESTIONS

1 What are controlled processes? Provide an example to support your answer.

2 Name two devices that can be used to monitor consciousness and explain what they measure.

3 List three characteristics of an altered state of consciousness.

4 Describe the effects stimulant drug use has on the body and the brain.

5 Distinguish between selective and divided attention, using an example of each.

6 Explain the differences between amplitude and frequency in relation to brainwaves.

7 Explain how the electromyograph (EMG) and electrooculograph (EOG) are used.

8 Describe the measurement devices that will be used when spending a night in a sleep laboratory.

9 Describe the effects depressant drug use has on the body and the brain.

10 Explain the effects of sleep deprivation and why it is important not to drive when sleep deprived.

SECTION C: EXTENDED-RESPONSE QUESTION

You are part of a research team interested in the different ways drugs affect brainwave patterns as measured by an EEG. You want to test the difference in brainwave patterns between stimulant drug use and depressant drug use. For this study, you intend to compare three groups of participants. One group will be given a stimulant drug (such as caffeine), one group will be given a depressant drug (such as alcohol) and one group will not be given any stimulant or depressant drugs. The EEG recordings of all three groups of participants will be compared.

You are now required to design this investigation and write an introduction and method section of a scientific investigation report for this study. In your answer include the following:

INTRODUCTION

- a description of the key terms relating to the background of this research
- identification of the independent and dependent variables
- an aim and testable hypothesis

METHOD

- participants
- apparatus
- procedure.

This question is worth 10 marks.

SECTION D: ASSESSMENT TASK

DATA ANALYSIS

An important component of psychology is conducting research to learn more about the field. To understand the research you need to analyse the data that you collect. Complete the task below and answer the questions regarding the findings of each experiment.

TASK

Find a small group of participants. You could use some friends or your family. You will conduct two sessions (a meditation and a presentation) on two separate occasions with this group of participants.

MEDITATION SESSION

1 Find a guided meditation recording that you could use for a meditation session. You could use a DVD or download a meditation track from the Internet. The session should last for 10 minutes, so make sure your track is long enough. (If you cannot find a track, you can conduct the session in silence.)

2 Listen to the track and write down four questions about the material your participants will hear. The questions should help you identify whether the participants were concentrating on the track during the session. (If you are conducting the meditation session in silence, write down four noises you will make during the session.)

3 Run a 10-minute meditation session with your participants, playing the track. (If you are conducting a silent session, make sure you make the planned four noises during the session.)

4 At the conclusion of the meditation session, ask participants to record how much time they feel has passed and to answer the questions you wrote about the guided meditation session. (If you conducted a silent meditation, ask them to identify the four noises you made.)

PRESENTATION SESSION

1 On a separate occasion, present information to your participants on a topic of your choice. It could be something you have learnt at school or the latest storyline in your favourite TV show. Your presentation should last for approximately 10 minutes.

2 At the conclusion of the presentation, ask participants to record how much time has passed and to answer questions about the lecture.

Collate your data from the questions asked after both the meditation and the presentation. Work out the average number of minutes participants thought had passed for each condition and the number of questions correct for each condition.

QUESTIONS

1 Draw a graph that illustrates the results for accuracy of time.
- **a** Discuss the differences between NWC and ASC in terms of time perception.
- **b** What are possible reasons for this difference?
- **c** What are other contributing factors or extraneous variables that may have brought about this change?
- **d** Was the data as expected? Explain your answer.

2 Draw a graph that illustrates the results for accuracy of memory.
- **a** Discuss the differences between NWC and ASC in terms of memory.
- **b** What are possible reasons for this difference?
- **c** What are other contributing factors or extraneous variables that may have brought about this change?
- **d** Was the data as expected? Explain your answer.

3 Look at the way your data has been presented. Is this data an objective or subjective way to determine an individual's state of consciousness? Explain your answer.

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CHAPTER 07

IMPORTANCE OF SLEEP

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KEY KNOWLEDGE INCLUDES:

- sleep as a regular and naturally occurring altered state of consciousness that follows a circadian rhythm and involves the ultradian rhythms of REM and NREM Stages 1–4 sleep excluding corresponding brainwave patterns and physiological responses for each stage
- theories of the purpose and function of sleep (REM and NREM) including restoration theory and evolutionary (circadian) theory
- the differences in sleep across the lifespan and how these can be explained with reference to the total amount of sleep and changes in a typical pattern of sleep (proportion of REM and NREM).

SLEEP

Sleep is a naturally occurring altered state of consciousness that we all experience every day. We spend approximately one-third of our lives asleep so, unsurprisingly, this altered state of consciousness is very important for our health and wellbeing. The physiological effects of sleep are often measured using devices such as the electroencephalograph (EEG), electromyograph (EMG) and electrooculograph (EOG), and also by looking at the behavioural characteristics of the sleeping person. **Sleep** is described as an altered state of consciousness that features the suspension of awareness of the external environment and is accompanied by a number of physiological changes to the body. The need to sleep is innate (or inborn) in humans, but because sleep is familiar, many people think they know all about it. Before reading more, test your knowledge about sleep by completing Try it yourself 7.1.

7.1 TRY IT YOURSELF >>

SLEEP QUIZ

Five of the following statements regarding sleep are true (T) and five are false (F). Decide which is which, then discuss your answers as a class to see what you already know about sleep.

1. People will not suffer any short-term effects of sleep loss if they only sleep a few hours per night.
2. Most people dream every night.
3. Some dreams are in black and white.
4. Resting during the day can replace lost sleep.
5. As people get older, they sleep more.
6. Hot chocolate will not help a person get to sleep.
7. If a person goes without sleep for long enough, death will occur.
8. Dreams mostly occur during deep sleep.
9. A person prevented from dreaming would soon go crazy.
10. Sleepwalking occurs when a person acts out a dream.

MEASURING SLEEP

Sleep scientists have come to understand a great deal about the sleep cycle, including the physiological changes that occur during the sleep cycle, how this cycle changes across the lifespan and also how to treat people who may be suffering from sleep disturbances. Most sleep research takes place in a **sleep laboratory** (see Figure 7.1), which is a controlled environment that enables the electronic recording and measurement of sleep patterns. A sleep laboratory also allows researchers to watch people's behaviour over an extended period as they sleep. Sleep laboratories are usually designed to look like a normal bedroom so that sleep is more natural and comfortable for the person. Common reported sleep problems often bring individuals to visit a sleep laboratory. These sleep problems include frequent waking during the night, excessive sleepiness during the day, snoring or difficulty breathing while sleeping, night terrors and sleepwalking. The use of a laboratory allows researchers to monitor a variety of responses that may explain some of these problems. A patient may be attached to an **electroencephalograph (EEG)** to record brainwave activity during sleep, an **electromyograph (EMG)** to record the electrical activity of muscles that control their voluntary movement, an **electrooculograph (EOG)** to record the electrical activity of muscles that control their eye movement, or even an **electrocardiograph (ECG)** to record the electrical activity of their heart muscles throughout the night. In conjunction with these physiological measures, a patient will also be asked to self-report their sleep activity because they may experience symptoms that physiological devices will not detect.

FIGURE 7.1 In a sleep laboratory, sleep scientists study the physiological responses that occur during the sleep cycle.

THE SLEEP CYCLE: AN OVERVIEW

There are two distinct types of sleep: **rapid eye movement (REM)** and **non-rapid eye movement (NREM) sleep**. When first falling asleep, we experience the first stage of NREM sleep. NREM sleep is divided into four distinct stages: Stages 1, 2, 3 and 4. In each stage, the sleep experienced becomes progressively deeper.

The sleeper initially enters Stage 1, and this is the only time throughout the sleep cycle they will enter

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Stage 1 NREM sleep. After Stage 1 NREM, the sleeper progresses through the subsequent stages (2, 3 and 4), gradually entering deeper sleep. Once they have reached Stage 4, the sleeper then goes back through Stages 3 and 2 in reverse order. Instead of entering Stage 1 NREM sleep again, the sleeper moves from Stage 2 into their first period of REM sleep. The cycle then begins again: Stage 2 NREM, followed by Stage 3 NREM, followed by Stage 4 NREM, followed by Stage 3 NREM, followed by Stage 2 NREM, followed by REM. Every sleep cycle lasts approximately 90 minutes. As the night progresses, the time we spend in NREM sleep becomes shorter while the time we spend in REM sleep lengthens. Close to the end of a night's sleep we can be spending up to an hour in REM sleep during one cycle (see Figure 7.2b). Each of the sleep stages is discussed in more detail later in the chapter.

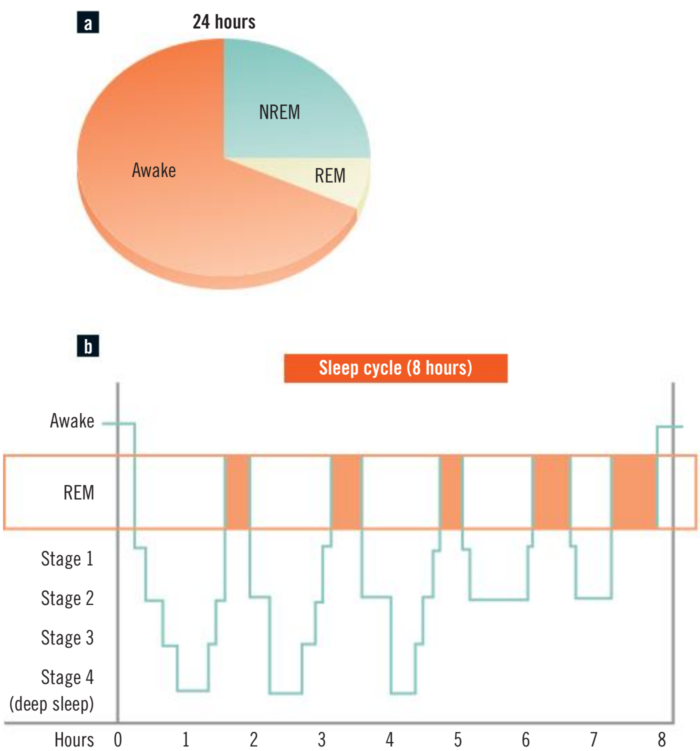

FIGURE 7.2 (a) The average proportion of time an adult spends in REM and NREM sleep during a 24-hour period; (b) typical changes in sleep stages over one night

To identify the types and stages of sleep and the corresponding physiological variations that accompany each stage, researchers primarily use the EEG to measure the electrical activity of brain neurons. This is because neurons communicate with each other by transmitting information in an electrochemical form. An EEG detects, records and amplifies this electrical activity in the form of brainwaves so we can identify how active the brain is. When we are awake, brainwaves are generated at a rapid rate, so we remain active and alert. When we are asleep, the frequency of brainwaves slows, so we become less active and alert. As we move through the sleep stages, EEG recordings show that there are distinct changes in the pattern of brainwave activity.

As discussed previously, the four types of brainwaves are beta, alpha, theta and delta waves. All have different combinations of frequency and amplitude, and all are named after letters of the Greek alphabet. These waves are measured in cycles per second, expressed as 'hertz', which is the unit for frequency (Hz is the abbreviated form). The lower the number of hertz, the slower the brain activity or the slower the frequency of the activity. **Frequency** refers to the number of brainwaves per second. Brain activity is also measured by amplitude, or intensity. **Amplitude** is measured by the size of the peaks and troughs in brain activity compared to a baseline of zero activity.

When you are awake and alert, a pattern of **beta waves** indicates that the brain is active. Beta waves are characteristic of normal waking consciousness and they have a high frequency and low amplitude.

sleep An altered state of consciousness that features the suspension of awareness of the external environment and is accompanied by a number of physiological changes to the body

sleep laboratory A controlled environment that enables the electronic recording and measurement of sleep patterns

electroencephalograph (EEG) A machine used to detect, amplify and record the brain's electrical activity, measured in brainwaves

electromyograph (EMG) A machine used to detect, amplify and record the electrical activity of voluntary muscles

electrooculograph (EOG) A machine used to detect, amplify and record the electrical activity of muscles that control eye movement

electrocardiograph (ECG) A machine used to detect, amplify and record the electrical activity of heart muscles

REM sleep A type of sleep characterised by brainwaves with high frequency and low amplitude; the muscles of the body are in a state of paralysis and dreams may be experienced

NREM sleep A type of sleep that is broken into four stages, where the sleeper falls into a deeper and deeper sleep as the stages progress; characterised by relaxation of the muscles, a slowing down of physiological functions and brainwaves that decrease in frequency and increase in amplitude

frequency (of brainwaves) The number of brainwaves per second

amplitude (of brainwaves) The strength of a brainwave as measured by the size of the peaks and troughs from a baseline of zero activity

beta waves Brainwaves characteristic of normal waking consciousness, with a low amplitude and high frequency

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When we start to relax, beta waves shift to a pattern of larger and slower waves called alpha waves. Alpha waves are experienced during a deeply relaxed state and they have a medium-high frequency and low-medium amplitude. These waves occur when you are about to fall asleep and your thoughts begin to drift. As you fall asleep, your breathing becomes slow and regular, your pulse rate slows and your body temperature drops. Soon after, you enter the first cycle of sleep.

7.1 CHECK YOUR UNDERSTANDING >>

1 Which of the following statements about sleep is incorrect?
   - A Sleep is a part of normal waking consciousness.
   - B The need for sleep is innate in humans.
   - C Sleep is a naturally occurring altered state of consciousness.
   - D There are two distinct stages of sleep.

2 Describe the experience of spending a night in a sleep laboratory.

3 What will the EOG detect during REM sleep and NREM sleep?

4 How long does one sleep cycle last?
   - A 120 minutes
   - B 60 minutes
   - C 90 minutes
   - D 30 minutes

5 What happens to stages of REM sleep as the night progresses?

6 Which of the following stages of sleep will a sleeper only enter once throughout the night?
   - A NREM 1
   - B NREM 2
   - C NREM 3
   - D NREM 4

NREM SLEEP

As outlined earlier, there are four stages of NREM sleep. During NREM sleep, progressively slower heart and respiratory rates are recorded. There is an increase in growth-hormone secretion, and vigorous stimulation is required to wake the sleeper, especially in Stages 3 and 4. Sweating and shivering because of temperature changes occur during NREM sleep, and stop during REM sleep.

Unlike REM sleep, which is characterised by dreaming, NREM sleep is dream-free approximately 90 per cent of the time (Jouvet, 1999). We spend approximately 80 per cent of the night in NREM sleep, although the amount of time spent in NREM sleep may increase after physical exertion, which suggests that NREM sleep helps us recover from fatigue incurred during the day. In comparison, daytime stress tends to prompt an increase in REM sleep.

Stage 1 NREM sleep

As you start to relax, you enter Stage 1 NREM sleep. Your nervous system begins to slow, your heart rate slows, your breathing becomes irregular and your muscles relax. This physiological slowing down during the transition between wakefulness and the first stage of NREM sleep is called a hypnogogic state and it can last for several minutes. The hypnogogic state is characterised by slow, rolling eye movements as detected on an EOG. People in a hypnogogic state sometimes see vivid mental images or flashes of light and colour, which are known as hypnogogic images. Although they are somewhat dream-like, these images are usually not associated with dreaming. The hypnogogic state may also trigger a hypnic jerk. A hypnic jerk (also known as a myoclonic jerk or a sleep start) is a reflex muscle-contraction or twitch throughout the body that may momentarily jerk a person awake. Electromyograph recordings of muscle movement during the sleep stages indicate that they only occur in Stage 1 NREM sleep, often just as someone is falling asleep. Hypnic jerks are common, completely normal experiences and people often describe them as a falling sensation or being like a mild electric shock. What causes hypnic jerks is unknown, but one theory suggests they may be the result of the muscles relaxing. Another theory suggests they may be a reflex used to keep the body functioning when your brain misperceives the slower rate of internal activity as a sign that you are falling, so it alerts your arms and legs to stay upright. Some researchers also believe certain factors, such as stress, anxiety, fatigue, caffeine and sleep deprivation, may increase the frequency or severity of hypnic jerks.

Stage 1 sleep, also known as light sleep, is marked by low–medium amplitude and medium–high frequency alpha brainwaves. As you progress through Stage 1, theta waves begin to appear. Theta waves are a mix of medium–high amplitude and low–medium frequency brainwaves that indicate that the electrical activity in your brain is slowing and you are moving further away from consciousness. So, although the brainwaves in Stage 1 sleep are irregular, they become higher in amplitude and lower in frequency as you move through this stage.

Stage 1 lasts for approximately 2–10 minutes. People wakened during this stage may or may not feel as if they have been sleeping.

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Stage 2 NREM sleep

As sleep deepens, body temperature drops, and physiological responses such as heart and respiratory rate continue to slow down. Stage 2 sleep is a fairly solid type of sleep; however, the sleeper is still receptive to external stimuli, such as loud noises. The EEG indicates that there is a high prevalence of theta-wave activity at this time. Theta brainwaves have a low–medium frequency, with medium–high amplitude activity. The EEG recording also begins to show sleep spindles, which are bursts of distinctive brainwave activity, indicated by a short burst of high-frequency brainwaves that last for approximately one second. Sleep scientists suggest that sleep spindles may mark the true boundary of where sleep begins.

The EEG also shows that Stage 2 sleep is characterised by a phenomenon known as a K-complex. A K-complex is a single, large burst of high-amplitude brainwaves. Scientists don't know why we have sleep spindles and K-complexes. One theory suggests that sleep spindles occur because the brain is attempting to block signals from external stimuli (for example, the sound of a crying baby) from disturbing sleep. It has also been suggested that K-complexes help suppress arousal and aid in memory consolidation.

Stage 2 sleep lasts for approximately 20–30 minutes. Most of the time, if a person is wakened within 4 minutes of spindles appearing, they will report that they felt as if they were asleep.

Stage 3 NREM sleep

In Stage 3 sleep, physiological responses begin to steady. Theta waves continue to appear; however, delta brainwaves also begin to appear. This is known as the emergence of slow-wave sleep (SWS). Delta waves are high in amplitude and low in frequency, and their presence signals deeper sleep and a further loss of consciousness.

Stage 3 is a transitional stage and lasts 3–10 minutes. The sleeper is in quite a deep sleep and is therefore more difficult to wake than in earlier stages.

Stage 4 NREM sleep

Deep sleep is reached after about an hour of entering the sleep cycle. In Stage 4 sleep, brainwaves become almost pure delta waves. If a sleeper is wakened from Stage 4 sleep, for example by a very loud noise, they will wake in confusion and may not recall hearing the noise. They may also take a few minutes to orientate themselves.

Stage 4 can last for approximately 20–30 minutes, but decreases in length as the night progresses. It is during Stage 4 sleep that we typically see the appearance of sleep problems such as sleepwalking or bedwetting.

7.2 CHECK YOUR UNDERSTANDING >>

1. The hypnogogic state is characterised by slow, rolling eye movements and is most typically experienced:
   - A as we begin to wake from sleep.
   - B during deep sleep.
   - C during REM sleep.
   - D as we begin to fall asleep.
2. Stage 1 sleep is characterised by contraction of the muscles as the body relaxes. This is known as:
   - A the hypnogogic stage.
   - B a hypnogogic jerk.
   - C a hypnic jerk.
   - D an anti-contraction.
3. Describe the two unique brainwave patterns that occur during Stage 2 NREM sleep and describe why they occur.
4. During which stage of sleep does sleepwalking occur?
   - A Stage 1 sleep
   - B Stage 2 sleep
   - C Stages 3 and 4 sleep
   - D REM sleep
5. Slow-wave sleep is when the emergence of __________ brainwaves are experienced, which occurs during __________ NREM sleep.
   - A alpha; Stage 2
   - B delta; Stage 2
   - C delta; Stages 3–4
   - D theta; Stages 3–4
6. As NREM stages progress, what happens to our heart rate and breathing rate?
7. How long do we typically spend in NREM sleep each night? What factors contribute to this changing?

alpha waves Brainwaves experienced during a deeply relaxed state, with a low–medium amplitude and medium–high frequency

hypnogogic state A state when alpha waves begin to present on the EEG and a person is drifting from wakefulness to sleep

hypnic jerk A reflex muscle contraction that occurs during Stage 1 NREM sleep as the body is relaxing

theta waves Brainwaves experienced during the early stages of sleep, with a mix of medium–high amplitude and a low–medium frequency

sleep spindles A type of brain activity characterised by a short burst of high-frequency brainwaves, experienced during Stage 2 NREM sleep

K-complex A short burst of high-amplitude brainwaves, experienced in Stage 2 NREM sleep

slow-wave sleep (SWS) A sleep state characterised by the emergence of delta waves; SWS is experienced during Stages 3 and 4 NREM sleep

delta waves Brainwaves experienced during the deepest stages of sleep, with high amplitude and low frequency

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REM SLEEP

If you watch a person who is asleep, you may be able to determine which stage of sleep they are experiencing by noticing whether their eyes occasionally move under their eyelids. These movements, known as rapid eye movements, are indicative of a sleeper experiencing REM sleep. The first period of REM sleep occurs at the end of the first sleep cycle, approximately 90 minutes after falling asleep.

FIGURE 7.3 When we are dreaming during REM sleep, our eyes are moving but our body is motionless. These rapid eye movements indicate that we are dreaming. If you observe a baby's eyelids to be flickering, you know they are dreaming.

Rapid eye movements are strongly associated with dreaming. Roughly 85 per cent of the time, people woken during REM periods report vivid **dreams**. In fact, the brain is so active during REM sleep that EEG readings look as if the person is awake (Hobson, Pace-Schott, Stickgold, & Kahn, 1998).

EEG recordings during REM sleep show a saw-tooth pattern of beta-like waves of low amplitude and high frequency, similar to those experienced when awake and alert. Although the brainwaves resemble alertness, REM sleep is actually considered quite a deep sleep because it is difficult to wake an individual in this stage. This is one reason that REM sleep is referred to as **paradoxical sleep**. The word 'paradoxical' means 'something that contradicts itself'. For example, during REM sleep the heart beats faster, breathing is more rapid and irregular, blood pressure varies, the genitals become aroused and the eyes dart around in their sockets. Yet with all of this internal activity going on, the body appears totally relaxed – in fact, the muscles are in a state of atonia, or paralysis. The purpose of REM sleep is still not fully understood but, although we still have much to learn about sleep, it is clear that REM sleep and dreaming are vital for keeping the brain functioning properly (Hobson, 1999). Research suggests that REM sleep helps us sort memories formed during the day and consolidate them into stable long-term memories (Ackermann & Rasch, 2014).

REM sleep may increase dramatically when there is some sort of emotionally charged event in a person's life, such as a death in the family, trouble at school or family conflict. However, on average, REM sleep totals about 90 minutes per night or 20 per cent of the total night's sleep. The amount of REM sleep increases as the night progresses. The first period of REM sleep may be as brief as a few minutes, and the final period of REM sleep may last up to one hour.

Because of the distinct differences in NREM and REM sleep, measurement of physiological responses can indicate which stage of sleep an individual is experiencing. An EEG indicates beta-like (REM) or alpha–delta (NREM) brainwaves; an EOG can monitor the presence of rapid eye movement, and an EMG can detect muscle movement, such as the experience of a hypnic jerk, or no movement, such as that experienced in REM sleep.

Table 7.1 compares the differences between NREM and REM sleep.

See Figure 7.4 for the EEG, EMG and EOG recordings of a young adult during the different stages of sleep. Figure 7.5 shows EEG recordings of the brainwaves demonstrated during REM and each stage of NREM sleep.

TABLE 7.1 Some of the differences between NREM and REM sleep

	NREM sleep	REM sleep
Eye movements	Non-rapid eye movements	Rapid, jerky eye movements
Brainwaves	Alpha to delta waves	Beta-like waves
Physiological arousal	Decreases	Increases
Muscles	Some sharp movements and a small amount of muscular activity	Atonia – the muscles are in a state of paralysis
Dreams	Not likely to be present but when they are, they are illogical	Common
Duration	Approximately 80% of our total night's sleep Decreases as the night progresses	Approximately 20% of our total night's sleep Increases as the night progresses
Type of replenishment	Replenishes the body	Replenishes the mind

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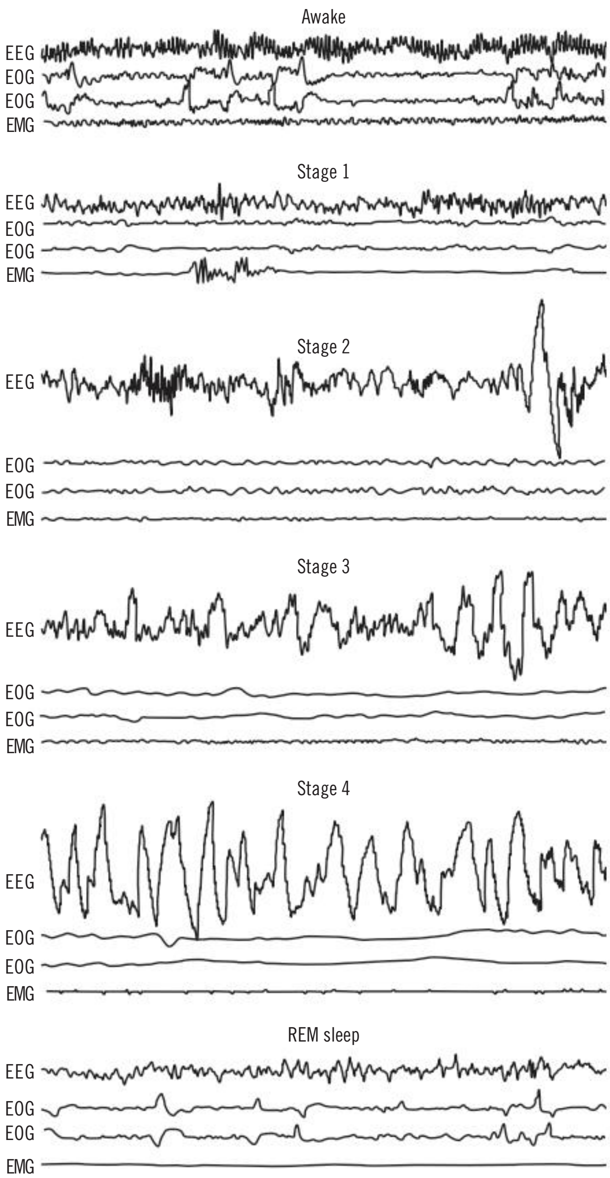

FIGURE 7.4 EEG, EMG and EOG recordings of a young adult

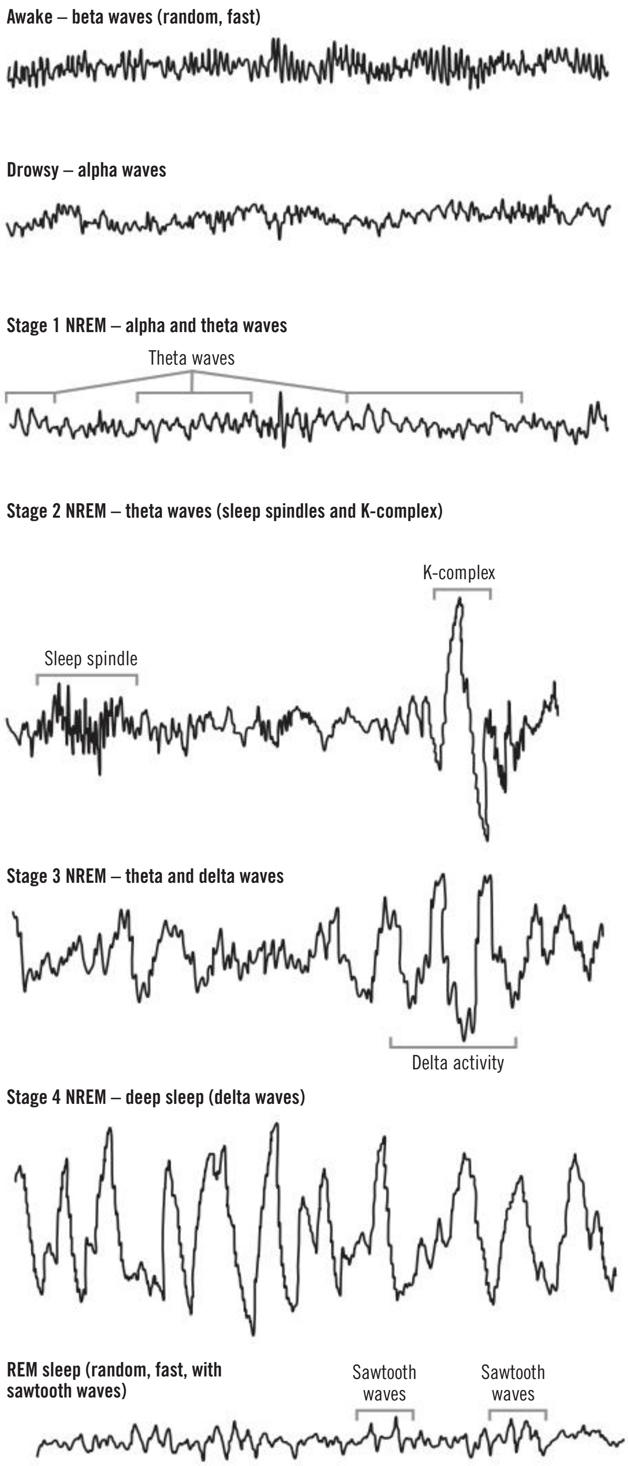

FIGURE 7.5 EEG recordings of someone awake, drowsy, in the four stages of NREM sleep and in REM sleep

Dreaming

Dreams are a series of images, thoughts and emotions that pass through our mind during sleep. Approximately 80 per cent of dreams are experienced during REM sleep and approximately 20 per cent during NREM sleep. Dreams experienced during REM sleep tend to be longer, clearer and more detailed than thoughts and images that occur in NREM sleep (Shafton, 1995). Studies have shown that brain areas associated with imagery and emotion become more active during REM sleep, which may explain why REM dreams tend to be more vivid than those experienced during NREM sleep (Braun, Balkin & Herscovitch, 1998).

As already mentioned, your body becomes quite still when in REM sleep, as if you are paralysed (atonic). But imagine if this were not the case – what would be the result of acting out some of your dreams? REM-sleep paralysis can actually fail, and when it

dreams A series of images, thoughts and emotions that passes through the mind during sleep

paradoxical sleep Occurs during REM sleep where physiologically a lack of muscle tone is experienced and the body is still and relaxed, but cortically the brain is active and alert does, some hilarious – and dangerous – night-time escapades can occur. People may thrash violently or leap out of bed and attack their bed partners. A lack of muscle paralysis during REM sleep is called **REM behaviour disorder**. One documented patient suffering from this disorder tied himself to his bed every night. That way, he could not jump up and crash into furniture or walls (Shafton, 1995). See Try it yourself 7.2 for some tips on how to enhance your dream recollections, and Focus on research 7.1 to learn more about REM behaviour disorder.

7.2 TRY IT YOURSELF >>

ENHANCING YOUR DREAM RECOLLECTIONS

Many people report not being able to remember their dreams. Some may believe they do not dream at all. Dreams are likely to be remembered if you wake up during REM stage of sleep because this is when dreaming occurs. Follow the steps below each night for one week, then complete the reflective questions that follow to determine whether your dream recollections have improved.

STEP 1

Get a good night's sleep (at least 8 hours). As you are aware, periods of REM sleep increase the longer we have been asleep. If you are only averaging 4–5 hours of sleep per night you are not experiencing longer periods of REM sleep and therefore are less likely to remember your dreams.

STEP 2

Consciously remind yourself to remember your dream before you fall asleep. Tell yourself you will remember your dream when you wake up in the morning.

STEP 3

Keep a dream journal close to your bed. Each time you wake up in the morning (or in the middle of the night if this occurs) write down anything you can remember about your dream, no matter how illogical or fragmented it may seem.

During the day, if you see, hear or smell something familiar that reminds you of a dream you had, write this down and add it to your dream journal when you get home.

QUESTIONS

1. At the end of the 7-day period did you record any improvements in your dream recollections?
2. Did you identify any patterns between dream content and daytime activities?
3. Did you notice any patterns across the 7-day period that enhanced or decreased your dream recollection? (For example, consumption of caffeine before bed, emotional state, stress levels and so on)
4. Share your dream recollections with a classmate. Were there any common dream themes reported?
5. Search the Internet to find the top 10 most common dreams experienced by people.

7.1 FOCUS ON RESEARCH

REM BEHAVIOUR DISORDER AND MOTOR DYSFUNCTION IN PARKINSON'S DISEASE

REM behaviour disorder is characterised by a lack of muscular atonia during REM sleep. This can lead to violent bursts of physical activity during REM sleep as a person may try to act out their dreams. REM behaviour disorder can occur in isolation; however, it is commonly a comorbid condition (a medical condition that occurs with another) with neurodegenerative disorders such as Parkinson's disease. Parkinson's disease is a neurodegenerative disorder characterised by movement deficiencies such as muscular rigidity, tremors, uneven posture and bradykinesia. Bradykinesia refers to slowness of movement, which is a cardinal symptom of Parkinson's sufferers. Research has found that REM behavioural disorder is a frequent nocturnal disturbance for patients with Parkinson's disease. Some studies even suggest that Parkinson's sufferers with REM behaviour disorder may have a different underlying pattern of neurodegeneration compared to Parkinson's sufferers without REM behaviour disorder (Lee, Kim, Shin, & Sohn, 2010).

One longitudinal study conducted by Bugalho & Viana-Baptista (2013) aimed to investigate the progression of REM behavioural disorder over time in Parkinson's disease sufferers. A group of Parkinson's sufferers who were in the early stages of the disease were used as participants for this research. They were tested twice, once at the beginning of the study, then 2 years later. They were tested for symptoms of REM behavioural disorder, including measuring their movement behaviour during sleep, vocalisation during sleep or any other characteristics indicative of dream enacting. They were also assessed on the severity of their Parkinson's symptoms using the Unified Parkinson's Disease Scale. Symptoms assessed included tremors, bradykinesia, rigidity and postural instability. When participants were again tested on the same items 2 years later, some differences were found. These included a 12.5 per cent increase in patients with REM behavioural disorder, and patients with REM behavioural disorder at the beginning of the study reported a significant increase in the severity of Parkinson's symptoms in the 2-year follow-up. This study concluded that the presence of REM behavioural disorder symptoms could be a risk factor for motor function deterioration, especially the symptom of bradykinesia, which significantly worsened in REM behavioural disorder sufferers.

QUESTIONS

1. Describe some of the characteristics of REM behavioural disorder and Parkinson's disease.
2. What is meant by a longitudinal study?
3. Briefly outline the results of this study.
4. What can be concluded based on the results of this study?

 ISBN 9780170365628

7.3 CHECK YOUR UNDERSTANDING >>

1 If you watch a person who is asleep, how might you know they are in REM sleep?
  - A Their body is constantly twitching.
  - B They may get up and begin to sleepwalk.
  - C Their eyes are completely still beneath their eyelids.
  - D Their eyes are moving rapidly beneath their eyelids.

2 REM sleep helps us to:
  - A consolidate our memories.
  - B restore our muscles.
  - C grow our hair.
  - D slow down our breathing.

3 The brainwaves present when in REM sleep are characterised by _________ frequency and _________ amplitude.
  - A high; high
  - B low; high
  - C high; low
  - D low; low

4 Describe some of the reasons why REM sleep is often referred to as paradoxical sleep with references to the meaning of the word 'paradoxical'.

5 What are the characteristics of REM behavioural disorder? Provide an example of how this disorder could be dangerous.

6 Compare the dreams experienced in REM with those experienced in NREM.

7 Analyse Figure 7.4 and describe the pattern of physiological changes as a person progresses through wakefulness to the different stages of sleep as measured by the EEG, EOG and EMG. Present your answer in a table such as the one shown below.

	EEG	EMG	EOG
Awake			
Stage 1 NREM			
Stage 2 NREM			
Stage 3 NREM			
Stage 4 NREM			
REM			

BIOLOGICAL RHYTHMS

Biological rhythms are the cyclical natural rhythms our body follows in order to perform a variety of functions. Examples of biological rhythms include the sleep–wake cycle, body temperature changes, endocrine activity, the menstrual cycle and levels of alertness. Biological rhythms can be influenced by internal factors such as our internal body clock or external factors such light, noise and other environmental stimuli. Our body experiences a number of biological rhythms, including circadian rhythms and ultradian rhythms.

FIGURE 7.6 Many of our bodily processes and daily activities are controlled by innate biological rhythms.

CIRCADIAN RHYTHMS

Circadian rhythms are biological processes that roughly follow a 24-hour cycle. The term 'circadian' is derived from Latin, meaning 'about a day'. Circadian rhythms are largely endogenous, which means they are controlled by internal biological processes such as the body temperature cycle. However, circadian rhythms are also influenced by **zeitgebers** (German for 'time givers'), which are external cues that can influence cyclical changes, such as light, external temperature, noise and food.

For humans, the dominant circadian rhythm is the sleep–wake cycle. Throughout the 24-hour day, there are periods of time when we naturally feel awake, active and alert, and periods of time when we are inactive, asleep and resting. This biological circadian rhythm is largely controlled by our internal body clock and other

REM behaviour disorder A disorder whereby there is a failure of the muscle paralysis that occurs during REM sleep

biological rhythms The cyclical natural rhythms our body follows to perform a variety of functions

circadian rhythms Regular automatic physiological changes that occur during a 24-hour cycle to regulate bodily processes (e.g. body temperature)

zeitgeber An external cue such as light, temperature, noise and food that can influence biological cyclical changes biological processes. Our internal biological clock (or circadian clock) is found in the hypothalamus and is called the suprachiasmatic nucleus (SCN). The SCN is a cluster of 20 000 nerve cells found deep within the brain located just above the optic chiasm, which is where the optic nerves from the two eyes cross (see Figure 7.7). The SCN receives information from the optic nerve about light, which assists its function. At night, the lack of light stimulation activates the SCN to trigger another brain region, the pineal gland, to release a hormone called melatonin (see Figure 7.7). The pineal gland is located in the centre of the brain, between the two hemispheres, and helps regulate body rhythms and sleep cycles. Melatonin levels in the bloodstream respond to cycles of light and dark by rising at dusk and peaking around midnight. This increased production of melatonin makes us feel drowsy, which helps us to fall asleep. The higher the melatonin level, the higher the level of sleepiness. Melatonin levels then fall again as morning approaches, making it easier for us to wake up.

Although circadian rhythms are influenced by zeitgebers, they are largely endogenous because research has found that even in the absence of light humans still follow a similar sleep–wake cycle, although this circadian cycle seems to extend to roughly 25 hours in total darkness. Research has also found that when the SCN of animals has been damaged, their sleep–wake cycles become totally disrupted and disorganised.

Other disruptions to our circadian rhythms can be caused by flying across time zones, where individuals may experience jet lag, or working in shifts, with workers forced to stay awake at night and sleep during the day.

7.4 CHECK YOUR UNDERSTANDING >>

1 Circadian rhythms last:
   - A approximately 24 hours.
   - B longer than 24 hours.
   - C longer than 48 hours.
   - D less than 24 hours.

2 Distinguish between the terms ‘endogenous’ and ‘zeitgebers’.

3 Describe the most dominant circadian rhythm in humans.

4 Our internal body clock is found in the:
   - A hypothalamus.
   - B thalamus.
   - C cerebral cortex.
   - D amygdala.

5 Describe the function and location of the suprachiasmatic nucleus.

6 Which part of the human brain is responsible for the release of melatonin?
   - A The thalamus
   - B The hypothalamus
   - C The pineal gland
   - D The pituitary gland

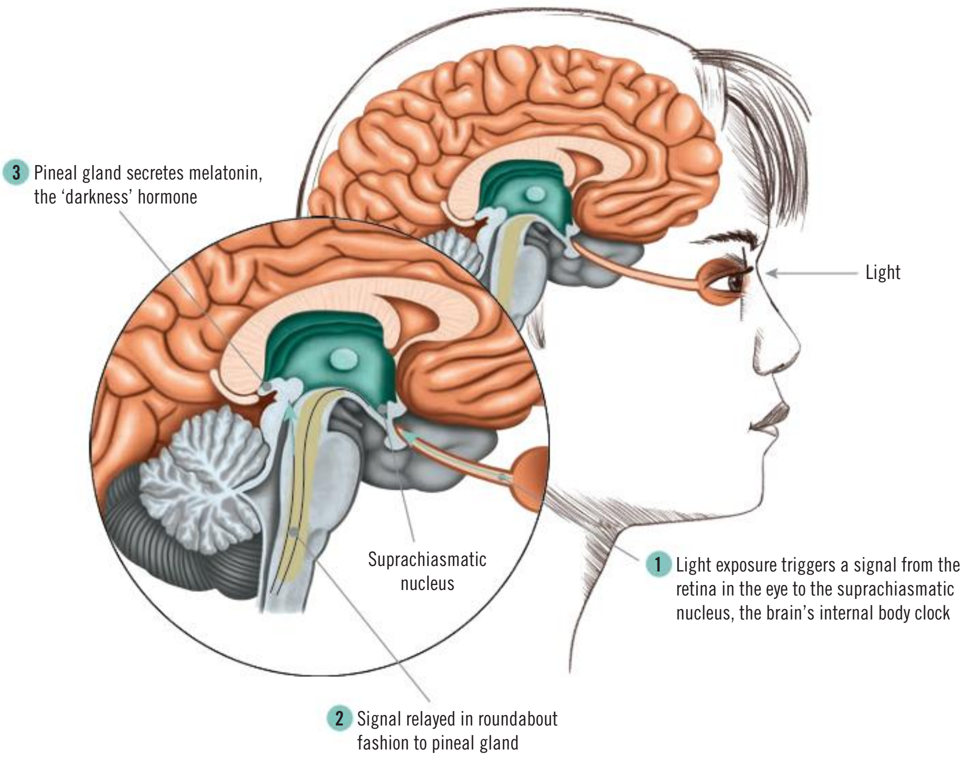

FIGURE 7.7 The suprachiasmatic nucleus and pineal gland in the human brain responding to light

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ULTRADIAN RHYTHMS

Ultradian rhythms are another example of biological rhythms our body follows, although they differ from circadian rhythms in length of time before biological cyclical changes occur. While circadian rhythms roughly follow a 24-hour cycle, ultradian rhythms are biological rhythms that follow a cycle of less than 24 hours; for example, eye-blinks, heartbeats and sleep patterns. Conversely, infradian rhythms are those that follow a cycle of longer than 24 hours, these cycles can last days or even months, such as the female menstrual cycle, which lasts approximately 28 days.

Ultradian rhythms can last 1 minute. For example, humans blink approximately 24 times in 1 minute and our heart beats approximately 60–100 times per minute. Another example of biological rhythms includes the cyclical sleep stages, where each cycle lasts approximately 90 minutes. As discussed previously, when we sleep, a number of physiological changes occur at different stages of our sleep cycle. For example, our eye movements, muscle tension and brainwaves all change cyclically throughout a typical night's sleep. The first sleep cycle, which involves Stages 1, 2, 3 and 4 NREM sleep followed by Stages 3 and 2, and then REM, makes up one ultradian cycle that lasts approximately 90 minutes. As the night progresses, this sleep cycle changes slightly, with periods of Stage 1 NREM no longer occurring; Stages 2, 3 and 4 NREM getting shorter; and stages of REM sleep getting longer. However, each cycle still lasts approximately 90 minutes, so we will typically experience five ultradian sleep cycles each night.

Some researchers also argue that ultradian rhythms can be seen when we are awake through our varying levels of alertness. Our levels of alertness, including our attention span and concentration levels, are also believed to occur in 90-minute cycles. These cycles are then followed by a period of drowsiness. This is why researchers argue that to improve our work efficiency and productivity we should have a 15 to 20-minute break every 90 minutes. After 90 minutes of high alertness we have a period of drowsiness, and if we try to push through and work through these periods it can lead to low performance.

You might be able to relate to these findings depending on the length of each period at your school. Some schools have 70-minute lessons, whereas other schools have double periods lasting 100 minutes.

During a typical lesson at your school, when does your attention span tend to wear out?

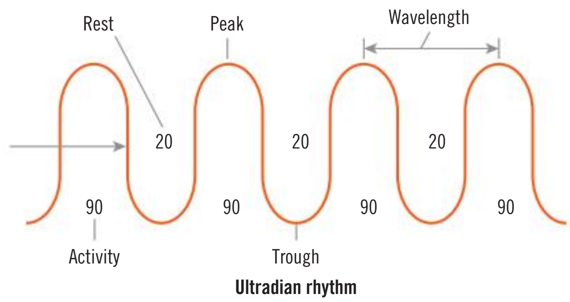

FIGURE 7.8 Levels of alertness during an ultradian rhythm cycle

TABLE 7.2 A comparison of circadian and ultradian rhythms

	Circadian rhythm	Ultradian rhythm
Definition	A biological process that roughly follows a 24-hour cycle	A biological rhythm that follows a cycle of less than 24 hours
Examples	The sleep–wake cycle	Eye-blinks, heartbeats and sleep patterns
Factors affecting this rhythm	» Internal factors such as our internal body clock through the release of hormones » External factors such as light, noise and other environmental stimuli	

7.5 CHECK YOUR UNDERSTANDING >>

1 Ultradian rhythms last:
   - A approximately 24 hours.
   - B longer than 24 hours.
   - C longer than 48 hours.
   - D less than 24 hours.

2 What are some examples of biological ultradian rhythms?

➜

hypothalamus A brain structure that activates, controls and integrates the peripheral autonomic nervous system, endocrine processes and many somatic functions, such as body temperature, sleep and appetite

suprachiasmatic nucleus (SCN) A cluster of neurons in the hypothalamus situated directly above the optic chiasm that receives information about the intensity and duration of light from the retina via the optic nerve, which it uses to regulate the body's circadian rhythms associated with the sleep–wake cycle

pineal gland A gland in the centre of the brain that secretes melatonin and helps regulate body rhythms and sleep–wake cycles

melatonin A hormone secreted by the pineal gland that causes drowsiness and helps to regulate the sleep–wake cycle

ultradian rhythm A biological rhythm that follows a cycle of less than 24 hours; such as eye-blinks, heartbeats and sleep patterns

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3 Describe why sleep cycles are considered ultradian rhythms.

4 Which of the following is not an example of a biological rhythm?

A Ultradian rhythm
B Infradian rhythm
C Circadian rhythm
D Endogenous rhythm

5 Approximately how long do our levels of alertness last?

A 30 minutes
B 60 minutes
C 90 minutes
D 120 minutes

7.2 FOCUS ON RESEARCH

DISRUPTION OF CIRCADIAN RHYTHMS DUE TO CHRONIC CONSTANT LIGHT LEADS TO DEPRESSIVE AND ANXIETY-LIKE BEHAVIOURS IN RATS

Research has shown that mood disorders such as depression are closely related to the circadian system, particularly when the circadian system is disrupted (Tapia-Osorio, Salgado-Delgado, Angeles-Castellanos, & Escobar, 2013). Long periods of artificial light, shift work and jet lag can all disrupt the circadian system as it affects the suprachiasmatic nucleus (SCN) (internal biological clock). People suffering from mood disorders such as depression also often report changes in sleep patterns.

A team of researchers (Tapia-Osorio et al., 2013) was interested in determining whether circadian disruption, caused by long-term constant light, would lead to depressive symptoms in rats and whether these symptoms are related to altered activity of the SCN. To carry out this study, researchers used a group of rats and separated them into three groups. One group of rats was exposed to regular light and dark conditions across a 24-hour cycle, one group was exposed to constant darkness for 24 hours a day, and one group was exposed to constant artificial light for 24 hours. All conditions lasted for 8 weeks. Baseline behaviours of the rats were recorded before the experimental condition took place and were then compared with behaviours at the conclusion of 8 weeks. Following the 8 weeks, rats were tested on their general behavioural activities, levels of pleasure and the neuronal activity of the SCN. Results found that rats in the constant light group experienced anhedonia (inability to feel pleasure), which was measured using a sucrose consumption test where rats showed a significantly reduced consumption of sucrose indicating a depressive-like state. These rats were also prone to increased grooming, suggesting an anxiety response. Higher levels of corticosterone (stress hormone in animals) and lower body weight also indicated a depressive-like state. When comparing the circadian rhythms of all three groups, rats in the control group's cycle remain rhythmic; rats in the dark group did not express any major disruption in rhythmic activity, with a cycle generally lasting longer than 24 hours; rats in the light group, however, reported a major disruption in rhythmic activity, with rats following an ultradian rhythm of activity approximately every 4 hours. Researchers concluded this was due to the changes in neural activity in the SCN.

QUESTIONS

1 What was the aim of this study?

2 Identify the control group and the experimental groups in this study.

3 How were the rats' circadian rhythms affected by the different exposure to light?

4 Write a conclusion for this study.

7.3 TRY IT YOURSELF >>

ANALYSE YOUR SLEEP CYCLE USING YOUR SMARTPHONE

Ever wondered what your sleep patterns are like? How much time you spend in REM and NREM sleep? How many times you wake up throughout the night? You can analyse your sleep cycle without spending a night in a sleep laboratory. To do this you will need to download a sleep cycle app on your smartphone. Here are two of the free ones available:

» SleepTime smart alarm clock (Android)
» Sleep Cycle alarm clock (iPhone and Android).

Once you have the app on your phone, open the application before you are about to go to bed and set an alarm for the time you have to wake up in the morning. Once this is done the application should alert you to place your phone underneath your pillow so it can detect any movements you make throughout the night. When you wake up in the morning the application should present you with your sleep data to analyse. You might like to use the app two nights in a row and then compare the results, or you might like to compare your sleep data with one of your classmates. The data you should be able to analyse includes how many hours you slept, the proportion of time spent in REM and light sleep, and the number of times you woke up. With this data, answer the following questions.

QUESTIONS

1 Were there any factors affecting your sleep pattern that night? (For example, stress, activities before bed)

2 Did you spend the correct proportion of sleep in REM sleep during the night?

3 How does your sleep compare with that of your classmates? Explain.

4 Did you get the required amount of sleep? If not, how many hours sleep deprived are you and what effects (if any) did this have on you during the day?

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THE PURPOSE OF SLEEP

We know that we have an innate biological need for sleep. But why is this so? There are two main theories that seek to explain the purpose of sleep. Some theorists believe that sleep helps to restore and replenish the mind and body, while others say it helps with survival.

RESTORATION THEORY

The restoration theory suggests that sleep is vital for replenishing and revitalising the physiological and psychological resources depleted by our waking activities, therefore sleep keeps the mind and body functioning at an optimal level. If this restoration did not happen, then the functioning of the brain and body would gradually break down.

This theory suggests that NREM sleep is essential for the restoration of the body, including repair of muscle and tissue damage and detoxification of muscles. It also suggests that REM sleep is essential for the restoration of mental processes, allowing the brain time to regenerate and refocus.

NREM sleep: Restoring, repairing and revitalising the body

The restoration theory suggests that NREM sleep is essential for the restoration of biological processes, such as restoring hormone levels depleted by daytime activity, repair of muscles and tissue that may have been damaged as a result of daytime activity, and detoxification of muscles. Because we feel tired when we go to sleep and refreshed when we wake, supporters of this theory suggest that this indicates NREM sleep revitalises us. They also point out that many physiological activities (for example, brain neuron activity, heart rate and muscle tension) slow down during NREM sleep, indicating that sleep is the time when the body gains the vital rest it needs in order to function. In addition, they claim that because many of the major restorative functions in the body such as muscle growth and detoxification, tissue repair and growth hormone release occur during NREM sleep, particularly during deep, slow-wave sleep, that this suggests that NREM sleep is necessary so the body can physically rest, repair and grow. This claim is supported by studies of people who suffer the effects of sleep deprivation. These studies indicate that lack of adequate sleep weakens our immune system, thus we become more susceptible to illness and disease (Ackermann et al., 2012).

Supporters of the restoration theory of sleep also propose that children and young people (who are generally more physically active during the day than older people) spend a larger portion of their sleep in slow-wave sleep than older people because NREM sleep restores the body and replenishes energy. In recent years, these ideas have gained support from empirical evidence collected in human and animal studies. The most striking of these is that animals deprived entirely of sleep lose all immune function and die in just a matter of weeks.

Evidence in support of the restorative purpose of NREM sleep stems from research conducted into the amount of time that individuals who partake in strenuous physical activity (such as marathon runners) spend in NREM sleep. It has been found that after completing vast amounts of physical exercise, the amount of NREM sleep, particularly Stages 3 and 4, increases during that night's sleep, and continues to stay above average on subsequent nights following the activity.

One study conducted by Dworak et al. (2008) investigated the effects of moderate and high-intensity physical exercise on sleep patterns in school-aged children. Eleven healthy children (11–13 years old) were recruited for the study. They underwent two exercise sessions on a bicycle ergometer. The sessions were performed 3 to 4 hours before bedtime, lasted 30 minutes, and varied in intensity. The moderate-intensity exercise was at 65–70 per cent of maximal heart rate, while the high-intensity exercise was at 85–90 per cent of maximal heart rate. The results demonstrated that only high-intensity exercise resulted in a significantly elevated slow-wave sleep proportion and less time spent in Stage 2 sleep. The results therefore suggest that exercise intensity is responsible for the effects on slow-wave sleep in children (Dworak et al., 2008). However, one criticism of the restorative theory is that people who are bedridden (and therefore get no physical activity) still experience the same amount of NREM sleep as non-bedridden individuals who undertake average amounts of activity.

restoration theory A theory that states that sleep is vital for replenishing and revitalising the mind and body to keep them functioning at optimal levels

ISBN 9780170365628

FIGURE 7.9 The restoration theory suggests that because we feel tired when we go to sleep and refreshed when we wake, NREM and REM sleep are essential for the restoration, repair and revitalisation of the body and the mind.

REM sleep: Restoring, repairing and revitalising the mind

The restoration theory suggests that REM sleep is essential for the restoration (or renewal) of mental processes because it allows the brain time to replenish itself, regenerate and refocus. Supporting evidence for this comes from the amount of time we spend in REM sleep over our lifespan. During our life, the amount of time spent in REM sleep is greatest during periods of development, such as infancy, when the brain is growing rapidly or undergoing reorganisation. For example, newborn babies typically spend 8 to 9 hours a day – approximately 50 per cent of their total sleep time – in REM sleep. In adulthood, when the brain is fully developed, REM sleep only occupies approximately 20 per cent of our sleep time. Supporters of the restoration theory suggest that this reduction in time spent in REM sleep as we age indicates that REM sleep provides the neural stimulation necessary for the brain to develop neuronal circuits early in life.

The decrease in the amount of time spent in REM sleep also supports the restorative theory, because it explains that as we age we are not learning as much new information, so the need for REM sleep also decreases. Further evidence to support this theory stems from research that shows that during periods of high mental stress and emotional problems there is an increase in the amount of REM sleep an individual experiences.

Psychologists also believe that REM sleep plays a vital role in memory, particularly in the formation and consolidation of memories. Consolidation is the memory process that transfers new short-term memories into more permanent long-term memories. Memory processes are discussed in detail in Chapter 5.

Research into total sleep deprivation, whereby individuals have experienced constant wakefulness over a temporary period of time, lends some support to the restoration theory. This can be seen in the case of Peter Tripp (see Chapter 6), a New York DJ who volunteered to take part in a sleep deprivation study in 1959, and stayed awake for 8 days. During this time, Tripp experienced abnormal behaviours such as delusions and hallucinations. Tripp's experience supports the idea that the purpose of sleep is to restore the brain and body so that it functions efficiently, because being deprived of sleep brings about adverse and potentially dangerous side effects.

FIGURE 7.10 The restorative functions of REM and NREM sleep

7.6 CHECK YOUR UNDERSTANDING >>

1 According to the restoration theory of sleep what is NREM sleep responsible for?

2 What stages of NREM sleep are particularly important for restorative functions such as muscle growth, tissue repair and growth hormone release?

A Stage 1 NREM

B Stage 2 NREM

C Stages 1 and 2 NREM

D Stages 3 and 4 NREM

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3 Provide three research examples that support NREM's restorative functions.

4 According to the restoration theory of sleep what is REM sleep responsible for?

5 Describe the supporting evidence that highlights REM's restorative functions.

6 Psychologists believe that REM sleep plays a vital role in:

A memory consolidation.

B tissue repair.

C muscle detoxification.

D hormone release.

EVOLUTIONARY THEORY

The evolutionary theory (or circadian or adaptive theory) of sleep suggests that we undertake periods of inactivity, or sleep, when we do not need to engage in activities that are important to our survival.

The evolutionary theory takes into consideration the amount of time an animal needs to stay awake in order to complete the activities required for their survival, such as hunting and eating. According to this theory, the remaining hours of the day are best spent asleep, because sleep does not expend much energy and also keeps the animal out of sight of predators. For example, large grazing animals such as elephants and cows need to consume a lot of calories to obtain the energy they need to live. As the type of food (vegetation) they eat contains few calories, they must consume a lot of it to meet their requirements, and this consumption takes time. For example, it is thought that this is why elephants only sleep 3–4 hours a day because it is all they have time for. If elephants slept for 8 hours a day, they probably wouldn't have enough wake time for all their necessary activities and requirements (Dworetzky, 1997).

Smaller animals such as bats and possums do not need to consume very much food in order to meet their calorific requirements, so they need few waking hours to eat and conduct other activities necessary for survival. They spend approximately 20 out of 24 hours asleep.

As adult humans, we need approximately 16 waking hours to sustain our lifestyle. Therefore, we spend an average of 8 hours sleeping per day. Figure 7.12 compares the sleeping times of various animals.

FIGURE 7.11 Koalas sleep for approximately 20 hours a day or more. Because the eucalyptus leaves they eat do not provide a great deal of nourishment, koalas need to conserve their energy. Sleeping for extended periods allows them to slow their metabolism and maintain their energy levels.

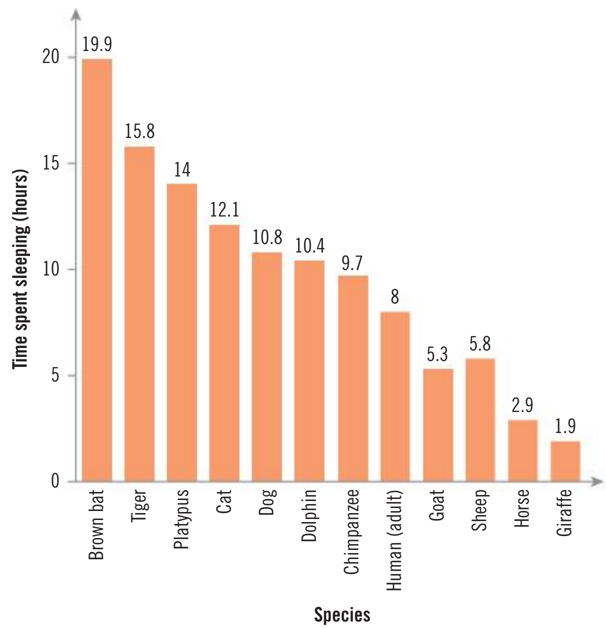

FIGURE 7.12 The amount of sleep required by different species of animals

evolutionary theory A theory that suggests that we have periods of inactivity, or sleep, when we do not need to engage in activities important to our survival

Another facet to the evolutionary theory is the proposal that sleeping actually protects animals from attack. When an organism is asleep, it is not moving, and is therefore less likely to attract the attention of predators than when it is awake. So, in this way, sleep protects the organism from harm.

Small animals usually have the greatest number of predators and are therefore in danger much of the time. However, one criticism of the evolutionary theory is that if small animals sleep a lot, they are left defenceless and are more vulnerable to attack. One of the activities necessary for survival is the simple act of staying alive; therefore, if an animal is small and has many predators, its best chance of survival is to be on guard and watching for potential threats – not to be asleep. Criticisms of the evolutionary theory therefore state that if the theory relates to conducting activities important for survival, then small animals with many predators should spend most of their hours awake rather than asleep. Table 7.3 compares the two theories that seek to explain the purpose of sleep.

Animal sleep patterns

Some interesting facts about other species' sleep patterns:

- All mammals experience REM and NREM sleep. Birds do as well, but their cycles are shorter.
- Small mammals sleep for 10 to 20 hours a day, whereas large mammals sleep for 2 to 10 hours a day.
- Brown bats are the champion sleepers, needing almost 20 hours a day, while giraffes get by on only 2 hours a day.
- Hippopotami sleep under the water and then wake up to go to the surface to breathe.
- Dolphins keep one half of their brain awake so they are always only half asleep and can keep on swimming while sleeping.
- Horses lock their knees into the standing position so they don't fall over while they sleep.
- Elephants and rhinoceroses cannot sleep lying on their sides for too long because they would drown from the fluid entering their lungs. This is due to the pressure of their bulky bodies. (Zoofriends, 2007)

7.7 CHECK YOUR UNDERSTANDING >>

1 Which of the following does not relate to the evolutionary theory of sleep?
  A We sleep in order to remain inactive.
  B We have periods of sleep and wakefulness in order to carry out activities that are essential for survival.
  C It is safer for us to be asleep so we do not attract attention from predators.
  D We sleep in order to restore and replenish our brains and bodies.

2 Describe why the sleep–wake cycle of an elephant is a good example to support the evolutionary theory of sleep.

3 How many hours do adults need to be awake to sustain their lifestyle activities necessary for survival? Do you believe this amount of time is sufficient?

4 Explain the criticisms of the evolutionary theory of sleep.

5 Which animal needs the least amount of sleep?
  A Chimpanzee
  B Giraffe
  C Dog
  D Cat

TABLE 7.3 Comparison of the two theories of sleep

Theory	Explanation	Evidence for theory	Criticisms of theory
Restoration theory	A theory that states that sleep is vital for replenishing and revitalising the mind and body to keep them functioning at optimal levels	Research shows that following vigorous activity there is an increase in NREM sleep as the body needs more replenishing. Similarly, we experience longer periods of REM after being deprived of REM sleep.	This theory has been criticised because, while dreaming, the brain is active when it is supposed to be conserving energy. People that are not active (bedridden) experience as much NREM sleep as active individuals.
Evolutionary theory	A theory that suggests that we have periods of inactivity, or sleep, when we do not need to engage in activities important to our survival, and animals that are sleeping are less likely to be attacked	Animals that have few physical needs sleep for longer than animals with greater physical needs.	One of the activities necessary for survival is the simple act of staying alive. Small animals with many predators should therefore stay awake – not be asleep – for much of the day so they can be alert to attack.

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SLEEP–WAKE CYCLE ACROSS THE LIFESPAN

As discussed earlier in this chapter, the need for sleep is innate. The amount of sleep that is needed across the lifespan and patterns of sleep, however, varies with age. Generally, the older we get the less sleep we require and the less time we spend in REM sleep. Although recommended hours of sleep are suggested for each age group, the need for sleep will depend on individual differences and may vary among two people of the same age.

NEWBORNS AND INFANTS

When we are infants, the world is full of new and exciting things. There are things to discover and explore and, as a result, our brain is making many new meaningful connections. On average, newborn babies sleep for approximately 16 hours a day, and 50 per cent of their sleep time is spent in REM sleep. This is supportive evidence for the restorative theory, which would suggest that babies need a lot of REM sleep to help replenish the mental processes they exhaust when learning information during the day. Another explanation as to why babies need so much REM sleep is because it is believed that newborn babies lack the capacity for long, deep NREM sleep; a capacity that only develops with brain maturation during childhood and adolescence (Hobson, 2001). By the end of infancy the amount of sleep drops to 12–13 hours with the proportion of sleep in REM also dropping.

CHILDREN

Children require on average 10–11 hours of sleep with the amount spent in REM dropping to approximately 20–25 per cent. It is normal for children to continue napping in the day until the age of 3 to 5. If a child still requires daytime naps after the age of 5, this may indicate they are not getting enough sleep at night.

ADOLESCENTS

During adolescence the need for sleep drops again to approximately 9 hours, with 20 per cent consisting of REM sleep and 80 per cent consisting of NREM sleep. Following adolescence, the amount of time spent in REM and NREM stabilises throughout the lifespan. Many adolescents do not always get the required 9 hours of sleep a night, and this may be due to their busy lives, trying to juggle school, work and social commitments. It could also be due to a natural sleep–wake cycle shift that prevents adolescents from feeling tired until late in the evening. This shift is discussed in more detail in Chapter 8.

ADULTS

The need for sleep in adults drops again to approximately 7–8 hours a night, with 20 per cent of this spent in REM sleep. Adults also often report not always getting the required hours of sleep because of their busy lifestyles. As mentioned earlier, while some adults sleep 6 hours a night without experiencing any negative effects of sleep deprivation, others may require 8–9 hours of sleep to function effectively. This is due to the variability in individual sleep requirements.

ELDERLY

As people enter old age, they sleep less than they did earlier in life – approximately 6 hours on average. Only 20 per cent of their sleep time is spent in REM sleep. As people move into old age they will also report waking more frequently throughout the night and they spend less time in Stages 3 and 4 NREM (deep sleep).

If you are unsure whether you are getting the required amounts of sleep each night you should consider how you feel and function throughout the day. If you feel well rested, energetic and alert during the day, then the sleep you are getting is likely to be adequate, even if it is below the recommended hours of sleep for your age group. Alternatively, if you are experiencing fatigue, irritability or concentration problems you may want to revise your sleep habits to improve your sleep quality. On the following page are some suggestions on how to do this.

See Table 7.4 for a comparison of sleep across the lifespan. The percentage of time spent in NREM and REM sleep across the lifespan is shown in Figure 7.13.

TABLE 7.4 Sleep across the lifespan

Age	Amount of sleep required	Proportion of time spent in NREM sleep	Proportion of time spent in REM sleep
Newborn	16 hours	50%	50%
Child	10–11 hours	75–80%	20–25%
Adolescent	9 hours	80%	20%
Adult	7–8 hours	80%	20%
Elderly	6–7 hours	80%	20%

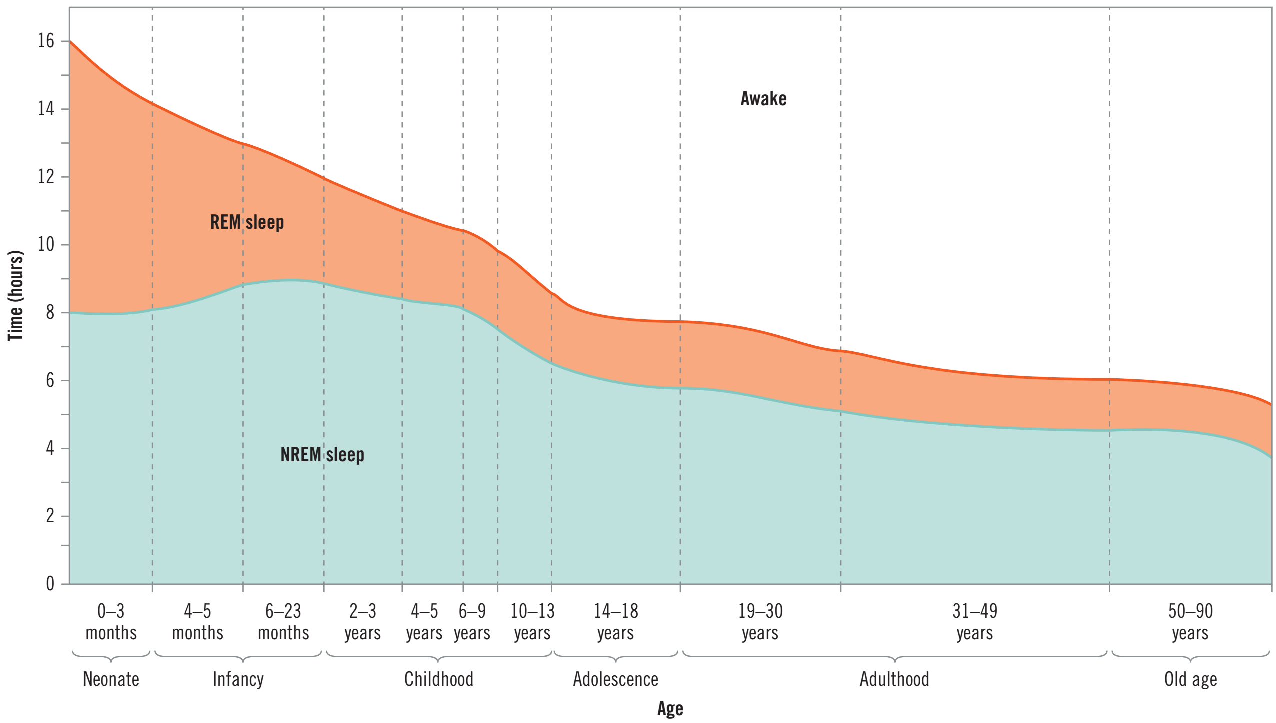

FIGURE 7.13 The amount of time we spend asleep decreases as we age, as does the percentage of time spent in REM sleep. (Graph not to scale)

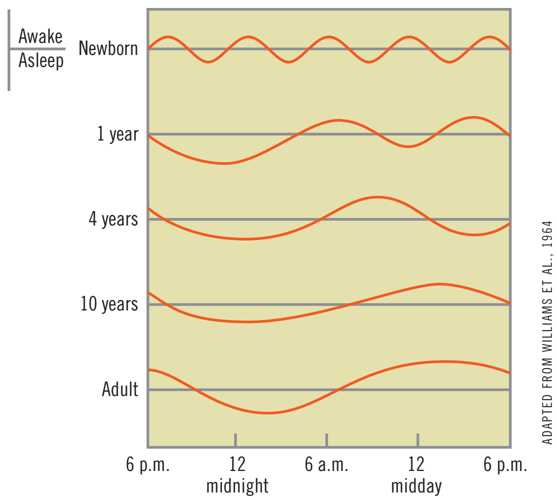

FIGURE 7.14 The development of sleep patterns, showing sleep cycles from infancy to adulthood

Complaints of poor-quality sleep or insufficient amounts of sleep are common due to our busy lifestyles. This is especially so for adolescents who try to maintain a balance between the demands of school, work, sport and social commitments. The following are some tips to try to ensure sleep comes easily (see Figure 7.15).

- Make sleep a priority; don't skimp on the amount of sleep required just to fit in other activities.
- Regularise your sleep cycle; go to bed and wake up at the same time every night/morning.
- Don't go to sleep unless you are tired; this may lead to shallow or fragmented sleep.
- Manage your stress; wind down both physically and mentally.
- Have a relaxed atmosphere in the bedroom.
- Don't drink caffeine within 6 hours of bedtime.
- Stop smoking.
- Exercise before dinner time (Reid, 2008).
- Avoid screen time before bed (see Focus on research 7.3 for more information on how screen time affects sleep).

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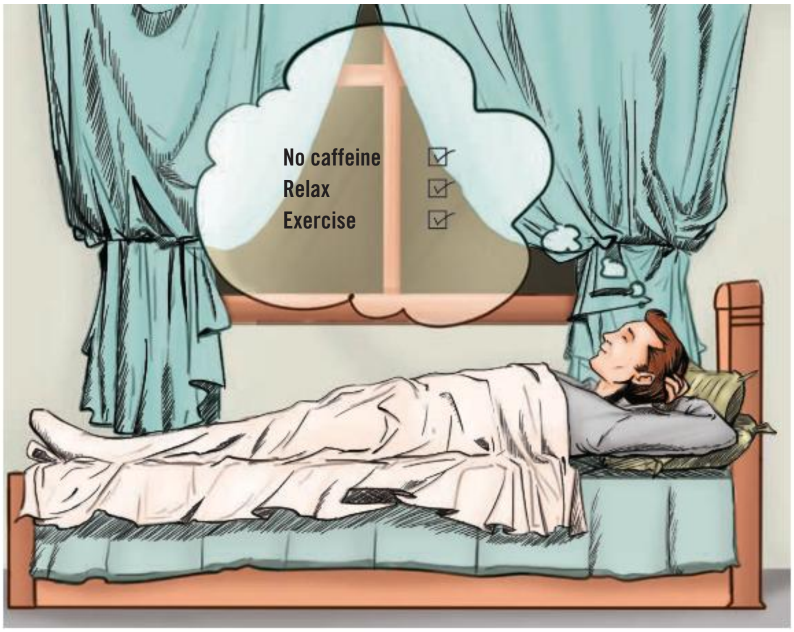

FIGURE 7.15 There are many tips to help ensure sleep comes easily.

FOCUS ON RESEARCH

7.3

SCREEN TIME AND SLEEP AMONG SCHOOL-AGED CHILDREN AND ADOLESCENTS: A SYSTEMATIC LITERATURE REVIEW

Screen time refers to the amount of time spent in front of an electronic device with a 'screen'. Some of these devices include mobile phones, gaming consoles, televisions and computers. The Australian guideline for the amount of screen time for children aged 2–18 years is no more than 2 hours a day. Children who spend less than 2 hours in front of a screen each day may be less likely to be overweight, engage in more positive social interactions, and have improved school performance and sleep patterns. The Australian Health Survey on Physical activity in 2011–12 revealed that children and adolescents (aged 5–17 years) spent more than 2 hours a day on a screen-based activity, with physical activity decreasing and screen-based activities increasing as age increased (Australian Bureau of Statistics, 2013).

One study conducted by Hale and Guan (2015) compared 67 studies conducted between 2009 and 2014 investigating the relationship between sleep outcomes and screen time among adolescents and school-aged children. The analysis revealed that screen time was adversely related to sleep outcomes. In 90 per cent of the studies, increased screen time led to poorer sleep patterns, including delayed sleep time and shortened duration of sleep. Researchers concluded that young people should be limiting their screen time, especially near their bedtime, to prevent a disruption to their sleep patterns and general wellbeing.

QUESTIONS

1 How many hours per day do you spend in front of a screen? Is this above or below the recommended time per day?

2 What was the aim of this study?

3 What can be said about the reliability of the studies that were reviewed?

4 What did researchers conclude based on the findings of this study?

7.8 CHECK YOUR UNDERSTANDING

1 As we progress through the lifespan:

A the amount of time spent in REM increases.

B the amount of sleep needed increases.

C the amount of time spent in NREM sleep increases.

D the amount of time spent in NREM sleep decreases.

2 Describe the sleep patterns of newborns and how this changes when a newborn reaches infancy.

3 What is one reason why newborns spend so much time in REM sleep?

A Newborns need to dream a lot.

B Newborns require the mental replenishment that REM sleep provides.

C Newborns require the physical replenishment that REM sleep provides.

D Rapid eye movement helps newborns grow.

4 Children require approximately __________ hours of sleep, with __________ of that time spent in REM sleep.

A 9–10; 40 per cent

B 10–11; 20 per cent

C 10–11; 20–25 per cent

D 9–10; 20–25 per cent

5 Describe the similarities and differences between the sleep patterns of adolescents and adults.

6 How are the sleep patterns of elderly people different compared to any other stage of the lifespan?

7 What are some of the reasons why adolescents often report feeling sleep deprived and what can be done to help adolescent sleep quality?

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CHAPTER SUMMARY

What is sleep?

- Sleep is an innate biological rhythm essential for survival.
- There are two basic sleep states: rapid eye movement (REM) sleep and non-rapid eye movement (NREM) sleep. REM sleep is strongly associated with dreaming.
- NREM sleep occurs in four stages.
- Stage 1 NREM is a light sleep characterised by hypnic jerks and a relaxed brain.
- Stage 2 NREM is also considered a light stage of sleep. In this stage the muscles and brain relax further. Sleep spindles and K-complexes uniquely occur during this stage.
- Stages 3 and 4 NREM are deep sleep. This type of sleep is characterised by a slowing of physiological functions.
- REM sleep is characterised by an increase in physiological functions, because the brain is in a state of arousal and eyes move rapidly beneath the eyelids; however, at the same time there is complete muscular paralysis (atonia).
- During a night's sleep we cycle through all stages of NREM and REM sleep. Each cycle lasts approximately 90 minutes, with periods of NREM decreasing as the night progresses and periods of REM increasing.
- Most sleep research takes place in a sleep laboratory, which is a controlled environment that enables the electronic recording and measurement of sleep. Recording devices in a sleep laboratory include the electroencephalograph, electromyograph, electrooculograph and electrocardiograph. Self-report measures will also be used.

Biological rhythms

- Biological rhythms involve the cyclical natural rhythms our body follows in order to perform a variety of functions. Circadian rhythms and ultradian rhythms are two examples of such rhythms.
- Circadian rhythms are biological processes that roughly follow a 24-hour cycle. They are influenced by both internal and external factors.
- The sleep–wake cycle is an example of a circadian rhythm that is largely controlled by our internal biological clock, which is called the suprachiasmatic nucleus (SCN).
- The SCN is a cluster of nerve cells found deep within the brain that helps us decipher day and night to enable us to feel awake or sleepy by triggering other brain structures, such as the pineal gland, to release hormones.
- The pineal gland releases the hormone melatonin, which makes us feel drowsy and therefore helps us to fall asleep. It knows when to release melatonin by responding to light or dark environmental cues.
- Ultradian rhythms are biological rhythms that follow a cycle of less than 24 hours; for example, eye-blinks, heartbeats and sleep patterns.
- The cyclical sleep stages are ultradian rhythms because each cycle lasts for approximately 90 minutes. When we sleep, a number of physiological changes occur at different stages of our sleep cycle, such as eye movements, muscle tension and brainwaves patterns. Each sleep cycle consists of NREM and REM stages of sleep.

The purpose of sleep

- The restoration theory of sleep suggests that sleep is vital for replenishing and revitalising the mind and body. NREM sleep is essential for the restoration of the body and REM sleep for the restoration of the mind.
- The evolutionary theory of sleep suggests that a species sleeps at times when it does not need to conduct activities necessary for its survival.

The sleep–wake cycle

- As we age, our need for sleep reduces and we spend less time in REM sleep.
- Newborn babies require 16 hours of sleep a day, with approximately 50 per cent of this time spent in REM sleep.
- Adolescents require 9 hours of sleep a day and adults 7–8 hours, with approximately 20 per cent of this time spent in REM sleep.
- The elderly sleep, on average, 6 hours a night, with approximately 20 per cent of this time spent in REM sleep.
- The elderly often report frequent waking during the night.

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APPLY YOUR KNOWLEDGE AND SKILLS

SECTION A: MULTIPLE-CHOICE QUESTIONS

Answer the following questions by writing the correct letter in your workbook. Only one answer is correct for each question.

1 Sleep is an example of:
- **A** normal waking consciousness.
- **B** an altered state of consciousness.
- **C** paradoxical consciousness.
- **D** hypnogogic consciousness.

2 Beta waves are found during:
- **A** deep sleep.
- **B** light sleep.
- **C** hypnosis.
- **D** normal waking consciousness.

3 As a person progresses through the stages of NREM sleep:
- **A** the muscles jerk frequently.
- **B** dreaming becomes more common.
- **C** the brain is in a more relaxed state.
- **D** the eyes begin to move rapidly beneath the eyelids.

4 The transition between wakefulness and sleeping is known as:
- **A** a hypnic jerk.
- **B** a hypnogogic state.
- **C** an REM rebound.
- **D** a paradoxial sleep.

5 Circadian rhythms are influenced by:
- **A** internal processes only, such as the release of hormones.
- **B** external processes only, such as how much light or noise is in the environment.
- **C** both internal and external processes.
- **D** the role of the suprachiasmatic nucleus.

6 During what stage of sleep does atonia occur?
- **A** Stage 2 NREM
- **B** Stage 3 NREM
- **C** Stage 4 NREM
- **D** REM

7 The hormone that is released by the brain to make us feel sleepy is:
- **A** serotonin.
- **B** melatonin.
- **C** dopamine.
- **D** acetylcholine.

8 Which of the following is not an example of an ultradian rhythm?
- **A** Heartbeats
- **B** Eye-blinks
- **C** Sleep patterns
- **D** Sleep–wake cycle

9 Craig was having problems sleeping, and spent a night in a sleep laboratory on his doctor's suggestion, so that his brainwaves could be measured. Craig took a long time getting to sleep, but he finally fell into a deep sleep. The doctor used a device called __________ to determine Craig's brainwave activity. When Craig was in the deep sleep, his brainwaves became __________ in terms of their frequency.
- **A** an EMG; faster
- **B** an EEG; slower
- **C** an ECG; slower
- **D** an ECG; faster

10 Craig's doctor also measured his muscle movement. He found during one stage of sleep Craig's muscles were jerking. Craig's doctor used the __________ to measure his muscles; when he experienced jerking it was likely he was in __________.
- **A** EMG; Stage 1 NREM
- **B** EOG; Stage 2 NREM
- **C** EOG; Stage 1 NREM
- **D** EMG; Stage 2 NREM

11 Which brainwaves are characteristic of Stage 1 NREM sleep?
- **A** Beta waves
- **B** Sleep spindles
- **C** Alpha and theta waves
- **D** Delta waves

12 What stage of sleep typically has sleep spindles?
- **A** Stage 1
- **B** Stage 2
- **C** Stage 3
- **D** Stage 4

13 Lexi is 17 years old and has gone to a sleep clinic because she is having difficulty sleeping at night. How much sleep would the staff at the clinic recommend Lexi gets each night?
- **A** 16 hours
- **B** 12 hours
- **C** 9 hours
- **D** 4 hours

14 The belief that REM sleep replenishes the mind and NREM sleep replenishes the body is the basis of the __________ theory of sleep.
- **A** adaptive
- **B** survival
- **C** evolutionary
- **D** restoration

15 As we age, our sleep patterns alter. It would be true to say that as age increases:
- **A** the amount of REM and NREM sleep becomes equal.
- **B** the amount of REM sleep decreases and the amount of NREM sleep increases.
- **C** the amount of REM sleep increases and the amount of NREM sleep decreases.
- **D** the amount of NREM sleep decreases and the amount of REM sleep increases.

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SECTION B: SHORT-ANSWER QUESTIONS

1 Describe the EEG recordings of a person as they progress through the different stages of sleep.

2 Give one reason why REM sleep is sometimes referred to as paradoxical sleep.

3 Explain how an electromyograph (EMG) and an electrooculograph (EOG) could indicate whether an individual was experiencing REM sleep.

4 Provide three differences between REM and NREM sleep.

5 Explain the occurrence of dreams in both REM and NREM sleep.

6 Compare and contrast circadian rhythms and ultradian rhythms.

7 Compare the restorative functions of REM and NREM sleep.

8 Describe two arguments that support the evolutionary theory of sleep.

9 Describe two differences between the sleep patterns of a newborn and an elderly person.

10 Describe two differences between the sleep patterns of an adolescent and an adult.

SECTION C: EXTENDED-RESPONSE QUESTION

Dr Mim is interested in testing the effectiveness of a new drug she created that aims to treat people suffering from REM behaviour disorder. The drug induces muscle paralysis during REM sleep, which enables sufferers to sleep without the threat of acting out their dreams and potentially harming themselves or others. A total of 30 research participants were recruited from the Epworth Sleep Centre database for patients who had been admitted to the sleep centre and diagnosed with REM behaviour disorder within the last 12 months. Participants all gave informed consent before the experiment took place. The first 15 participants to consent to the study were placed in the experimental group. These 15 participants were to take the drug each night 1 hour before they went to bed for 2 weeks. The other 15 participants were placed in the control group. They were to take a placebo drug each night 1 hour before they went to bed for 2 weeks. Participants did not know whether they were receiving the real treatment or the fake treatment. For the first 11 days of the study participants were required to keep a sleep diary reporting their sleep patterns and night-time disturbances (if any). On the 12th night, all participants spent the night in the sleep laboratory and their sleep was measured using the EEG, EMG and EOG. Results of the study revealed participants in the experimental group reported fewer night-time disturbances in their sleep diaries. EMG recordings also found little to no activity when participants were in REM sleep compared to participants in the control group.

You are now required to write two parts of a psychological report: an introduction section that includes the variables being tested in operationalised terms and a research hypothesis. You also need to write a discussion section that identifies the experimental design used, including its limitations, any extraneous variables present in the study, and suggested improvements and a conclusion.

This question is worth 10 marks.

SECTION D: ASSESSMENT TASK

You are required to create an informative pamphlet for people who will be spending a night in a sleep laboratory. In the pamphlet you should include:

- an overview on what to expect during a night spent in a sleep laboratory, with reference to some of the devices sleep scientists may use to measure their sleep
- an overview of what sleep scientists will be looking for during each stage of sleep. This should include a description of the physiological occurrences during REM sleep and Stages 1–4 NREM
- an explanation of the sleep cycle, including how many a person should progress through each night
- how many hours of sleep are required across the lifespan.

Present your pamphlet with images, charts and diagrams to make it appealing and easy to understand for the reader.

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CHAPTER 08

SLEEP DISTURBANCES AND TREATMENTS

ISTOCKPHOTO/VICTOR TONGDEE

KEY KNOWLEDGE INCLUDES:

- changes to a person's sleep–wake cycle and susceptibility to experiencing a circadian phase disorder, including sleep–wake shifts in adolescence, shift work and jet lag
- the effects of partial sleep deprivation (inadequate sleep either in quantity or quality) on a person's affective (amplified emotional responses) behavioural and cognitive functioning
- the distinction between dysomnias (including narcolepsy and sleep-onset insomnia) and parasomnias (including sleep apnoea and sleepwalking) with reference to the effects on a person's sleep–wake cycle
- the interventions to treat sleep disorders including cognitive behavioural therapy (with reference to insomnia) and bright light therapy (with reference to circadian phase disorders).

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SLEEP

At some time in their life, most people have difficulty sleeping. This is a normal response to a range of factors such as stress and illness. Once these factors have disappeared, most people return to their typical sleeping pattern, which is characterised by normal NREM–REM sleep cycles. However, if their sleeping pattern is regularly disturbed over a prolonged period of time their sleep–wake cycle may become unbalanced. If this imbalance causes the person distress or interferes with their ability to carry out their normal daily activities, their sleep problem may have developed into a sleep disorder. **Sleep disorders** are a group of syndromes characterised by a disturbance in a person's amount, quality or timing of sleep, or in behaviours or physiological conditions associated with sleep. Sleep disorders interfere with normal physical, mental and emotional functioning because they disrupt normal restorative sleep.

To be diagnosed with a sleep disorder, the sleep problem must be persistent and cause the person significant emotional distress as well as interfere with their social or occupational functioning.

FIGURE 8.1 There's only one cure for insomnia ...

SLEEP–WAKE CYCLE: A CIRCADIAN RHYTHM

The **sleep–wake cycle** refers to the rhythmic biological pattern of alternating sleep with wakefulness over a 24-hour period. For human adults, this cycle typically equates to 8 hours of night-time sleep and inactivity, and 16 hours of daytime wakefulness and activity. The sleep–wake cycle, like many human biological processes, is controlled by circadian rhythms (from the Latin *circa* meaning 'about or around' and *dies* for 'a day'). The main environmental stimulus that synchronises these rhythms to a 24-hour day is light.

Circadian rhythms consist of regular automatic physiological changes that occur during a 24-hour cycle that regulate a person's chemical and hormonal production and metabolism. Circadian rhythms are primarily affected by the amount of light in a person's environment and they operate like an internal biological clock, or 'body clock', that adjusts a range of physical, mental and behavioural processes. These include body temperature, brain wave activity, alertness level, appetite, hormone secretion, blood temperature, pulse rate as well as sleep and wakefulness timing. These rhythmical processes are coordinated with the environmental changes that occur during a 24-hour day–night cycle to allow for high activity during the day and low activity at night. For example, body temperature automatically rises as dawn approaches, peaks during the day when we feel more energised, dips in early afternoon, and drops before we go to sleep at night. This regulation of physiological activity is important for maintaining homeostasis because it keeps our body working and resting when it needs it. Our body clock tells us when to wake up and when to sleep, and it has to be set daily. This is because the length of a day (or period of day light) changes over the course of a year as the seasons change.

Research indicates that for most humans the circadian rhythms are slightly longer than 24 hours, so precise synchronisation to a 24-hour day depends on exposure to environmental time signals, most importantly, the solar light–dark cycle. When these light signals are absent (for example, when people are kept in the dark), circadian rhythms typically 'free-run' on a 25-hour cycle. This suggests that if our circadian rhythms are to maintain normal synchronisation with a 24-hour day–night cycle, the suprachiasmatic nucleus (SCN) must reset itself daily by making regular adjustments to changes in environmental timing cues, such as changes in the amount of external light (Dijk & Lockley, 2002). These timing cues can also come in the form of exposure to other cues associated with the daily sleep–wake cycle, such as an alarm clock, an evening bath or pre-sleep habits. The body's circadian rhythms may be altered by the timing of various factors including daytime naps, exercise and exposure to light.

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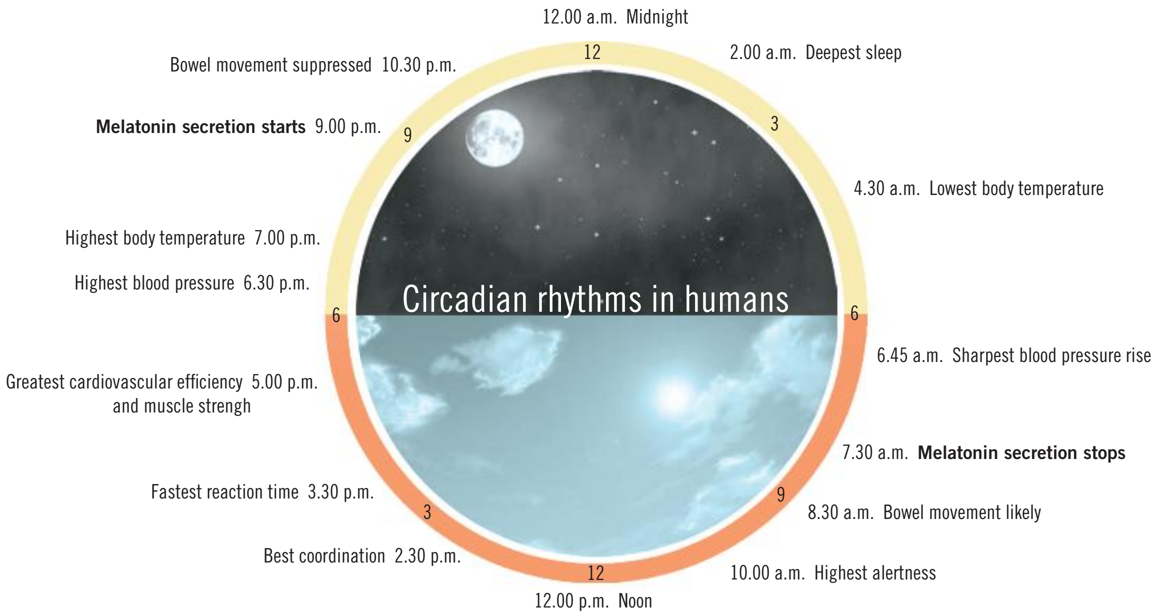

FIGURE 8.2 Human circadian rhythms are automatic physiological changes that regularly occur during a 24-hour cycle. These rhythms regulate a number of our body processes, including chemical and hormonal production, metabolism and our sleep–wake cycle.

8.1 TRY IT YOURSELF >>

TRACKING CHANGES IN YOUR BODY TEMPERATURE

How aware are you that your body temperature automatically changes during a 24-hour period? To track these changes you will need a thermometer, graph paper, a ruler and a pen.

TASK

1. Measure your temperature every 2 hours from the time you get up in the morning to the time you go to sleep. (If you can't measure your temperature every 2 hours, measure it as often as possible but try to keep the time periods between measurements as consistent as you can.) Don't eat or drink anything right before you take your temperature. Make sure you take your temperature the same way every time and that you read the temperature very accurately – the differences in your body temperature are only a few tenths of a degree.
2. Create a graph of your body temperature over time. Use the *x*-axis for 'Time of day' and *y*-axis for 'Body temperature'.
3. Do you see a pattern? How can you explain this?

THE ROLE OF LIGHT AND THE SUPRACHIASMATIC NUCLEUS (SCN) IN THE SLEEP–WAKE CYCLE

Although they are generated by the body, circadian rhythms are influenced by regular variations in the environment. For example, our primary circadian rhythm, the sleep–wake cycle, is controlled by the regular changes in the amount of natural light that is characteristic of the alternation of night and day in a 24-hour period. When the amount of light decreases at the close of the day, the visual system sends signals about how much light there is to the brain's **suprachiasmatic nucleus (SCN)**, a tiny cluster of approximately 20 000 neurons in the **hypothalamus**, the brain's control centre for many circadian rhythms.

The SCN is located deep in the centre of the brain, immediately above the optic chiasm (the crossing of the optic nerves). The SCN controls body functions associated with sleep, such as body temperature, urine production, and changes in blood pressure. The SCN has neural links to the

sleep disorder A condition that consistently disrupts the normal NREM–REM sleep cycle

sleep–wake cycle The rhythmic biological pattern of alternating sleep with wakefulness over a 24-hour period

circadian rhythms Regular automatic physiological changes controlled by the suprachiasmatic nucleus that occur during a 24-hour cycle to regulate bodily processes (e.g. body temperature)

suprachiasmatic nucleus (SCN) A cluster of neurons in the hypothalamus situated directly above the optic chiasma that receives information about the intensity and duration of light from the retina via the optic nerve, which it uses to regulate the body's circadian rhythms associated with the sleep–wake cycle

hypothalamus A brain structure that activates, controls and integrates the peripheral autonomic nervous system, endocrine processes and many somatic functions, such as body temperature, sleep and appetite

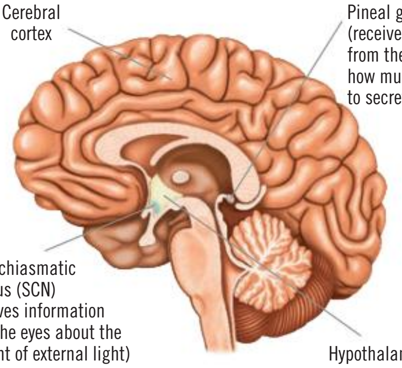

FIGURE 8.3 The location of the hypothalamus, suprachiasmatic nucleus (SCN) and pineal gland

pineal gland, the gland responsible for secreting melatonin, a hormone that has a relaxing effect on the body and induces the drowsiness and lower body temperatures we experience when we become sleepy. During daytime, SCN neurons signal the pineal gland to reduce the secretion of melatonin, which results in a rise in body temperature.

The SCN also has neural links to the visual system. When night-time approaches, the eyes' retinas send messages to the SCN about the strength and duration of light the eyes receive. The SCN then sends signals to the pineal gland indicating that the light level is low or its duration is short. In response, the pineal gland secretes more melatonin. The less external light there is, the more melatonin is secreted and the sleepier we become. Then, as we approach dawn the amount of light in our environment increases, which in turn increases SCN activity and helps reset our 24-hour biological clock so our circadian rhythms are in time with environmental changes. When our SCN becomes more active, it begins to send signals to the pineal gland to reduce the amount of melatonin secreted. These outputs from the SCN also result in an increased secretion of cortisol, a hormone associated with arousal, which in turn leads to a heightened level of alertness. So, because of the activity of the SCN, we begin to feel energised as we wake up to begin our period of daily activity. Research into the role of the SCN in controlling biological rhythms has shown that, if the SCN is damaged or removed, an organism's sleep–wake patterns are disrupted. For example, when the SCN in a group of chipmunks was destroyed, they became more active at night than normal chipmunks and were more likely to be taken by nocturnal predators (DeCoursey, Walker, & Smith, 2000).

Circadian rhythms influence when, how much and how well people sleep. People with normal circadian systems wake in the morning in time to complete their daily activities, and fall asleep at night in time to get enough sleep before having to get up. They are able to sleep and wake up at approximately the same time every day, if they want to. If they start a new routine that requires them to wake earlier than usual, they are generally able to fall asleep at night earlier within a few days. However, if a person's circadian rhythms are disrupted on a regular basis, they may develop a *circadian phase disorder*, and they may experience the debilitating effects of sleep deprivation.

As we saw in the previous chapter, the stages of sleep and the sleep cycle remain largely unchanged throughout the lifespan. However, sleep efficiency and the architecture (structure and pattern) of the sleep–wake cycle changes continuously and considerably with age. From infancy to adulthood, there are marked changes in the timing of when sleep is initiated and how long it is maintained, as well as the percentage of time spent in each stage of sleep. These changes are determined by several factors, including the environment, time awake and activities engaged in during this wake time. Natural changes in circadian rhythms and lifestyle choices – such as type of employment and modes of travel – can also bring about changes in the sleep–wake cycle.

8.1 CHECK YOUR UNDERSTANDING >>

1 The part of the brain that functions like a 'biological clock' is the:
   A optic chiasm.
   B suprachiasmatic nucleus.
   C hypothalamus.
   D optic nerve.

2 The suprachiasmatic nucleus influences the release of melatonin by its effect on the:
   A optic chiasm.
   B hypothalamus.
   C pineal gland.
   D adrenal glands.

3 In humans, a surge of melatonin release occurs during the:
   A morning.
   B late afternoon.
   C early afternoon.
   D evening.

4 Which of the following appears to be the sequence of events associated with resetting one's biological clock?
   A The hypothalamus signals the optic chiasm, which in turn sends signals to the pineal gland.
   B The hypothalamus signals the optic chiasm to release or suppress the release of melatonin.

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C The suprachiasmatic nucleus signals the pineal gland to increase or decrease secretion of melatonin.
D The pineal gland sends signals to the thalamus, which stimulates the secretion of melatonin.

5 What are circadian rhythms?

6 Explain how our circadian rhythms are affected by external light.

7 Explain how the suprachiasmatic nucleus influences our sleep–wake cycle.

CIRCADIAN PHASE DISORDERS: DISTURBING CIRCADIAN RHYTHMS

A circadian phase disorder, often referred to as a circadian rhythm disorder, results from disruptions to a person's circadian rhythms that cause them to operate out of alignment with rhythms in the external environment, particularly the natural night–day cycle.

Circadian phase disorders can be caused by *intrinsic* (caused by the body itself) factors, such as medical conditions and age-related natural shifts in the sleep–wake cycle. They can also be caused by *extrinsic* factors (caused by the environment or external behavioural factors), such as the experience of shift work or jet lag.

Circadian phase disorders can affect people in a number of ways but one key feature shared by these disorders is a disruption to the sleep–wake cycle. When this disruption is persistent, the person develops a circadian phase sleep disorder. This is a form of sleep disorder that disturbs the timing of sleep and the ability to sleep and wake for the periods of time necessary to maintain good health and wellbeing. People with circadian phase sleep disorder are generally able to get enough sleep if allowed to sleep and wake at the times dictated by their body clocks. Unless they have another sleep disorder, their sleep is of normal quality.

SYMPTOMS AND EFFECTS OF CIRCADIAN PHASE SLEEP DISORDER

Symptoms of circadian phase sleep disorder include difficulty falling asleep at the desired time, difficulty maintaining sleep and waking frequently during the night, chronic tiredness during waking hours, difficulty trying to follow a daytime schedule, and not feeling refreshed or energised when waking. If left untreated, the person can suffer from severe sleep deprivation, which may cause serious problems (discussed in more detail later in the chapter); for example, depression, impaired work performance, disruption of social schedules and stressed relationships. However, the person is generally able to recover if they get enough uninterrupted sleep and are allowed to sleep and wake at the times dictated by their body clocks.

Some people are more susceptible than others to developing a circadian phase sleep disorder. The disorder can be related to a person's stage of life, rapid time-zone travel, the demands of work or school schedules, or social needs or expectations.

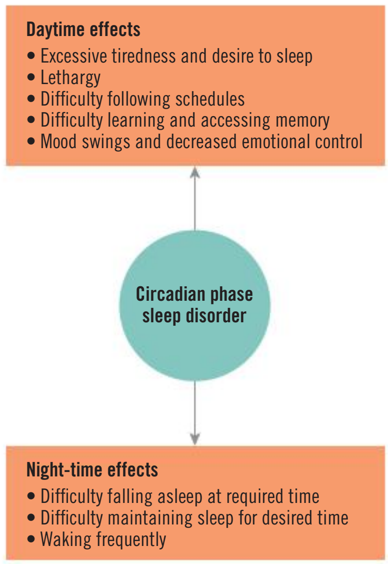

FIGURE 8.4 Typical effects of circadian phase sleep disorder

TREATMENTS FOR CIRCADIAN PHASE SLEEP DISORDER

Treatment for circadian phase sleep disorder is aimed at 'resynchronising' a person's circadian rhythms to their desired sleep schedule, so properly timed light exposure is essential. Treatment is based on the type of disorder and it can include teaching the person proper sleep hygiene techniques and external stimulus therapy, such as exposing a person to bright light in

pineal gland A gland in the centre of the brain that secretes melatonin and helps regulate body rhythms and sleep–wake cycles

melatonin A hormone secreted by the pineal gland that causes drowsiness and helps to regulate the sleep–wake cycle

circadian phase disorder A sleep disorder that disturbs a person's ability to sleep and wake for the periods of time necessary to maintain good health and wellbeing, caused by the sleep–wake cycle being out of sync with the natural night–day cycle of the external environment the morning, avoiding bright light in the evening, and taking melatonin supplements. When combined, these therapies may produce significant results in people with circadian rhythm disorders; however, treatment does not work for everyone. Sleeping pills are rarely effective when used in conflict with the body's natural cycle because they do not correct the underlying circadian abnormality.

SLEEP–WAKE SHIFTS IN ADOLESCENCE

The circadian rhythms that regulate the sleep–wake cycle naturally shift to a later sleep and wake time as children move into puberty and adolescence. This **sleep–wake cycle shift** results in a **sleep phase delay**. The shift in their sleep–wake pattern towards the evening causes a delay in *sleep onset*, or the transition period between wakefulness and sleep. The adolescent is unable to fall asleep until very late at night (or into the early hours of the morning). Delayed sleep onset then causes them to have difficulty waking at the time required by their daily work, school or social commitments. Because they have to rise at a normal time, adolescents get less sleep each night and they suffer the effects of sleep deprivation (covered in more detail later in the chapter). The automatic shift in the sleep–wake cycle during adolescence, and the sleep deprivation that results, has been observed across various cultures throughout the world and even across several mammalian species (Hagenauer, Perryman, Lee, & Carskadon, 2009). Researchers studying the sleep periods of adolescents have found that under controlled conditions (for example, with no clocks or lighting cues), adolescents typically sleep 9 hours a night (Carskadon, 2002). However, most adolescents fall short of this sleep time.

The timing of melatonin and cortisol release

The shift in the sleep–wake cycle of adolescents (and the sleep deprivation it brings) occurs because, as a result of puberty, there is a hormonally induced shift of the body clock forward by 1–2 hours. This occurs because melatonin, the sleep hormone, is released approximately 1–2 hours later. As a result, the adolescent does not feel sleepy until late at night, usually around 11 p.m. (or later). Then, as dawn approaches, melatonin secretion slows but the secretion of cortisol, a hormone that contributes to heightened arousal and alertness, increases, signalling to the adolescent's brain that is time to wake up. However, because adolescents need approximately 9 hours of sleep per night, if they have not fallen asleep until around 11 p.m. they are not ready to wake and be alert before 8 a.m. Unfortunately, the demands of their daily school or work schedules don't allow them to sleep until this time, so their total amount of sleep is reduced. As a result, they incur a **sleep debt**, which can lead to chronic sleep deprivation. A sleep debt is the amount of sleep loss accumulated from an inadequate amount of sleep, regardless of the cause. According to Melbourne adolescent psychologist Michael Carr-Gregg (2007), by being forced to get up after only 7 hours of sleep rather than 9, teenagers are building up a sleep debt, losing up to 10 hours or more of sleep every school week.

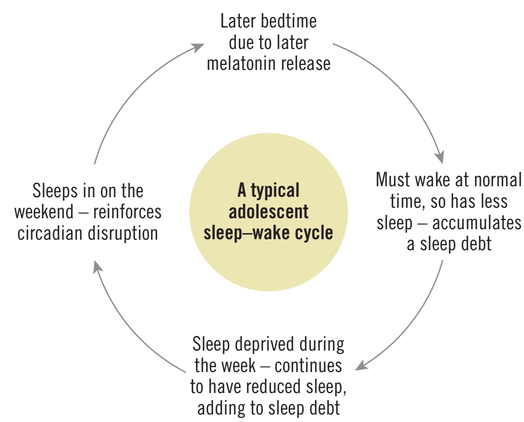

FIGURE 8.5 A typical adolescent sleep cycle

For the adolescent, this sleep debt is exacerbated by other demands on their time such as homework, sport, part-time work and social commitments. Leisure activities enjoyed during night-time also contribute to them staying awake until late. Watching television or using mobile phones and computers at night expose the adolescent brain to light cues, which can prevent adequate production of melatonin and keep their brain aroused so they are less able to fall asleep. To compensate for their sleep debt, adolescents typically sleep very late into the morning or afternoon on weekends.

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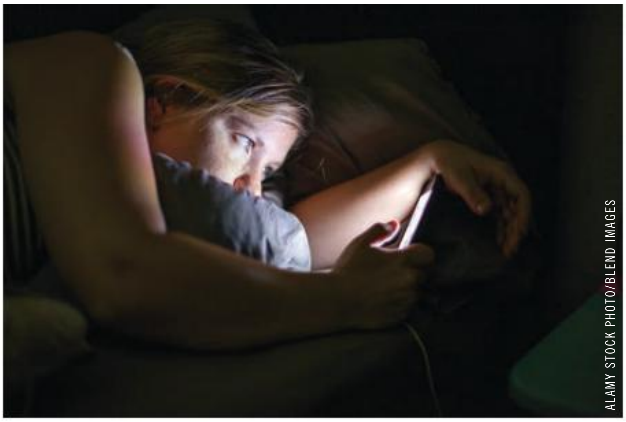

FIGURE 8.6 Many already sleep-deprived teenagers use their mobile phone when they are in bed. The artificial light emitted by the phone stimulates their brain and slows the release of melatonin, making it difficult to fall asleep at a reasonable time. Because they have to wake up at their normal time, their reduced sleep time adds to their sleep debt.

8.2 TRY IT YOURSELF >>

CREATE AND KEEP A SLEEP DIARY

To learn about your sleep habits, keep a sleep diary for one week. To create your sleep diary, follow the instructions below.

INSTRUCTIONS

1 Write a simple schedule in class of your typical daily activities to see how much time you allow yourself for sleep.
2 Create a simple sleep diary for one week (including the weekend) in which you record the following:
   » the time you went to bed
   » the time you woke up
   » how many hours you slept
   » how you felt when you woke up (e.g. refreshed, OK, so-so, tired)
   » whether you drank soft drinks or caffeinated drinks and ate sugary foods in the morning, in the afternoon, or before bedtime
   » how much exercise you did and when you did it (e.g. morning, afternoon, right before bedtime, none).
   » what you did before going to bed (e.g. reading, watching television, doing homework, using the computer).
3 At the end of the week, analyse the information and answer the following questions.
   a Was there a pattern to your sleep time?
   b Are you getting the required amount of sleep for your age?
   c Do you think that any of the activities you engaged in affected your sleep? If so, which ones and what effect did they have?
   d Can you think of any way(s) you could improve your sleep habits?

Effects of the adolescent sleep–wake shift

Chronic sleep debt in adolescents negatively affects various aspects of their lives. Apart from finding it hard to fall asleep early in the evening and to wake up early in the morning, the adolescent generally experiences further difficulties. These include daytime tiredness and fatigue, impaired cognitive functioning, difficulty concentrating, an increase in moodiness, and diminishing motivation. Sleep deprivation also has an adverse effect on memory, creativity and learning, so the adolescent's academic performance may be adversely affected (Stickgold, Hobson, Fosse, & Fosse, 2001). Insufficient sleep means adolescents not only perform worse in the short-term, but there are long-term implications. Reduced REM sleep does not allow mental processes to be fully revitalised and restored. The results of sleep research also suggests a link between sleep deprivation and memory formation. During REM sleep the brain consolidates the information that has been learnt during the day. If adolescents do not get enough REM sleep, they will have difficulty processing information and consolidating it into long-term memories. So, as a result of lack of REM sleep, their learning is impaired. In addition, lack of adequate NREM sleep impedes the body's ability to repair itself and strengthen the

FIGURE 8.7 The automatic shift in the sleep–wake cycle during adolescence causes adolescents to be less alert during the day. This affects their learning because they find it more difficult to concentrate and processes information.

sleep–wake cycle shift Changes in how sleep is initiated and maintained as well as the percentage of time spent in each stage of sleep, caused by the circadian rhythms that regulate the sleep–wake cycle shifts to a different sleep and wake time

sleep phase delay A shift in the sleep–wake pattern towards the evening that causes a delay in sleep onset

sleep debt The amount of sleep loss accumulated from an inadequate amount of sleep, regardless of the cause

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immune system and build bone and muscle tissue. So, lack of NREM sleep can have a negative impact on their physical health.

Sleep deprivation, particularly lack of REM sleep, also affects decision-making skills, executive function, and behavioural inhibition (Harrison & Horne, 2000; Pace-Schott, Nave, Morgan, & Spencer, 2012). As a result, a sleep-deprived adolescent has an increased risk for accidents and injuries, particularly if they are driving a car (Pack et al., 1995). Not enough sleep also weakens their immune system and makes them more susceptible to serious illness.

If this problem is persistent, it may develop into delayed sleep phase disorder, an extrinsic form of circadian phase disorder. Delayed sleep phase disorder is a chronic disorder of sleep timing in which a person's sleep–wake cycle is persistently delayed by 2 hours or more from a normal sleep pattern. This disorder can range from mild to severe and affects not only an individual's sleep but also daytime functioning.

Coping with the adolescent sleep–wake cycle shift

Although the adolescent sleep–wake cycle shift is unavoidable, the adolescent can take measures to help them cope with its effects. For example, they should:

- avoid exposure to any electronic devices within 1 hour of bedtime to prevent light stimulation that prolongs sleep onset.
- avoid intense study periods before bed and allow adequate 'wind-down' time
- refrain from stimulants such as caffeine and nicotine, particularly after lunchtime, because the stimulating effects can persist for hours after intake.
- avoid alcohol because it can disrupt sleep
- review their commitments and stick to a reasonable schedule that allows time for homework and adequate rest.
- establish a consistent sleep schedule that ensures adequate sleep on weekdays and weekends. If they are able to establish a good sleep pattern during the week, they should try to maintain this on the weekend to avoid sabotaging the positive effects of their weekday sleep routine.
- avoid bright light in the evening, but open blinds or turn on lights as soon as the morning alarm goes off to assist waking.
- only sleep in on the weekend, but no more than 2 or 3 hours later than their usual waking time so they do not sabotage any positive effects of their weekday sleep routine and disrupt their body clock even further.

8.2 CHECK YOUR UNDERSTANDING >>

1 The natural shift in the adolescent sleep–wake cycle is an example of a:
   A circadian rhythm.
   B sleep phase advance.
   C sleep debt.
   D delayed sleep phase disorder.

2 The sleep–wake cycle shift experienced by adolescents is usually the result of:
   A depression and sleep debt.
   B a delayed release of the hormone adrenaline.
   C a delayed release of the hormone melatonin.
   D an early release of the hormone melatonin.

3 Discuss how melatonin and cortisol contribute to the adolescent shift in the sleep–wake cycle.

4 Explain what causes a circadian phase disorder.

5 What biologically based explanation could you give to a parent to explain why their 17-year-old adolescent is regularly tired and irritable during the day?

6 Explain why sleeping with a television on exacerbates an adolescent's lack of adequate sleep.

7 Describe three symptoms of a delayed sleep phase disorder.

SHIFT WORK: WORKING OUT OF SYNC WITH CIRCADIAN RHYTHMS

Humans are not nocturnal animals. They are programmed to be active and alert during the daytime and inactive, or asleep, during the night. However, shift work requires people to be active and alert at a time when their natural circadian rhythms would prepare them for sleep. Shift work involves hours of paid employment that are outside the period of a normal working day and may follow a different pattern in consecutive periods of weeks. Shift-work schedules include night shifts, early-morning shifts and rotating shifts.

Shift work disrupts natural circadian rhythms and, consequently, sleep and waking cycles. People who work a night shift need to be active and alert during the night when melatonin levels are naturally higher and adrenalin and cortisol (hormones that have an arousing and energising effect) levels are lower. Then, they need to sleep during the day when melatonin levels are

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naturally lower and adrenalin and cortisol levels are higher. So, to succeed at performing their work tasks efficiently, shift workers must try to override their body's natural circadian rhythms. If their attempt to sleep out of adjustment with their body clock continues for an extended period of time, the person may develop shift work disorder.

Shift work disorder occurs when a person's work hours are scheduled during the normal sleep period (at night) causing their circadian rhythms to be out of step with their work schedule. People with shift work disorder are forced to be awake when their circadian rhythms dictate that they should be sleeping, and they may sleep up to 2 hours less than the average worker. Shift work disorder is an extrinsic circadian phase sleep disorder because it is caused by external behavioural factors and it is characterised by insomnia, chronic sleep deprivation and excessive sleepiness when awake.

FIGURE 8.8 Night-shift workers need to be alert and active at a time when their body's natural circadian rhythms prepare them for sleep.

Effects of shift work

When their circadian rhythms are no longer synchronised to patterns in the external environment, shift workers often feel sleepy during their work shift. One reason this occurs is because the natural tendency to fall asleep and stay asleep occurs during the decreasing phase of the temperature circadian rhythm, which is between midnight and 4 a.m. Then, as body temperature rises, it is more difficult to stay asleep. This is one of the reasons why night workers who try to fall asleep at 8 a.m. often struggle to go to sleep and remain asleep through the day.

In particular, people who work night shift find it difficult to adjust to an inverted night–day schedule of activity. Night-shift workers often drive home in morning daylight, which makes it harder to reset their biological clocks. On days off they often resume a normal day–night schedule to spend time with family, and this also disrupts any adjustments their circadian rhythms may have made. It takes about 10 days for the body to adjust to night-shift work. However, it is common for night-shift workers to revert to daytime routines for a day or two during days off, which tends to make the circadian rhythm unstable.

Problems with circadian adjustment are also increased by the fact that many night-shift workers work indoors, where the artificial light is too weak to shift their circadian rhythms towards a night–day schedule. However, circadian adjustments can be increased by having very bright indoor lighting at the workplace, keeping bedrooms dark and quiet, and maintaining a schedule of daytime sleep even during days off.

Research into shift work suggests that shift work can lead to partial sleep deprivation (discussed in more detail later in the chapter) as daytime sleep is typically 1–2 hours shorter than night-time sleep (Tilley, Wilkinson, Warren, Watson, & Drud, 1982). The effects of this reduced quantity of sleep are intensified if their daytime sleep occurs in two split periods. If they sleep for a few hours in the morning and then an hour or so before going to work, progression through the sleep stages is disrupted – and this fragmented sleep decreases the quality of their sleep. Environmental factors also make it harder for shift workers to sleep during the day. For example, during the day temperature is generally higher than at night, there is more natural light and there are more disturbances by the activity of those around them. Because their sleep is easily disturbed, shift workers don't spend enough time in REM sleep, the period in the sleep cycle that revitalises and restores mental

delayed sleep phase disorder A disorder of sleep timing in which a person's sleep–wake cycle is routinely delayed by 2 hours or more from a normal sleep pattern, causing a person to go to sleep later and wake later and may follow a different pattern in consecutive periods of weeks

shift work Hours of paid employment that are outside the period of a normal working day

shift work disorder A circadian phase disorder caused by a person's work hours being scheduled during the normal sleep period (at night), causing their circadian rhythms to be out of step with their work patterns

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processes. They also miss out on NREM sleep, the sleep cycle stages when the body repairs and regrows tissues, builds bone and muscle, and strengthens the immune system. If this decreased and fragmented sleep pattern becomes the norm, their psychological and physical functioning is impaired. For example, the risk of diabetes mellitus type 2 is increased in shift workers, especially in men and people working rotating shifts (Yong, 2014). Gastrointestinal disorders and ulcers, obesity, cardiovascular problems, depression, anxiety and other mood disorders are also more common in shift workers.

The problems associated with shift work are exacerbated if the person is working on a rotating shift because their circadian rhythms don't have a chance to adjust to the frequent changes. A rotating shift schedule is a job schedule in which employees work one set of hours for a period and then rotate, or move, to a different set of hours. Rotating shift schedules typically divide the work day into three 8-hour periods. For example, 7 a.m. to 3 p.m., 3 p.m. to 11 p.m. and 11 p.m. to 7 a.m. With a rotating shift schedule, each employee would work one shift for a certain number of weeks and then move onto a different shift. The shifts rotate at regular intervals so that each employee works each shift for the same amount of time. Frequent changes in a work schedule make it difficult for a person's circadian rhythms to adjust, and regular disruption to circadian rhythms can lead to chronic fatigue and other health problems.

Shift work increases the risk of:

- sleep disorders ✓
- obesity ✓
- digestive problems ✓
- miscarriage during pregnancy ✓
- cardiovascular disease ✓
- diabetes ✓
- hypertension ✓
- chronic fatigue ✓
- on-the-job accidents or motor vehicle accidents ✓
- developing some cancers ✓
- headaches ✓
- sexual dysfunction ✓
- mental health problems such as depression ✓
- mood swings ✓
- chronic fatigue ✓
- relationship breakdown. ✓

FIGURE 8.9 Possible effects of shift work

Sleep research also suggests that, as a result of the effects of sleep deprivation caused by disruption to their circadian rhythms, shift workers increase their risk of having an accident or making a workplace error, particularly in the early hours of the morning, when body temperature is at its lowest point. (Colquhoun, 1976; Folkard & Monk, 1979; Richardson, Miner, & Czeisler, 1989).

FOCUS ON RESEARCH 8.1

WORKING NIGHT SHIFT BURNS LESS ENERGY, INCREASES RISK OF WEIGHT GAIN

Researchers have known that people who work, and therefore eat, at night when their bodies are biologically prepared to sleep are prone to put on weight. But the reasons why have not been clear. According to a new study led by the University of Colorado Boulder, people who work the night shift are likely burning less energy during a 24-hour period than those on a normal schedule, increasing their risk for weight gain and obesity. 'When people are on a shift work-type schedule, their daily energy expenditure is reduced and unless they were to reduce their food intake, this by itself could lead to weight gain,' said Kenneth Wright, senior author of the research paper.

For this study, 14 healthy adults spent 6 days at the University of Colorado Hospital's Clinical and Translational Research Centre. For the first 2 days, participants followed a normal schedule, sleeping at night and staying awake during the day. They then transitioned to a 3-day shift work schedule when their routines were reversed. During the experiment, participants' meals were carefully controlled, and they were given the amount of food they would normally need to eat at home to maintain their current weight. When the participants transitioned to the shift work schedule, the timing of their meals changed but the total amount of calories remained the same.

The participants also were given the same 8-hour sleep opportunity regardless of whether those hours were scheduled during the day or night.

Results showed that total daily energy used by participants decreased when they were put on a shift work schedule. The reduction is probably linked to the mismatch between the person's activities and their circadian clocks, Wright said. Humans have evolved to be awake – and eat – when it's light outside and sleep when it's dark. In large part, the human circadian clock is set by exposure to sunlight. People's circadian clocks can shift over time – even radically – with the use of artificial lights if they aren't exposed to the sun. But because shift workers typically switch back to a daytime schedule on their days off, their biological clocks don't flip to fit their night-shift schedules. 'Shift work goes against our fundamental biology,' said Wright. 'Shift work requires our biological day to occur at night and our biological night to occur

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during the day and that's very difficult to achieve because the sun is such a powerful cue. We can have some change in our clock – a couple of hours – but then on days off, it goes right back. Shift workers never adapt.'

The research team was surprised to find that participants burned more fat when they slept during the day compared to when they slept at night. It's not clear why this happens, but Wright said it's possible the extra fat-burning is triggered by the transition day between a daytime schedule and a night-time schedule. On that day, shift workers often take an afternoon nap to prepare for the first night shift, but in total, they are typically awake more hours than usual and, therefore, burn more energy. The need to meet the extra demand for energy may cause the body to begin burning fat, Wright said.

Further research is needed to determine if the fat-burning phenomenon would happen among actual shift workers, whose diet is not being strictly controlled, Wright said. For example, shift workers may eat more calories on the transition day – an option not available to study participants – which could eliminate the need for the body to start burning fat. Still the findings suggest that shift workers may be prone not only to gaining weight, but also to a changing composition of fat and muscle mass in their bodies.

Wright cautions that even though participants initially burned more fat, this would not lead to weight loss because, in total, the energy expenditure over the three days of shift work was lower.

Source: Adapted from University of Colorado at Boulder. (2014, November 17). Working night shift burns less energy, increases risk of weight gain. *ScienceDaily*.

QUESTIONS

1. Identify the independent variable and dependent variable in this study.
2. Write a possible hypothesis for this study.
3. State the results of this study.
4. What conclusions can be drawn from these results?
5. Identify two ethical principles the researchers would need to follow. Describe these principles and explain how the researchers would implement them.

Reducing the effects of shift work

To alleviate the negative health impacts of shift work, the shift worker should try to stay on one shift as long as possible so their circadian rhythms can adjust. If they have to rotate shifts, they should try to get successively later shifts rather than successively earlier shifts. That is, they should try to move their shift forwards in time so each new shift begins later. Because the human internal clock is slightly longer than 24 hours, it is easier to adjust to lengthening a day than shortening a day by the same amount of time. In other words, moving forwards disrupts the rhythms less than moving backwards. It is also important that shift workers maintain a regular sleep pattern that allows for 7–8 hours of uninterrupted sleep per day and that they take measures to relax and unwind following night-shift work. Shift workers should also try to eat regular meals and a healthy and balanced diet. They should avoid hard-to-digest foods before bed, avoid caffeine and stimulants at least 6 hours before they plan to sleep, and they should try to exercise regularly during free time. They should also ensure that their sleeping environment is conducive to sleep. For example, they could darken their bedroom and keep it cool, use earplugs and an eye mask to block out sound and light, and have a regular bedtime routine. For people who work night shift, avoiding morning light (for example, by wearing dark goggles or glasses during travel home in the morning) may help their body clock to adapt (Crowley, Lee, Tseng, Fogg, & Eastman, 2004).

8.3 CHECK YOUR UNDERSTANDING >>

1. Shift work disorder results from:
   - A a disruption to circadian rhythms.
   - B not getting adequate sleep during the daytime.
   - C being required to be alert and active during the night and asleep and inactive during the day.
   - D All of the above
2. For optimal performance in the work place, employers should place shift workers on:
   - A rotating shifts on a regular basis.
   - B one shift, then rotate their shifts weekly so that everyone on shift work gets as much night sleep as possible.
   - C one shift for several weeks, then rotate their shift backwards one shift.
   - D one shift for several weeks, then rotate their shift forwards one shift.
3. Which of the following health problems are more common in shift workers than day workers?
   - A Respiratory problems, stomach ulcers, high blood pressure
   - B Type 2 diabetes, high blood pressure, insomnia
   - C Respiratory problems, heart disease, mood disorders
   - D All of the above
4. What is shift work disorder?
5. Explain how shift work affects circadian rhythms.
6. Why does working on rotating shifts cause greater interference to circadian rhythms than working on a set shift?
7. Describe three reasons why shift workers may find it difficult to sleep during the day.

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JET LAG

The time changes experienced when travelling across time zones can also disrupt your body's circadian rhythms. When this happens you experience the physiological condition known as jet lag. Jet lag (also referred to as 'rapid time zone change syndrome' or desynchronosis) is a temporary extrinsic circadian phase disorder characterised by fatigue and sleep disturbance that result from a disruption of the body's normal circadian rhythm following long periods of air travel through several time zones in one day. When a person travels across time zones, night-time begins several hours earlier (or later) in their new time zone than it did in their normal time zone. As a result, their circadian rhythms, in particular their sleep–wake cycle, must shift, but these rhythms don't all shift together. This is due to the time it takes for your internal biological clock to recognise your new time zone and resynchronise your sleep–wake cycle. When you travel from one time zone to another, the external cues that your body clock uses to regulate your sleep–wake cycle (for example, the amount of light) are different. Until your circadian rhythm has adjusted to the new external cues, there is a conflict between your body clock's internal time and the external time cues.

Jet lag is a temporary condition and each circadian rhythm requires a different amount of time to adjust. For example, the sleep–wake cycle usually takes a few days to adjust, but temperature and hormonal rhythms require about a week. When the person reaches their destination, they are exposed to light at times that do not match their circadian rhythms, so they must sleep and wake at times that are misaligned with their body clock. Symptoms of jet lag, such as excessive sleepiness during the day and inability to sleep at night, lack of daytime alertness, digestive upsets, irritability, memory lapses, impaired judgement and poor performance, usually occur one or two days after air travel across at least two time zones.

How quickly the person is able to resynchronise their body clock depends on a variety of factors, such as the distance travelled, how long the travel took, how many time zones were crossed and the direction of the travel. Whether the person was able to sleep while travelling, individual differences in their body's tolerance to environmental change, and the availability and intensity of circadian time cues in their new environment also impact on how quickly their circadian rhythms adapt.

Reducing the effects of jet lag: West is best

The body naturally adjusts approximately 1 hour or less per day to time zone changes. To minimise the effects of jet lag it is best to travel in a westerly direction if possible. Typically, people adjust faster when flying west because countries that are west of where you begin your flight are behind in time. Therefore, travelling west lengthens your day because you gain an hour for each time zone you cross. This causes a delay in your biological clock because it extends the time you need to stay awake. As discussed earlier, the body adjusts more quickly moving forwards. If you arrive at your destination late in the day or during the night, you can avoid exposure to light, so your circadian rhythms can move 'ahead' of local time.

Conversely, countries east of where you begin are ahead in time, so travelling east shortens your day and, because you lose hours from the day, this advances your biological clock. Although you will need to fall asleep earlier and wake up earlier than usual, your body's internal clock 'falls behind' the time at your destination. To shift your circadian rhythms into a stable relationship with your new 'more easterly' environment, you should avoid all bright light during the evening and

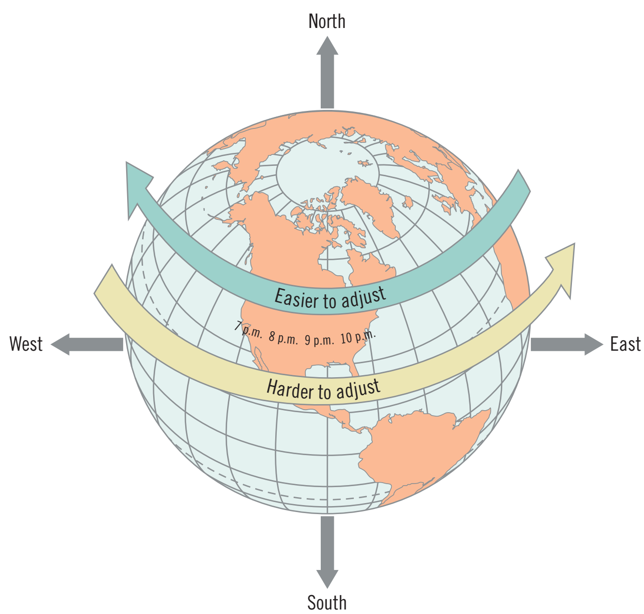

FIGURE 8.10 The effects of jet lag are reduced if you fly in a westerly direction. Countries west of where you begin your flight are behind in time. This extends your day because you gain an hour for each time zone you cross and your circadian rhythms adjust faster to a longer day than they do to a shorter day.

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expose yourself to as much light as possible during the day, particularly in the morning so that your body clock shifts forward and synchronises with local time.

Adjustment to either eastward or westward phase shifts often requires at least a 24-hour period for each time zone crossed (for example, crossing six time zones can require 5–7 days), assuming proper daily exposure to the new light–dark cycle. However, there are a number of things that you can do as a traveller to minimise the effects of jet lag and to help reset your biological clock. For example, you should change eating and sleeping times to fit the time you would do these activities in your place of arrival. When travelling, you can try to recreate the desired environmental cues to help you adjust to destination time. For example, you should open the shade on the aeroplane window or turn on the light to simulate daytime, or wear an eye mask to simulate night-time. If you arrive during daytime, you should try to stay awake by spending as much time as possible outside in natural light. Taking synthetic melatonin can also help to resynchronise your circadian rhythms. Slowly adjusting your sleep pattern by an hour each day before you travel can also help to reduce the effects of jet lag. If you are intending to travel east, you could expose yourself to more light in the morning; if you are travelling west, exposure to more light in the evening may help your circadian rhythms adjust to your new time zone as quickly as possible.

FIGURE 8.11 International air travellers can help to minimise the effects of jet lag by controlling the amount of light they are exposed to during their flight.

8.4 CHECK YOUR UNDERSTANDING >>

1 Jet lag is worse when you fly:
   - A in an easterly direction.
   - B in a westerly direction.
   - C at night.
   - D during the day.

2 After a long international flight, you are feeling badly jet-lagged. To speed up your adjustment to the new local time zone, for the first few days you should:
   - A avoid going outside at any time.
   - B try to remain outside from sunrise to sunset.
   - C avoid early morning daylight, but spend the late afternoon outside.
   - D spend early morning outside and avoid late afternoon daylight.

3 To avoid or reduce jet lag, which one of the following should you not do when you are travelling on an international flight?
   - A Avoid caffeine.
   - B Reset your watch to the new time zone as soon as you depart.
   - C Book a flight that leaves early in the evening and arrives late in the morning.
   - D Avoid alcohol and tobacco.

4 Which of the following statements about jet lag is not true?
   - A The length of a flight contributes to how jet-lagged a person feels.
   - B The number of time zones crossed contributes to how jet-lagged a person feels.
   - C Jet lag is a temporary condition that has no long-lasting effects.
   - D The amount of sleep a person has during a flight does not contribute to how jet-lagged they feel.

5 What is jet lag and why does it occur?

6 Describe one thing you can do to avoid or minimise jet lag and state why it would help.

7 Why does travelling in a westerly direction help to reduce jet lag?

PARTIAL SLEEP DEPRIVATION: AFFECTIVE, BEHAVIOURAL AND COGNITIVE EFFECTS

When an individual goes without sleep or does not get adequate amounts of sleep, they experience sleep deprivation and their wake state becomes destabilised. Sleep deprivation may result from a variety of factors, including work or study demands, social and family

jet lag A temporary circadian phase disorder characterised by fatigue and sleep disturbance that results from a disruption of the body's normal circadian rhythm following long periods of air travel through several time zones

sleep deprivation Going without sleep or not getting sufficient amounts of sleep to support optimal daytime functioning

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responsibilities, the sleeping environment, poor sleep hygiene, medical conditions and sleep disorders. Regardless of the cause of sleep deprivation, the effects are the same. Going without adequate sleep or without any sleep carries with it both short- and long-term psychological and physiological consequences.

The severity of the effects of sleep deprivation will be determined by the type of sleep loss experienced and the length of time the person was sleep deprived. If the person has some sleep in a 24-hour period but less than they normally require to perform at optimal level during the day, they experience partial sleep deprivation. If they have no sleep at all in a 24-hour period, they will experience total sleep deprivation.

How long might a person go without sleep? With few exceptions, four days or more without sleep becomes unbearable for anyone. Nevertheless, longer periods without sleep are possible. The world record is held by Californian Randy Gardner, who, at 17 years of age in 1964, went 268 hours (11 days) without sleep (see Chapter 6). At various times, Gardner experienced irritability, memory lapses, difficulty concentrating and difficulty in naming common objects. Surprisingly, Gardner needed only 14 hours of sleep to recover (Coren, 1996).

As Gardner's experience demonstrates, after a period of sleep deprivation it is not necessary to completely replace lost sleep. Most symptoms and side effects of sleep deprivation are reversed by a single night of uninterrupted sleep. People who have been sleep-deprived may report sleeping for a longer period of time than normal in the first few nights following deprivation, but there is generally no need to replace the total amount of sleep that has been lost.

EFFECTS OF PARTIAL SLEEP DEPRIVATION

Partial sleep deprivation can result when a person gets some sleep but not enough to support their normal waking alertness, performance and health. Partial sleep deprivation can occur because of reduced total sleep time (decreased quantity) or because of disruptions to the normal progression and sequencing of sleep stages, which leads to fragmented sleep (decreased quality). In the short term, acute partial sleep deprivation (a lack of adequate sleep time required for optimal daytime functioning, usually lasting one or two days) can affect judgement, mood, and ability to learn and retain information. Although acute sleep deprivation is usually short and temporary, it still increases the risk of serious accidents and injury. In the long term, chronic partial sleep deprivation (when an individual routinely sleeps less than the time needed for optimal functioning) may lead to a host of health problems including obesity, diabetes, hypertension, high blood pressure and cardiovascular disease. Early mortality may also result from chronic total sleep deprivation (Dinges, 1995).

It is not necessary to go completely without sleep to feel the effects of sleep loss. One-third of all adults and most teenagers do not get enough sleep each night. Sleep deprivation studies repeatedly show a variable (negative) impact on mood, cognitive performance, and behavioural (motor) function (Durmer & Dinges, 2005).

Affective functioning: Amplified emotional responses

Sleep helps us regulate our emotions and there is increasing evidence that sleep deprivation is detrimental to mood and emotion stability because it amplifies emotional responses. For example, research suggests that the brain's prefrontal cortex, the area of the brain responsible for executive functioning and emotional regulation, is particularly sensitive to sleep deprivation and that sleep loss causes deficits in our ability to regulate our emotions (Durmer & Dinges, 2005; Dahl & Lewin, 2002). Although the effects of sleep deprivation depend on the individual, the amount of sleep they lose, the type of sleep lost and how long they have been deprived of adequate sleep, many sleep-deprived people report a change in their affective functioning (emotional control and responses) as the first sign that they are sleep deprived. These changes typically include mood swings, increased irritability, lack of motivation and feelings of sadness and depression.

Sleep deprivation has been shown to greatly influence the ability to process emotional information, put it into context and produce controlled, appropriate responses (Kahn, Sheppes, & Sadeh, 2013). More specifically, frequently disrupted and restricted sleep seems to increase the tendency of the individuals to experience negative emotions and develop mood disorders such as depression and anxiety (Babson & Feldner, 2010; Belenky et al., 2003; Chang, Ford, Mead, Cooper-Patrick, & Klag, 1997; Riemann & Voderholzer, 2003; Van Dongen, Maislin, Mullington, & Dinges, 2003). Often, sleep-deprived people report feeling uncharacteristically anxious, irritable, angry, aggressive

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and unmotivated. Recent studies have shown that sleep loss affects the ability to recognise and categorise other people's emotions, particularly from facial expressions (Minkel, Htaik, Banks, & Dinges, 2010; Tempesta et al., 2010; Van Der Helm, Gujar, & Walker, 2010). This reduces the individual's self-perceived emotional intelligence. Because they are less able to understand another person's mental state in terms of emotions, feelings and thoughts, sleep-deprived people become less empathetic towards others (Killgore, Balkin, & Wesensten, 2006).

Lack of adequate sleep may also lessen their ability to cope with stress. When sleep deprived, people may feel overwhelmed by routine activities, such as completing homework, doing shopping, keeping up an exercise regime or waiting at traffic lights. Inadequate sleep not only affects mood, but mood and mental states can also affect sleep. For example, anxiety increases agitation and arousal, which makes it more difficult to sleep.

8.5 CHECK YOUR UNDERSTANDING >>

1 Individuals who are sleep deprived often find it:
   - A difficult to learn new information and skills.
   - B easy to complete routine tasks.
   - C easy to empathise with others.
   - D difficult to fall asleep quickly when they are given the opportunity.

2 Which of the following statements about sleep deprivation is true?
   - A The effects of sleep deprivation are only overcome when you make up the total amount of sleep lost.
   - B The effects of sleep deprivation are usually overcome by one full night of uninterrupted sleep.
   - C Sleep deprivation increases positive mood states.
   - D Sleep deprivation has no long-term psychological or physiological effects.

3 Explain the difference between partial and total sleep deprivation.

4 Explain the difference between acute partial sleep deprivation and chronic partial sleep deprivation.

5 Identify three emotional effects of partial sleep deprivation.

Cognitive functioning: Disruption of thinking processes

Sleep research suggests that sleep is essential for cognitive performance ranging from simple attention and alertness to higher-order executive functions (Maquet, 2001; Stickgold, 2005).

When sleep deprived, a person's mental abilities become impaired so their ability to perform cognitive tasks declines, particularly higher order tasks involving vigilant attention. For example, the person's spatial orientation may deteriorate and they may begin to think irrationally and illogically. Executive functioning (through the use of the prefrontal cortex) is compromised by sleep deprivation. As a result, the ability to plan, coordinate, implement and evaluate deliberate actions is disrupted. The person may have difficulty controlling attention and maintaining concentration for an extended time, so their ability to perform tasks to a set standard may be reduced (Durmer & Dinges, 2005). Their ability to make decisions and problem solve may suffer. They may make uncharacteristic errors in judgement because their ability to assess risk, assimilate changing information and revise strategies may be compromised.

Sleep deprivation also impairs memory and learning (Maquet, 2001; Pace-Schott & Hobson, 2002; Siegel, 2001; Stickgold et al., 2001). People who do not have adequate amounts of sleep find it difficult to concentrate on information long enough for it to be processed in short-term memory and transferred to long-term memory for relatively permanent storage. They also find it more difficult to access and retrieve information stored in long-term memory. At a cellular level, changes in synaptic efficacy and membrane excitability are thought to be critical for the formation of memories, and there have been some suggestions that these neuronal properties could be altered during sleep and by the lack of sleep (Bliss & Collingridge, 1993; Graves, Pack, & Abel, 2001). Sleep research suggests that the nerve connections that make our memories are formed and strengthened during sleep. For example, neuronal connections that were active during a previous learning experience are reactivated during sleep, suggesting that memory consolidation may actually occur during

partial sleep deprivation Getting some sleep in a 24-hour period but less than normally required for optimal daytime functioning

total sleep deprivation Getting no sleep at all in a 24-hour period

acute partial sleep deprivation A lack of adequate sleep time required for optimal daytime functioning; usually lasting 1–2 days

chronic partial sleep deprivation Routinely sleeping less than the normal time needed for optimal daytime functioning

affective functioning Emotional control or responsiveness

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sleep (Louie & Wilson, 2001). If sleep time is cut short or disrupted, it interferes with this process. For example, the percentage of time spent in rapid eye movement (REM) sleep is increased after certain learning tasks (Mandai, Guerrien, Sockeel, Dujardin, & Leconte, 1989; Smith & Lapp, 1986), and if REM sleep is prevented after the training, the subsequent performance of this task is impaired (Karni, Tanne, Rubenstein, Askenasy, & Sagi, 1994; Smith, 1995). Deprivation of sleep before task training also impairs performance in many behavioural tasks (Stern, 1971).

Sleep deprivation also leads to slower reaction times, especially on motor tasks. The sleep-deprived person's ability to successfully complete simple, monotonous or repetitive tasks, particularly those that require reaction speed or vigilance, declines. They struggle to simultaneously focus on several different related tasks and, because they do not have the speed or creative abilities they normally would have to make quick logical decisions, they find it more difficult to react quickly to unpredicted rapid changes in their circumstance. As a result, there are significant variations in their performance and they are prone to making a number of errors (Doran, Van Dongen, & Dinges, 2001). These effects make many activities, such as driving a car, playing contact sports or using power tools, very dangerous when you are sleep deprived.

FIGURE 8.12 When an individual is sleep deprived, it is difficult to maintain attention when undertaking the monotonous task of a long car drive.

Behavioural functioning: Impaired actions and reactions

The behavioural effects of sleep deprivation vary depending on a person's age and on how long or how much they have been deprived of sleep. With less sleep, less glucose is metabolised, so muscle strength, speed of movement and endurance are reduced. The ability to perform fine motor functions requiring coordination of the eyes and hands (such as handwriting, computer skills or operating machinery) is also impaired, causing an increase in clumsiness and accidents or injuries.

During the day if we are awake but sleep deprived, the body reacts with brief periods of sleep known as microsleeps. **Microsleeps** are short periods (a few seconds) where the individual appears to be awake – their eyes may even be open – however, EEG recordings of brain activity show brainwaves similar to those shown in the first stage of NREM sleep. This indicates that they are asleep but the individual may have no recollection of what occurred while they were having a microsleep. Microsleeps become more prevalent as a person accumulates a sleep debt, so the more sleep deprived a person is, the greater the chance a microsleep episode will occur. Microsleeps are especially prevalent when people who are sleep deprived complete monotonous or unstimulating tasks.

FIGURE 8.13 When driving a car, microsleeps can be potentially fatal because they cause the driver to lose awareness of their surroundings.

Although microsleeps may be one way the body attempts to cope with sleep deprivation, the effects of losing awareness for even a couple of seconds can be dangerous and devastating. For example, when driving a car a person may not notice a sudden change in their external environment. Microsleeps intrude

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into wakefulness and disrupt attention and they are regularly implicated in fatal accidents. For this reason, drivers who feel tired are encouraged to take a break or a 15-minute powernap.

TABLE 8.1 The typical effects of partial sleep deprivation

BEHAVIOURAL FUNCTIONING	EFFECTS OF SLEEP DEPRIVATION
Affective functioning	» Mood swings » Increase in negative emotions » Irritability » Reduced motivation » Easily bored » Reduced empathy towards others » Inability to cope with stress
Cognitive functioning	» Memory lapses » Difficulty maintaining attention and concentrating » Difficulty processing information » Difficulty thinking logically and problem-solving » Reduced creativity » Distorted perceptions » Poor decision-making » Slowed reaction rate » Reduced spatial awareness
Behavioural functioning	» Difficulty completing routine tasks » Reduced ability to assess risks » Increase in risk-taking behaviour » Reduced ability to perform fine motor tasks and an increase in clumsiness
Physical functioning	» Lack of energy » Extreme tiredness, lethargy » Trembling hands » Drooping eyelids » Staring and inability to focus the eyes » Increased sensitivity to pain » Headaches » Slowed reflexes

PHYSIOLOGICAL EFFECTS: HOW THE BODY REACTS

Typical physical reactions to sleep deprivation include lack of energy, tiredness or exhaustion, trembling hands, drooping eyelids, staring and inability to focus the eyes, increased pain sensitivity, occasional headaches and general discomfort. The pituitary gland, located at the base of the brain, releases growth hormones when you are in deep sleep, so prolonged lack of sleep, particularly NREM sleep, may cause physical growth processes to be interrupted, especially in children and teenagers. During sleep, our bodies also secrete hormones that help to control appetite, energy metabolism and glucose processing. Being sleep deprived upsets the balance of these and other hormones.

For most people, the effects of sleep deprivation disappear when the person becomes fully rested again. However, if partial sleep deprivation continues for a prolonged time, then its effects become similar to that of total sleep deprivation. In the long term, chronic partial or total sleep deprivation can lead to a range of health problems including obesity, diabetes and cardiovascular disease. Prolonged sleep deprivation can also result in biochemical changes that weaken the immune system and increase the chance of contracting infections (Ackermann et al., 2012).

8.6 CHECK YOUR UNDERSTANDING >>

1 Which of the following statements about sleep deprivation is false?
   - A When sleep deprived, it is more difficult for a person to process information and transfer it from short-term memory to long-term memory.
   - B When sleep deprived, it is more difficult for a person to retrieve information from long-term memory and return it to short-term memory.
   - C Sleep deprivation can interrupt growth processes.
   - D Sleep deprivation does not affect growth processes.

2 For his study into the effects of sleep deprivation on the successful completion of cognitive tasks, Professor Jones gave a set of mathematics problems to 40 sleep-deprived participants and 40 fully rested participants. Professor Jones obtained informed consent from all the participants. The type of research design used by Professor Jones is:
   - A a repeated measures design.
   - B an independent groups design.
   - C a matched participants design.
   - D a single blind design.

3 The effects of chronic partial sleep deprivation include:
   - A suppression of the immune system.
   - B altered metabolic and hormonal functioning.
   - C impaired creativity.
   - D All of the above

4 Explain why sleep deprivation affects performance on simple tasks more than complex tasks.

5 Explain what microsleeps are and how they can be dangerous.

6 Describe three physiological effects and three psychological effects of partial sleep deprivation.

microsleep A short period of sleep where the individual appears to be awake, but brain activity indicates that they are asleep; occurs because of sleep deprivation

8.2 FOCUS ON RESEARCH

CHRONICALLY SLEEP DEPRIVED? YOU CAN'T MAKE UP FOR LOST SLEEP

Researchers at Northwestern University in Illinois, United States, have discovered that when animals are partially sleep deprived over consecutive days they do not attempt to catch up on sleep, despite an accumulating sleep deficit. Their study is the first to show that repeated partial sleep loss negatively affects an animal's ability to compensate for lost sleep.

We've all experienced occasional partial sleep deprivation, perhaps by staying out too late at a party on a weeknight or studying into the early hours for a morning exam. It is well established that our bodies try to catch up by making us sleep more and/or more deeply the following night in order to maintain a homeostatic balance between sleep and wakefulness. But what happens when this sleep deprivation becomes chronic when we lose a little bit of sleep over a period of days, months or even years?

The study by sleep researchers at Northwestern University has shown that repeated partial sleep loss negatively affects an animal's ability to compensate for lost sleep. 'We now know that chronic lack of sleep has an effect on how an animal sleeps,' said Fred W. Turek, director of Northwestern's Center for Sleep and Circadian Biology and an author of the paper. 'The animals are getting by on less sleep but they do not try and catch up. The ability to compensate for lost sleep is itself lost, which is damaging both physically and mentally.'

In the study, the researchers kept animals awake for 20 hours per day followed by a 4-hour sleep opportunity, over 5 consecutive days. The team monitored brainwave and muscle activity patterns in order to precisely quantify sleep–wake patterns. After the first day of sleep loss, animals compensated by increasing their intensity, or depth, of sleep, which is indicative of a homeostatic response [maintaining the stability of the body's internal environment]. However, on the subsequent days of sleep loss, the animals failed to generate this compensatory response and did not sleep any more deeply or any longer than they did under non-sleep deprived conditions (baseline measurements). At the end of the study, the animals were given 3 full days to sleep as much as they wanted. Amazingly, they recovered virtually none of the sleep that was lost during the 5-day sleep deprivation period.

The findings support what other scientists have discovered in recent experimental studies in humans. Chronic partial sleep loss of even 2–3 hours per night was found to have detrimental effects on the body, leading to impairments in cognitive performance, as well as cardiovascular, immune and endocrine functions. Sleep-restricted people also reported not feeling sleepy even though their performance on tasks declined.

The Northwestern team's results suggest that animals may undergo a change in their need for sleep in situations where normal sleep time is prohibited or where sleep could be detrimental for survival. An extreme but realistic example of this, says Turek, would be how animals respond to catastrophic environmental conditions. No matter how sleep deprived an animal or human may be, it would not be adaptive for the sleep homeostat to kick in and to make the animal fall asleep when it is in the midst of a flood or forest fire. Therefore, the body undergoes some change that allows it to counter its homeostatic need for sleep and to stay awake to avoid danger.

Turek and his team propose that this change in the sleep regulatory system is reflective of an allostatic response (the process of achieving stability or homeostasis through physiological or behavioural change). In the short term, allostatic responses are adaptive, but when sustained on a chronic basis, such as in their study, an allostatic load will develop and lead to negative health outcomes. The allostatic load resulting from the accumulating sleep debt loops back to the sleep regulatory system itself and alters it.

'Even though animals and humans may be able to adapt their sleep system to deal with repeated sleep restriction conditions, there could be negative consequences when this pattern is maintained over a long period of time,' said Turek. 'This brings us back to the idea that repeated partial sleep restriction in humans has been linked to metabolic dysfunction and cardiovascular disease.'

'Our lab is very interested in the interactions between sleep loss and metabolic function,' said Aaron D. Laposky, another author of the paper. 'We believe that when partial sleep loss occurs repeatedly over a long period of time, individuals are predisposed to alterations in the function of many physiological systems.'

Source: Adapted from Northwestern University. (2007, July 2). Chronically sleep deprived? You can't make up for lost sleep. *ScienceDaily*.

QUESTIONS

1 Identify the aim of this study.
2 Identify the population of research interest.
3 Identify the independent variable(s) and dependent variable(s) in this study.
4 Identify the participants in this study.
5 What were the results of this study?
6 What conclusion(s) can be drawn from this study?

TOTAL SLEEP DEPRIVATION

If a person is totally sleep deprived, the effects of acute partial sleep deprivation are magnified. Severe total sleep loss can cause a temporary psychological problem known as sleep-deprivation psychosis. **Sleep-deprivation psychosis** is a major disruption of mental and emotional functioning brought on by lack of sleep, and has symptoms such as confusion and

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disorientation. Psychologically, they may feel paranoid, or they may become extremely anxious or depressed. If their sleep deprivation lasts for approximately 72 hours they may suffer from perception problems such as hallucinations. Hallucinations may be visual, such as seeing yourself wearing a 'coat of furry worms'; or tactile, such as feeling cobwebs on your face.

In general, people who have been totally sleep deprived for two or three days show little impairment on relatively interesting or complex mental tasks (Binks, Waters & Hurry, 1999). Simple and routine tasks, however, seem to be very difficult for the sleep-deprived, and in these tasks most people experience problems with attention and concentration. This is particularly important to note for vehicle drivers, pilots or machine operators as, for these people, making a mistake when conducting simple or routine tasks may prove fatal. Sleep deprivation has been shown to produce psychomotor impairments equivalent to those induced by alcohol consumption at or above the legal limit (Dawson & Reid, 1997). For example, in a study of simulated driving performance, impairments in lane-keeping ability after a night without sleep were equivalent to those observed at blood alcohol content (BAC) of 0.07 per cent (Fairclough & Graham, 1999). Similarly, a study of professional truck drivers found that deficits in performance accuracy and reaction time at 28 hours of sleep deprivation were equivalent to those found after alcohol intoxication (BAC of 0.1 per cent) (Williamson & Feyer, 2000). Sleep deprivation poses a risk to safely operating all modes of transport and performing in other safety-sensitive activities. If a task is monotonous (such as factory work), no amount of sleep deprivation is safe (Gillberg & Akerstedt, 1998).

RECOVERING FROM PARTIAL SLEEP DEPRIVATION

Fortunately, the effects of acute partial sleep deprivation tend to be minor and temporary and, once the person resumes their normal uninterrupted sleep pattern and their sleep debt is repaid, they quickly recover. Generally, they fall asleep quicker and sleep longer than normal on their first full night of sleep after being sleep deprived. The person does not need to fully compensate for the amount of sleep lost; a few hours of extra sleep over the next few nights is usually enough for them to recover.

If, during their period of sleep deprivation, the person has been deprived of REM sleep, once they sleep normally they usually compensate for their REM deprivation by having extra amounts of REM sleep. This is known as **REM rebound**. REM rebound probably explains why many alcoholics have horrible nightmares after they give up drinking. Alcohol suppresses REM sleep and sets up a powerful rebound when it is withdrawn. For this reason, it is worth remembering that while alcohol (and other depressant drugs that have a similar effect) may help a person get to sleep, the quality of sleep is greatly reduced (Lobo & Tufik, 1997). Later experiments have shown that missing any sleep stage can cause a rebound for that stage.

8.7 CHECK YOUR UNDERSTANDING >>

1 People who are totally sleep deprived have greater impaired performance on __________ tasks.
   A simple
   B complex
   C new
   D interesting

2 A person may experience hallucinations after __________ hours of total sleep deprivation.
   A 35
   B 48
   C 55
   D 72

3 Identify three effects of total sleep deprivation that are not associated with acute partial sleep deprivation.

4 What is REM rebound and what is its purpose?

5 Describe what a person might experience if they suffered from sleep-deprivation psychosis.

TYPES OF SLEEP DISORDERS

To determine whether someone is suffering from a specific sleep disorder, they are often asked to spend a night in a specialist sleep disorders laboratory or a hospital so that their sleep behaviours can be studied. Approximately 65 000 sleep studies are conducted each year in Australia (Sleep Disorders Australia, 2016). The information gathered enables a sleep scientist to diagnose whether or not they have a sleep disorder and decide on the best treatment. The ultimate investigation is *polysomnography*, which uses a number of monitoring methods to gather information about

sleep-deprivation psychosis A disruption of mental and emotional functioning as a result of lack of sleep

REM rebound The process whereby an individual experiences extra amounts of REM sleep after being deprived of it

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a person's physiological behaviour during the various stages of their sleep cycle, including:

- electroencephalography (EEG) – brainwave monitoring
- electromyography (EMG) – muscle tone monitoring
- recording thoracic-abdominal movements – chest and abdomen movements
- recording oro-nasal flow – mouth and nose airflow
- pulse oximetry – heart rate and blood oxygen level monitoring
- electrocardiography (ECG) – heart monitoring

Sleep disorders are divided into two categories: dysomnias and parasomnias.

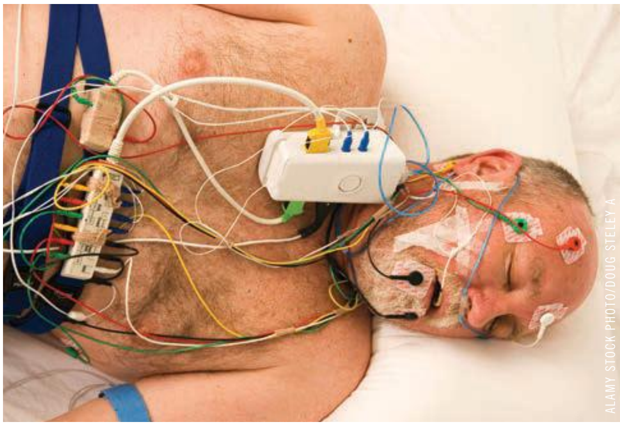

FIGURE 8.14 Specialist sleep laboratories use polysomnography to monitor and record a person's sleep behaviours. The results of the polysomnography allow sleep specialists to diagnose specific sleep disorders.

DYSOMNIAS: NARCOLEPSY AND SLEEP-ONSET INSOMNIA

Dysomnias are a group of sleep disorders characterised by persistent difficulty falling asleep, remaining asleep or waking up too early, and by hypersomnia (excessive sleepiness, usually during the day). Dysomnias disturb the amount, quality or timing of sleep, therefore they disrupt the body's natural sleep–wake cycle. As a result, people who suffer from a dysomnia do not get adequate restful or restorative sleep.

Dysomnias can be categorised according to the type of sleep problem the individual is experiencing. The three major categories of dysomnias include *intrinsic dysomnias* (arising from the body or a medical condition), *extrinsic dysomnias* (arising from environmental conditions) and *disturbances of circadian rhythm*. Common dysomnias include narcolepsy and sleep-onset insomnia.

Narcolepsy

Narcolepsy is a relatively rare sleep disorder but it is one of the most dramatic, serious and potentially dangerous dysomnias. Narcolepsy features recurrent sudden uncontrollable daytime sleep attacks that are accompanied by muscle paralysis. However, during some narcoleptic attacks the person may still continue automatic behaviour, particularly if they were engaged in a routine or a familiar or boring task when the attack began. In these cases, the individual often wakes with no memory of performing such activities.

Approximately 3 million people worldwide suffer from narcolepsy. Narcolepsy can occur in both men and women of any age; however, symptoms typically do not start until after puberty (SNORE Australia, 2016a). The sudden sleep may last anywhere from a few minutes to an hour, and the number and length of the attacks is not affected by the amount of sleep a person had the previous night. Narcoleptic attacks occur without warning and people with narcolepsy may fall asleep while standing, talking or even driving. Although there appears to be no specific trigger for or pattern to the attacks, emotional excitement (such as fear, anger or laughter) commonly triggers narcolepsy.

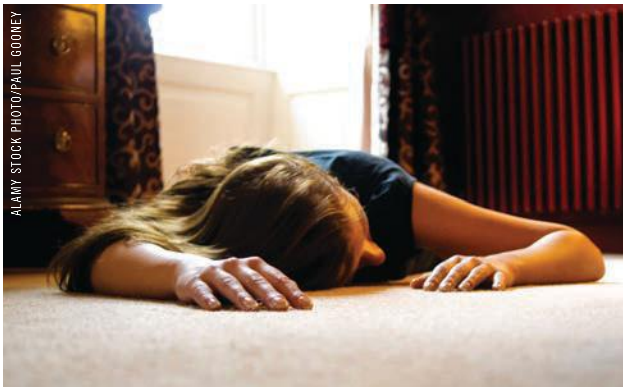

FIGURE 8.15 Individuals with narcolepsy are unable to resist sudden sleep attacks.

More than half of all people with narcolepsy also suffer from cataplexy, which is sudden and temporary loss of muscle tone and stability that leads to falling down, totally paralysed but fully conscious. Depending on the severity of the attack, minor effects such as slurring of speech may occur, but in severe cases complete loss of muscle tone occurs, resulting in the sufferer becoming limp and falling to the ground. In extreme cases of a full narcolepsy/cataplexy attack the person may experience auditory and/or visual hallucinations just before falling asleep (hypnagogic)

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or immediately after waking up (hypnopompic). Cataplexy is an abnormal version of the normal muscular paralysis that takes place during night-time REM sleep. For people without narcolepsy, REM sleep follows a period of NREM sleep, which lasts approximately 90 minutes. However, narcoleptics have abnormal sleep–wake cycles and when monitored on an EEG, narcoleptics tend to fall directly and rapidly into REM sleep. Thus, narcoleptic attacks and paralysis are thought to occur when REM sleep intrudes into waking consciousness (Siegel et al., 1991).

To be diagnosed with narcolepsy a person must present a clinical history of sleepiness that cannot be explained by other causes of daytime tiredness (such as obstructive sleep apnoea or other sleep disorders) and by a positive multiple sleep latency test, which measures **sleep latency** (the period of time it takes a person to fall asleep) and whether REM sleep occurs at sleep onset in multiple nap periods. Although the specific cause of narcolepsy is unknown, it is believed to be linked to a biochemical imbalance in the central nervous system. Narcolepsy usually begins in adolescence and lasts a lifetime. Although research suggests that narcolepsy probably results from a combination of genetic and environmental factors, its cause is unknown and there is no cure. Treatment focuses on the type of symptoms and how severe they are, not the cause.

FIGURE 8.16 Narcoleptic attacks occur without warning and people with narcolepsy may fall asleep while standing, talking or even driving.

Treatment usually involves a combination of stimulant drugs to reduce daytime sleepiness and antidepressant drugs (which suppress REM sleep) to decrease attacks of cataplexy. Daytime naps also help some narcoleptics to feel more alert, but their positive effects last for only a few hours. Light therapy (discussed later in this chapter) may help your body keep to a regular sleep and wake schedule.

Sleep-onset insomnia: Why can't I fall asleep?

Sleep deprivation differs from insomnia. **Insomnia** is a sleep disorder caused by the inability to sleep adequately regardless of ample opportunity to do so and it results in sleep deprivation. Insomnia is the most common sleep disorder and one of the most common health complaints in the general population. In Australia, the prevalence of insomnia is estimated between 13 and 33 per cent of the population (Bartlett, Marshall, Williams, & Grunstein, 2007). Insomnia can be caused by a range of psychological, physiological or behavioural factors. Insomnia can be acute or chronic and its causes and symptoms vary. Despite these variations, insomnia always results in sleep deprivation.

A diagnosis of insomnia requires that the symptoms persist for at least 1 month, and insomnia is considered chronic if it persists for at least 6 months (Stanford Health Care, 2015).

Insomnia can manifest itself in a number of ways, including an inability to fall asleep (sleep-onset insomnia), frequent night-time waking (sleep-maintenance insomnia), waking too early, or a combination of these.

Sleep-onset insomnia is a sleep disorder characterised by an inability to fall asleep at the

dysomnias A group of sleep disorders characterised by disturbance of normal sleep pattern, including quality, amount and timing of sleep

narcolepsy A sleep disorder in which an individual suffers sudden uncontrollable daytime sleep attacks accompanied by muscle paralysis lasting from a few minutes to half an hour

cataplexy A sudden temporary muscle paralysis that leads to falling down; where someone is totally paralysed but fully conscious

sleep latency The period of time it takes a person to fall asleep

insomnia A sleep disorder characterised by the inability to fall sleep, frequent night-time waking, waking too early, or a combination of these, which results in sleep deprivation

sleep-onset insomnia A sleep disorder characterised by an inability to fall asleep at the beginning of the night, or at the point of normal 'sleep onset'

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FIGURE 8.17 People who suffer from sleep-onset insomnia are unable to fall asleep when they go to bed and may not fall asleep until the early hours of the morning. Because of their reduced sleep time, they often feel tired and lethargic in the morning.

beginning of the night, or at the point of normal 'sleep onset'. The symptoms of sleep-onset insomnia vary depending on whether the insomnia is acute or chronic. Daytime symptoms include not feeling refreshed on waking and feeling tired and lethargic during waking hours, a reduced sense of wellbeing, difficulties with concentration and memory, mood swings, lack of motivation, feeling depressed or anxious, irritability, and increased clumsiness and impaired performance. If the insomnia is acute, these symptoms are short term and can last from one night to a few weeks; however, they generally subside once the person returns to their normal sleep pattern. Acute insomnia is often caused by emotional or physical discomfort, and it can be related to a single specific event. For chronic insomniacs, though, the symptoms associated with the disrupted sleep onset pattern can be severely debilitating to the point of shifting behaviour and psychological triggers that manage sleep and other natural rhythms.

CAUSES OF SLEEP-ONSET INSOMNIA

Psychological factors such as anxiety, depression, and excitement can lead to insomnia. Anxiety sufferers also commonly report disturbances in onset sleep latency. This means the period of time it takes them to fall asleep at night becomes longer, which adds to their anxiety and causes further sleep delays.

Physiological factors can also lead to sleep-onset insomnia. Factors such as genetic predisposition, disruption to circadian rhythms (for example, by delayed or reduced melatonin release), health problems that cause chronic pain or breathing difficulties, abnormal thyroid function, acid reflux disorder, restless legs syndrome and dementia have all been linked to insomnia.

Behavioural factors may also contribute to sleep-onset insomnia. The use of many drugs and commonly consumed substances such as coffee, nicotine and alcohol during the day or before going to bed can make it difficult to fall asleep. Lifestyle habits, lack of exercise, shift work and international travel can also result in insomnia. Visual stimulation as a result of watching television or working on a computer before going to bed can also play a role in sleep-onset insomnia. Not only does the artificial light from their screens reduce melatonin production, it increases evening cortisol levels. As a result, your sympathetic nervous system is kept activated and you feel aroused rather than sleepy.

TREATMENT OF SLEEP-ONSET INSOMNIA

At present, there is no cure for sleep-onset insomnia and most treatments focus on managing the disorder rather than curing it. These treatments try to control the sufferer's symptoms and adjust the sleep–wake cycle into a regular pattern. Like other forms of

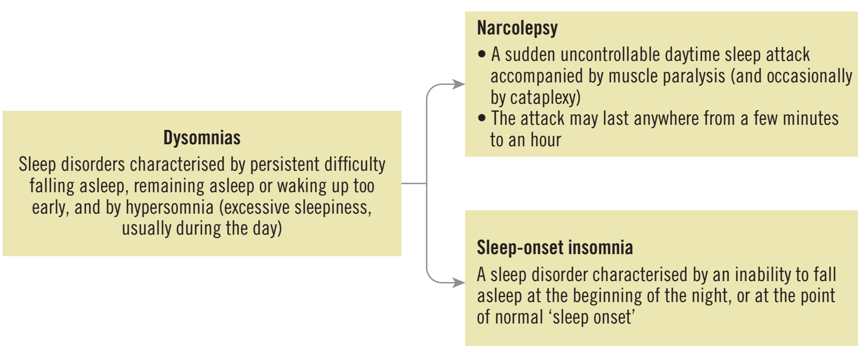

FIGURE 8.18 Common dysomnias

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insomnia, sleep-onset insomnia treatments can include one or a combination of the following:

- medication to help a person fall asleep and stay asleep; however, long-term use may disrupt the sleep cycle by decreasing the amount of REM sleep, so they become ineffective
- over-the-counter sleeping aids
- behavioural therapy, principally cognitive behaviour therapy (CBT)
- all-natural, homeopathic and alternative therapies, including teas, herbal therapies and acupuncture
- regular physical exercise – but not late in the evening
- developing a regular sleep routine and avoiding stimulants, hard-to-digest meals or alcohol before going to bed.

8.8 CHECK YOUR UNDERSTANDING >>

1 Brian has sudden and uncontrollable sleep attacks several times a day, and sometimes experiences a loss of muscle tone that causes him to collapse to the ground. It is most likely that Brian:
A has REM-sleep behaviour disorder.
B has narcolepsy.
C has severe insomnia.
D is experiencing free-running circadian rhythms.

2 Some narcoleptics are fully conscious but they lose muscle tone and fall down paralysed. When this happens, they are experiencing:
A sleep-onset insomnia.
B chronic insomnia.
C cataplexy.
D sleep latency.

3 Polysomnography is:
A a form of treatment for sleep disorders.
B a technique for recording activity during sleep.
C a medical condition that produces insomnia.
D a form of treatment for narcolepsy.

4 Symptoms of narcolepsy include all of the following, except:
A cataplexy.
B sleep attacks.
C sleep paralysis.
D sleepwalking.

5 Anna and her friend Zoe normally go to bed at 10.30 p.m. They both usually fall asleep around 11 p.m. and normally wake up at 7.30 a.m. One day, Anna tells Zoe that for the past 2 weeks she has been waking up at around 3 a.m. and can't get back to sleep. Zoe tells Anna that she has been finding it very difficult to fall asleep before 1 a.m. and, although she hasn't been waking during the night, when she wakes each morning she still feels very tired.
A Anna suffers from cataplexy and Zoe suffers from sleep-onset insomnia.
B Zoe suffers from narcolepsy and Anna suffers from sleep-onset insomnia.
C Anna suffers from narcolepsy and Zoe suffers from sleep-onset insomnia.
D Both Anna and Zoe suffer from insomnia.

6 Describe the characteristics of dysomnias.

7 Describe three symptoms a person diagnosed with sleep-onset insomnia would display.

PARASOMNIAS: SLEEP APNOEA AND SLEEPWALKING

Parasomnias are a group of sleep disorders characterised by abnormal movements, behaviours, emotions, perceptions or dreams that occur while falling asleep, at any point in the sleep cycle or on waking from sleep. Parasomnias interfere with certain stages of sleep or they disrupt the transition from sleep to awake. Although these behaviours may sometimes be complex and appear purposeful to others, the person experiencing them remains asleep during the event and often has no memory that it occurred. Parasomnias common during REM sleep include REM sleep behaviour disorder and recurrent isolated sleep paralysis. Parasomnias common during NREM sleep include teeth grinding (bruxism), night terrors, sleep talking, sleep-related eating disorder, sleep apnoea and sleepwalking.

Sleep apnoea

Someone once said, 'Laugh and the world laughs with you; snore and you sleep alone'. While nightly snoring is often harmless, it can signal a serious problem. A person who snores loudly, with short silences and loud gasps or snorts, may suffer from a form of sleep-maintenance insomnia known as sleep apnoea. **Sleep apnoea** is a sleep disorder where breathing stops between 20 seconds and up to 2 minutes while the person is asleep (apnoea means 'absence of breath'). Sleep apnoea deprives the body of oxygen and, as the need for oxygen becomes intense, the person wakes a little and gulps in air before settling back to sleep. They may even sit upright, fling their arms or experience a body jerk. But soon breathing stops again. This cycle is repeated hundreds of times a night, depriving the person of Stage 4 slow-wave or deep sleep. Sleep apnoea may occur during any stage of the sleep cycle.

parasomnias A group of sleep disorders characterised by abnormal or unusual behaviour or physiological occurrences during sleep

sleep apnoea A sleep disorder characterised by multiple non-breathing periods during sleep, where breathing stops between 20 seconds and up to 2 minutes

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FIGURE 8.19 Sleep apnoea can stop a person breathing, and hence wake them, hundreds of times a night.

The major symptom of sleep apnoea is loud, heavy snoring during sleep, which is often interrupted by pauses and gasps. Because sleep apnoea disrupts the sleep cycle, people with sleep apnoea usually experience excessive daytime sleepiness (hypersomnia), which is often accompanied by increased irritability or restlessness. Morning headaches, forgetfulness, changes in mood or behaviour, anxiety or depression and decreased interest in sex are also signs of sleep apnoea.

Sleep apnoea is diagnosed by measuring airflow and breathing effort (indicated by movement of the chest and abdomen). *Central sleep apnoea* occurs when there is no airflow and no effort to breathe. *Obstructive sleep apnoea* occurs when there is no airflow, but there is effort to breathe.

Sleep apnoea
Hundreds of times a night, a person stops breathing between 20 seconds and up to 2 minutes while asleep

Central sleep apnoea
The person has no airflow and makes no effort to breathe because their brain stops sending signals to their diaphragm muscles that control breathing to maintain normal breathing

Obstructive sleep apnoea
The person makes an effort to breathe but because their upper airways are blocked, they have no airflow

FIGURE 8.20 Types of sleep apnoea

CENTRAL SLEEP APNOEA (CSA)

Some sleep apnoea occurs because the brain stops sending signals to the diaphragm muscles that control breathing to maintain normal breathing, causing breathing to be regularly disrupted during sleep because the person does not try to breathe. This is known as **central sleep apnoea (CSA)**. Central sleep apnoea occurs when the brain is slow to recognise or doesn't respond to changes in oxygen and carbon dioxide levels when breathing decreases. It may result from heart problems, which may cause a pattern of overbreathing followed by underbreathing or by slow circulation that disturbs the normal reflex pathways. Some medications or strokes that affect the midbrain's breathing centres may also result in central sleep apnoea. Weakness in the breathing muscles also contributes to CSA (Shneerson, 2016).

OBSTRUCTIVE SLEEP APNOEA (OSA)

The most common form of sleep apnoea is obstructive sleep apnoea. **Obstructive sleep apnoea (OSA)** involves multiple non-breathing periods during sleep as a result of an obstruction or blockage in the upper airways, making it impossible for the person to breathe. When this happens, the chest and abdomen keep moving, but no air gets through to the lungs. Finally, reflexes kick in and the person gasps or produces a loud, startling snore, and rouses.

Obstructive sleep apnoea is most common among overweight, middle-aged males, particularly with excess fatty tissue around their neck (Sleep Disorders Australia, 2006). In Australia, approximately 9 per cent of women and 25 per cent of men have clinically significant OSA (SNORE Australia, 2016b). The shape of the person's jaw, throat or nose may also cause a narrowing of their upper airway; as will a large tongue or large tonsils. Illness or the use of some medications

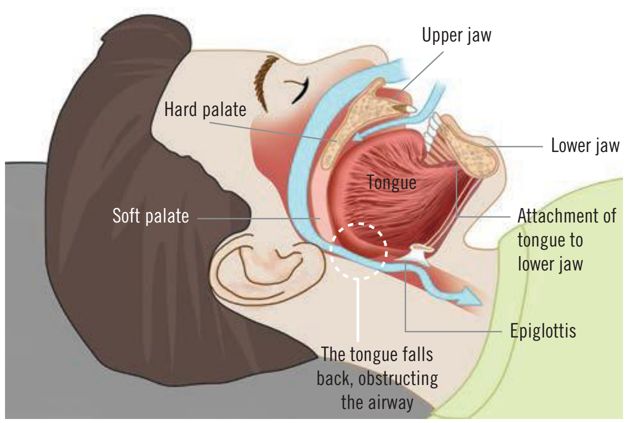

FIGURE 8.21 During sleep, gravity and muscle relaxation allow the tongue and surrounding soft tissues to fall back into the throat area, obstructing airflow.

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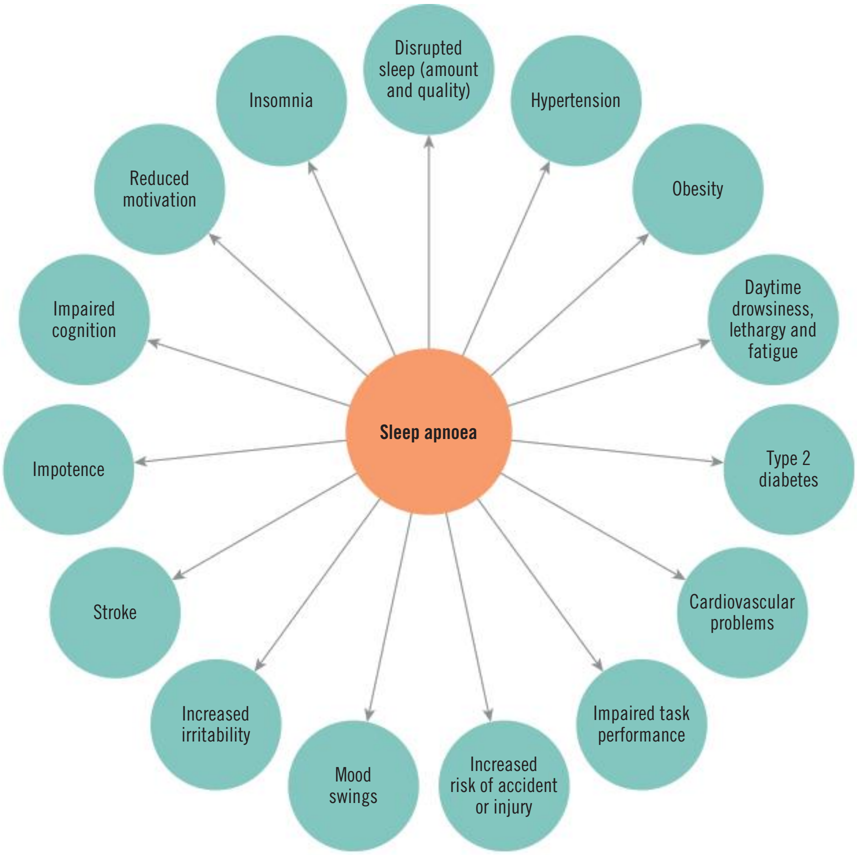

FIGURE 8.22 Complications associated with sleep apnoea

(for example, sedatives at night) can also cause sleep apnoea. Sagging tissue as throat muscles lose tension and become too relaxed during sleep can also cause OSA.

Effects of sleep apnoea

The continuous cycle of non-breathing and interruptions to the sleep cycle that occurs in people with sleep apnoea has detrimental effects on a person's health as well as their sleep quality. Sleep apnoea causes sufferers to feel tired, lethargic and irritable during their waking, daylight hours. It increases their risk of insomnia, obesity, high blood pressure, stroke, heart attack, type 2 diabetes, impotence, mood disorders, excessive daytime sleepiness, and motor vehicle and industrial accidents. Sleep apnoea also has a negative impact on cognitive function and quality of life. It can lead to depression, anxiety, lack of motivation, impaired memory and concentration, mood changes and behavioural changes. Sleep apnoea sufferers who are excessively sleepy during the day are also at high risk of accidents, particularly motor vehicle accidents. Daytime tiredness can also affect study, work performance and personal relationships (SNORE Australia, 2016b).

In addition, the sleep cycles of family members who sleep with or nearby the person with sleep apnoea are often disrupted.

Treatments for sleep apnoea

Sleep apnoea is sometimes treated by having the sleeper wearing a nasal mask attached to a pump that continuously delivers air, keeping the air passages open and maintaining regularity of breathing during sleep. This treatment is known as nasal continuous positive airway pressure (CPAP). However, treatment for sleep apnoea largely depends on the individual and the cause and severity of the disorder. For example, if CSA is caused by a heart condition, the treatment would focus on treating the heart condition itself. Some types of CSA are also treated with medicines that stimulate breathing. For those with obstructive sleep apnoea,

central sleep apnoea (CSA) A sleep disorder characterised by multiple non-breathing periods during sleep because the brain stops sending signals to the diaphragm muscles that control breathing to maintain normal breathing

obstructive sleep apnoea (OSA) A sleep disorder characterised by multiple non-breathing periods during sleep because of an obstruction or blockage in the upper airways tranquillisers may relax throat muscles and surgery may be performed to remove the obstruction blocking the airways.

In recent times, small disposable adhesive devices that cover the nostrils have also been successful in treating some obstructive sleep apnoea sufferers. With these devices, microvalves control the amount of airflow in and out of the nasal passage, increasing the air pressure inside the airways so they do not collapse. In addition, people with sleep apnoea are encouraged to sleep with their head on the side, so their airways stay open. This is because sleep apnoea and snoring are almost always worse when the person is sleeping on their back (or particularly, with the head in this position). In this position, the back of the tongue and muscles of the pharynx block the airway more easily mainly because our muscles relax during sleep and, when we are flat on our backs and face upwards, the tongue then sags backwards under the influence of gravity.

FIGURE 8.23 Sleep apnoea sufferers often find relief by using a continuous-positive-airway-pressure (CPAP) mask that delivers constant air pressure in their windpipe and helps their airways stay open when they sleep.

FOCUS ON RESEARCH 8.3

BRAIN DAMAGE CAUSED BY SEVERE SLEEP APNOEA IS REVERSIBLE

A recent neuroimaging study is the first to show that damage to the brain's white matter caused by severe obstructive sleep apnoea can be reversed by continuous positive airway pressure (CPAP) therapy. White matter carries nerve impulses between neurons. It is composed of bundles of myelinated nerve cell axons, which connect various grey matter areas (the locations of nerve cell bodies) of the brain to each other.

The study involved 17 men with severe, untreated obstructive sleep apnoea whose average age was 43 years. The participants were evaluated at baseline and after both 3 months and 12 months of treatment with CPAP therapy. At each time point they underwent a neuropsychological evaluation and a diffusion tensor imaging examination (DTI), a form of magnetic resonance imaging that measures the flow of water through brain tissue. Participants were compared with 15 age-matched, healthy controls who were evaluated only at baseline.

The results showed that participants with severe, untreated sleep apnoea had a significant reduction in white matter fibre integrity in multiple brain areas. This brain damage was accompanied by impairments to cognition, mood and daytime alertness. Although 3 months of CPAP therapy produced only limited improvements to damaged brain structures, 12 months of CPAP therapy led to an almost complete reversal of white matter abnormalities. Treatment also produced significant improvements in nearly all cognitive tests, mood, alertness and quality of life.

'Structural neural injury of the brain of obstructive sleep apneoa patients is reversible with effective treatment,' said principal investigator and lead author Vincenza Castronovo, clinical psychologist at the Sleep Disorders Centre at San Raffaele Hospital and Vita-Salute San Raffaele University in Milan, Italy. 'Treatment with CPAP, if patients are adherent to therapy, is effective for normalising the brain structure.'

A previous study by Castronovo's research team found similar damage to grey matter volume in multiple brain regions of people with severe sleep apnoea. Improvements in grey matter volume appeared after 3 months of CPAP therapy. According to the authors, the two studies suggest that the white matter of the brain takes longer to respond to treatment than the grey matter.

The study was published in the September 2014 issue of the journal *SLEEP*.

Source: Adapted from American Academy of Sleep Medicine. (2014, September 8). Brain damage caused by severe sleep apnea is reversible. *ScienceDaily*.

QUESTIONS

1 Identify the aim of this research study.
2 Identify the research design used in this study and state one advantage and one limitation of this design.
3 Write a possible hypothesis for this study.
4 Identify the results from this study.
5 What conclusions can be drawn from these results?

SLEEPWALKING

Sleepwalking, also known as somnambulism, is a sleep disorder that occurs when a sleeping person walks and sometimes does routine tasks or activities, often when in deep non-REM sleep. For example, in 2005 a 19-year-old woman in the United States who had a history of sleepwalking was found in her pyjamas and

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no shoes after she walked over 14 kilometres from her home while she was asleep (Mohney, 2015).

Sleepwalking episodes can range from quiet walking about the room to agitated running or attempts to 'escape'. Sleep walkers (somnambulists) have intact vision and coordination, so they can avoid obstacles, descend stairways and climb trees. On rare occasions, however, they may injure themselves accidentally, such as by falling down stairs or wandering out of their home. The sleepwalker's eyes are usually open, but a blank stare and shuffling feet reveal that the person is still asleep. In some cases, they may talk but they do not make sense. Although sleepwalking incidents generally involve simple, repeated behaviour, sleepwalkers can complete complex activities such as moving furniture, making coffee, dressing themselves or even driving a car. During an episode of sleepwalking the person is usually unresponsive to communication, so it is difficult to wake them. The sleepwalking episode can last a few seconds or for 30 minutes or longer. If the sleepwalker does wake, they are generally disoriented, confused and do not remember what it was that they were doing while sleepwalking. A parent who finds a child sleepwalking should gently guide the child back to bed. Waking a sleepwalker will do no harm, but is unnecessary. If they are not disturbed, sleepwalkers will go back to sleep and they usually do not remember the episode when they wake up.

Sleepwalking is an arousal disorder, and EEG studies have shown that sleepwalking typically occurs during deep sleep early in the night during the first or second sleep cycle. During these cycles people tend to sleepwalk during Stages 3 and 4 of NREM of sleep because they are still able to move rather than during REM sleep when dreams are most common and the body is paralysed (Horne, 1992; Kales & Kales, 1975). If sleepwalking occurs during REM sleep, it is part of REM behaviour disorder and tends to happen near morning.

FIGURE 8.24 Sleepwalking has been described in medical literature for centuries. In Shakespeare's 17th-century play *Macbeth* one of the principal characters, Lady Macbeth, is observed by a doctor and a maid as she walks, talks and rubs her hands in a washing motion while she sleeps. These behaviours were seen as evidence of her overwhelming guilt and insanity following her involvement in the brutal murder of King Duncan.

FIGURE 8.25 A 55-year-old British woman temporarily blinded herself after she overdosed on anti-malaria tablets during a sleepwalking episode. When she woke, she was dazed and confused but had no memory of taking the tablets.

Causes and treatments

Sleepwalking is most common in children, particularly in children aged 5–12 years. Although it usually disappears by early adolescence, it can continue throughout adulthood. The causes of sleepwalking are unknown, but fatigue, sleep deprivation, stress and anxiety are all thought to be contributing factors. The fact that parents who are sleepwalkers tend to have children who are sleepwalkers suggests

sleepwalking A sleep disorder characterised by a sleeping person walking and sometimes completing routine tasks or activities, often when in deep sleep (Stages 3–4 NREM)

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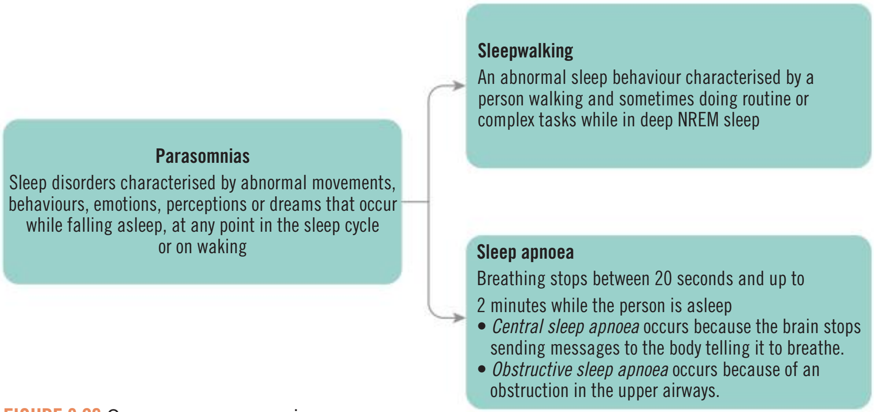

FIGURE 8.26 Common parasomnias

that sleepwalking may be hereditary. Sleepwalking occurs more frequently in identical twins, and is 10 times more likely to occur if a first-degree relative has a history of sleepwalking (Mersch, 2015). For adult sleepwalkers, daytime stress, alcohol, and certain physical illnesses, mental disorders and medications may also increase sleepwalking. In the elderly, sleepwalking may be a symptom of decreased mental function due to organic brain decay (organic brain syndrome) or REM behaviour disorder (Dugdale, 2013).

Isolated incidents of sleepwalking are generally not an indication of any serious problems that require treatment. However, if sleepwalking is a recurrent behavioural pattern, this may suggest an underlying sleep disorder. In these instances, a variety of treatments may be used to treat sleepwalking, including psychotherapy, hypnosis, drugs and routinely waking the person before the time they typically sleepwalk (Frank, Spirito, Stark, & Owens-Stively, 1997).

For most sleepwalkers, many experts advise putting away dangerous items and locking doors and windows before sleep to reduce risks of harmful activity. Good sleep hygiene and avoiding sleep deprivation are also recommended.

8.9 CHECK YOUR UNDERSTANDING >>

1 During most nights when asleep, Louis snores loudly and he stops breathing for short periods of time. When this happens, Louis wakes up, gulps in air and then goes back to sleep. Louis is experiencing:
  - A narcolepsy.
  - B a dysomnia.
  - C sleep apnoea.
  - D cataplexy.

2 Which of the following statements about sleepwalking is most accurate?
  - A Sleepwalking is generally the result of underlying psychological problems.
  - B It is unsafe to wake a sleepwalker.
  - C Sleepwalking typically occurs while the person is dreaming.
  - D There appears to be a genetic predisposition to sleepwalking.

3 A sleep disorder in which a person suffers from repeated, sudden and irresistible daytime REM sleep attacks is known as:
  - A insomnia.
  - B narcolepsy.
  - C somnambulism.
  - D sleep apnoea.

4 Sleepwalking usually occurs:
  - A during REM sleep.
  - B during Stage 2 NREM sleep.
  - C during Stages 3–4 NREM sleep.
  - D when people are dreaming.

5 Explain one similarity and two differences between central sleep apnoea (CSA) and obstructive sleep apnoea (OSA).

6 Even without being told that somnambulism is a non-rapid eye movement (NREM) event, you could have predicted that sleepwalking does not occur during REM dreaming. Explain why you could make this prediction?

TREATING SLEEP DISORDERS

Most people experience sleep disturbances at some point in their lives but not everyone develops a sleep disorder. Sleep disorders are a medical condition and like a number of other medical conditions, they may be caused by psychological, physiological or environmental factors – or a combination of these. Anyone at any age can develop a sleep disorder and, depending on the cause and the treatment, sleep disturbances can be short-term or long-term.

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Although all sleep disorders interfere with a person's sleep pattern and affect their daily functioning, each sleep disorder is unique. To successfully treat a sleep disorder, a trained therapist or medical practitioner must identify the type of disorder and its causes. Then, they can shape a treatment aimed at eradicating the disorder or reducing its effects.

COGNITIVE BEHAVIOURAL THERAPY: A PSYCHOLOGICAL TREATMENT FOR INSOMNIA

Cognitive behavioural therapy (CBT) is a type of psychotherapy that uses a range of cognitive and behavioural therapies and learning principles to help people change unhelpful or unhealthy thought processes, feelings and behaviour. It is a 'talking therapy' based on the premise that the way a person thinks about something, determines how they feel about it and respond to it. Therefore, if they change the way they think about it, they can then change their behaviour. Cognitive behavioural therapy focuses on identifying and changing behaviours, setting and achieving goals, increasing self-awareness and empowering an individual to take control of their problem.

When used as a treatment for insomnia (sleep-onset or sleep-maintenance insomnia), CBT-I (cognitive behavioural therapy for insomnia) focuses on overcoming the causes of a person's sleep problems and changing their maladaptive responses rather than just treating the symptoms. Recent studies that compared CBT-I to other treatments for insomnia consistently found that CBT-I is the most effective treatment for chronic insomnia. It achieves better results than other treatments and has no harmful side effects. For example, Jacobs, Pace-Schott, Stickgold and Otto (2004) found that the improvement in time taken to fall asleep and the amount of time spent awake during the night was maintained at 12, 24 and 36 months after treatment with CBT-I.

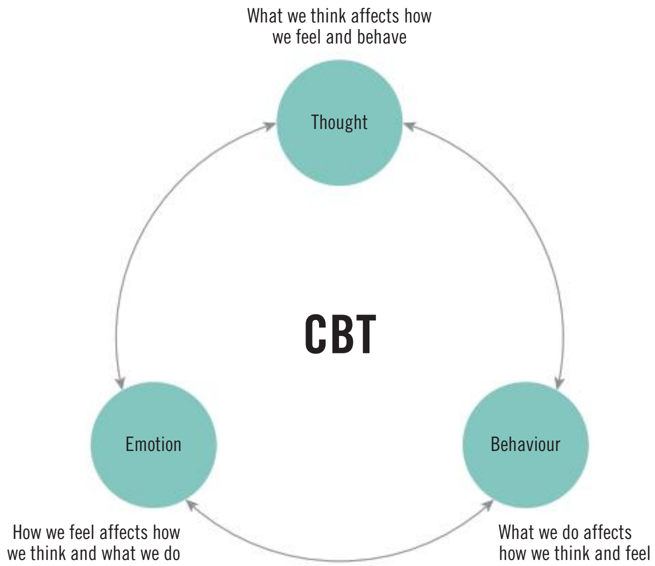

FIGURE 8.27 Cognitive behavioural therapy (CBT) is a psychotherapy that can be used to treat people with insomnia.

COGNITIVE COMPONENT

Cognitive therapy focuses on changing the way a person thinks about an issue that causes problems for them. The cognitive component of CBT-I focuses on correcting faulty cognitions or beliefs the person may have about sleep that may affect their sleeping behaviour. CBT-I begins by providing them with correct information about sleep, such as sleep norms, age-related sleep changes, reasonable sleep goals, the effects of ageing and sleep deprivation, and the influence of naps and exercise. Then, it teaches the person to identify and replace any sleep-interfering thoughts with more realistic and positive thoughts that promote sound sleep. The person may be asked to keep a sleep diary in which they record any thoughts they may have that interfere with their ability to fall asleep.

BEHAVIOURAL COMPONENT

Once the person's faulty cognitions have been attended to, the behavioural component of CBT-I focuses on identifying any negative or maladaptive behaviours they may have developed in response to their faulty cognitions, which hinder their ability to sleep. Then, the therapist works with them to develop strategies to modify or remove their unhelpful behaviours and develop positive sleeping habits.

Some common CBT techniques for insomnia include:

- *Stimulus control therapy*. This method targets factors that condition the mind to resist sleep. It encourages clients to use the bed for sleep rather than for activities that can stimulate the mind and interfere with sleep, such as reading, watching television, playing on your phone or computer, or planning activities for the next day.

cognitive behavioural therapy (CBT) The application of learning principles to change thought processes and human behaviour, especially maladaptive behaviour

- *Sleep restriction therapy*. This therapy aims to reduce the time spent lying awake through a strict bed- and wake-time routine, so that the time spent in bed better matches actual sleep time. Once sleep has improved, time in bed is gradually increased.
- *Sleep hygiene*. This method involves changing basic lifestyle habits that influence the quality and length of sleep, such as smoking or drinking too much caffeine late in the day, drinking too much alcohol, or not getting regular exercise. It also encourages the person to avoid the use of electronic media such as computers, televisions, game consoles, smartphones, e-readers or tablets at least 1–2 hours before sleep.
- *Relaxation training*. This method helps calm the mind and body. It includes meditation, guided imagery, progressive muscle relaxation and breathing exercises.
- *Sleep environment improvement*. This offers ways to create a comfortable sleep environment, such as keeping the bedroom quiet, dark and cool, not having a TV in the bedroom, and hiding the clock from view.

For some sufferers of insomnia, the most effective treatment approach may be a combination of several of these methods.

BRIGHT LIGHT THERAPY: A PHYSIOLOGICAL TREATMENT FOR CIRCADIAN PHASE DISORDERS

Bright light therapy, also called light therapy or phototherapy, exposes people to intense but safe amounts of artificial light for a specific and regular length of time to help synchronise their sleep–wake cycle with a normal external day–night cycle. Bright light therapy is a physiological treatment aimed at reducing the symptoms of sleep disorders, particularly circadian phase disorders caused by abnormal timing of circadian rhythms. The objective of bright light therapy is to adjust the person's circadian rhythm so their sleep–wake pattern is in sync with environmental shifts in natural light that occur during an external day–night cycle. Several hours of daily phototherapy can shift circadian rhythms by as much as 2–3 hours per day (Shanahan, Kronauer, Duffy, Williams, & Czeisler, 1999).

During bright light therapy, a person is exposed to a specific level of artificial light for brief periods during strategic times of the day that are intended to mimic natural daylight involved in regulating the body's sleeping and waking cycles. The person sits near a light box that consists of 2500- to 10 000-lux fluorescent bulbs with a diffusing screen. They do not look directly at the light but their body is angled towards the box in such a way that the light still hits their eyes. Usually sessions last about 30 minutes, but a session can last between 15 minutes and 2 hours. During a session, people engage in normal daily activities such as reading, eating, using a computer or watching television.

FIGURE 8.28 Bright light therapy exposes people to intense but safe amounts of artificial light so the circadian rhythms that control their sleep–wake cycle can realign to the natural cycle of night and day.

Bright light therapy has proved beneficial for people suffering from various forms of insomnia, particularly insomnias that result from a shift in their circadian rhythms. Individuals with sleep-onset insomnia have difficulty falling asleep at a 'normal' time but can maintain sleep once it is initiated. If their insomnia is associated with delayed or later-timed circadian rhythm, bright light therapy in the morning after waking can either advance or time circadian rhythms earlier, so they should find it easier to sleep at a normal time. Individuals who experience delayed sleep phase disorder, such as adolescents, may also benefit from bright light therapy. Adolescents should avoid bright light at night before they go to bed and expose themselves to light as soon as they wake up at the time required to begin their daily activities. If they find themselves becoming sleepy during the day, exposure to bright light can help to increase their alertness.

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8.3 TRY IT YOURSELF >>

THE POWER OF LIGHT

Choose a time during the day when you are feeling tired. Go outside and sit in the sunshine for 20 minutes. Compare how you felt at the beginning and end of your time in the sun. Do you notice any difference? How can you explain this?

Individuals experiencing early morning insomnia have no difficulty initiating sleep but wake before they intend to and are unable to go back to sleep. These individuals may have an advanced or early-timed circadian rhythm. Bright light therapy in the evening before sleep would be indicated for this type of insomnia as well as for the more extreme version, advanced sleep phase disorder.

Although it has proved useful in reducing the symptoms of sleep disorders, some users of bright light therapy have experienced negative side effects such as headaches, eyestrain or nausea during the first few sessions. These effects can be reduced by shortening the therapy sessions, or the patient can move further away from the light box. A rare response to bright light therapy is hyperactivity, making the patient feel high, irritable, restless, manic or agitated.

8.10 CHECK YOUR UNDERSTANDING >>

1 Which of the following statements about cognitive behavioural therapy for insomnia (CBT-I) is false?
   A CBT-I is the most effective treatment for insomnia.
   B CBT-I may increase insomnia in some patients.
   C CBT-I has no harmful side effects.
   D Initially, CBT-I focuses on changing faulty thoughts about sleep, then it focuses on identifying negative sleep behaviours and replacing them with positive behaviours.

2 CBT-I is:
   A a physiological therapy used to treat insomnia.
   B a psychological therapy used to treat insomnia.
   C a physiological therapy used to treat circadian rhythm disorders.
   D a psychological therapy used to treat circadian rhythm disorders.

3 Bright light therapy is:
   A a physiological therapy used to treat insomnia.
   B a psychological therapy used to treat insomnia.
   C a psychological therapy used to treat circadian rhythm disorders.
   D a physiological therapy used to treat circadian rhythm disorders.

4 Bright light therapy would be most useful for people who suffer from:
   A a circadian rhythm disorder.
   B insomnia.
   C narcolepsy.
   D sleep apnoea.

5 Explain the difference between the cognitive component and the behavioural component of cognitive behavioural therapy.

6 What is the aim of bright light therapy?

bright light therapy A treatment for circadian phase disorder that exposes people to intense but safe amounts of artificial light for a specific and regular length of time to help synchronise their sleep–wake cycle with a normal external day–night cycle

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CHAPTER SUMMARY

Circadian rhythms and the sleep–wake cycle

- Many of our behaviours are regulated by the body's innate circadian rhythms and the sleep–wake cycle is an example of a circadian rhythm that changes over the lifespan. Circadian rhythms are controlled by the suprachiasmatic nucleus (SCN) located in the brain's hypothalamus. The SCN reacts to changes in the level of external light, so it controls our sleep–wake cycle. It does this though its connection to the pineal gland, the gland that secretes the sleep inducing hormone melatonin. At night when the light level is low, the SCN signals the pineal gland to secrete more melatonin, so we feel sleepy. As dawn approaches, the light level increases so the SCN signals the pineal gland to decrease melatonin secretion. At the same time, there is a natural increase in the level of cortisol released into the bloodstream, which helps to wake and energise us.

Shifts in the sleep–wake cycle

- As we age, our circadian rhythms change and these changes contribute to a natural shift in our sleep–wake cycle. As a result, the amount of time we spend asleep and awake in a 24-hour period and the timing of sleep and wakefulness changes.
- Circadian phase disorders occur when the sleep–wake cycle is out of sync with the natural day–night cycle of the external environment that drives our circadian rhythms. This lack of synchronisation causes the timing and length of periods of sleep and wakefulness/alertness, as well as hormonal and other daily cycles, to be disrupted. Circadian phase disorder can be caused by age-related natural shifts in the sleep–wake cycle and the experience of shift work and jet lag.
- The circadian rhythms that regulate the sleep–wake cycle naturally shift to a later sleep and wake time as children move into puberty and adolescence. This shift results in a sleep phase delay, which causes a delay in sleep onset. As a result, adolescents get less sleep each night and they suffer the effects of sleep deprivation.
- Shift work disrupts the circadian rhythms that govern the sleep–wake cycle and this can result in shift work disorder. Rapid travel across multiple time zones also disrupts these rhythms and this results in jet lag.

Effects of partial sleep deprivation

- Disruptions to the sleep–wake cycle lead to sleep deprivation, which may affect the person psychologically and physically.
- Sleep deprivation can be partial, total, acute or chronic. Its psychological effects include amplified emotional responses and impairment of cognitive functioning. Behavioural effects include an inability to perform fine motor functions and an increase in clumsiness and accidents or injury.
- To alleviate the effects of sleep deprivation during the day, the body reacts with brief periods of sleep called 'microsleeps'. Microsleeps are brief periods of sleep that occur during wakefulness. Because they involve a lack of awareness, microsleeps are potentially dangerous.
- The effects of acute partial sleep deprivation are generally overcome by one full night of uninterrupted sleep.

Sleep disorders: Dysomnias and parasomnias

- Dysomnias involve persistent difficulty falling asleep, remaining asleep or waking up too early, and by hypersomnia. Dysomnias disturb the amount, quality or timing of sleep, therefore they disrupt the body's natural sleep–wake cycle, which results in sleep deprivation. Common dysomnias include narcolepsy and sleep-onset insomnia.
  - Narcolepsy is a relatively rare sleep disorder. It is characterised by recurrent, sudden, uncontrollable daytime sleep attacks that are accompanied by muscle paralysis. Narcolepsy is sometimes accompanied by cataplexy, a sudden and temporary loss of muscle tone and stability that leads to falling down, totally paralysed but fully conscious.
  - Sleep-onset insomnia involves an inability to fall asleep at the beginning of the night, or at the point of normal 'sleep onset'. Sleep-onset insomnia can be caused by a range of psychological, physiological or behavioural factors that all result in sleep deprivation.
- Parasomnias involve abnormal movements, behaviours, emotions, perceptions or dreams that occur while falling asleep, at any point in the sleep cycle or on waking. These abnormalities interfere with certain stages of sleep or they disrupt the transition from sleep to awake.
  - Sleep apnoea deprives the body of oxygen because breathing stops between 20 seconds and up to 2 minutes while the person is asleep. After the person stops breathing they wake up and gulp in air before going back to sleep. This cycle is repeated hundreds of times a night, depriving the person of Stage 4 slow-wave/deep sleep. Sleep apnoea may occur during any stage of the sleep cycle.
  - Sleepwalking occurs when a sleeping person walks and sometimes does routine tasks or activities, often during Stages 3–4 of NREM sleep.

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Treating sleep disorders: Cognitive behavioural therapy and bright light therapy

- CBT-I (cognitive behavioural therapy for insomnia) is a psychotherapy that focuses on overcoming the causes of a person's sleep problems and changing their maladaptive responses rather than just treating the symptoms.
  - The cognitive component of CBT-I focuses on correcting faulty cognitions or beliefs the person may have about sleep that may affect their sleeping behaviour. Then, it teaches the person to identify and replace any sleep-interfering thoughts with more realistic and positive thoughts that promote sound sleep.
  - The behavioural component of CBT-I focuses on identifying any negative or maladaptive behaviours the person may have developed in response to their faulty cognitions, which hinder their ability to sleep. Then, the therapist works with them to develop strategies to modify or remove their unhelpful behaviours and develop positive sleeping habits.
- Bright light therapy is a physiological treatment that exposes people to intense but safe amounts of artificial light for a specific and regular length of time to help synchronise their sleep–wake cycle with a normal external day–night cycle. It focuses on reducing the symptoms of sleep disorders, particularly circadian phase disorders caused by abnormal timing of circadian rhythms. Its objective is to adjust the person's circadian rhythm so their sleep–wake pattern is in sync with environmental shifts in natural light that occur during an external day–night cycle.

APPLY YOUR KNOWLEDGE AND SKILLS

SECTION A: MULTIPLE-CHOICE QUESTIONS

Answer the following questions by writing the correct letter in your workbook. Only one answer is correct for each question.

1 You volunteer for an experiment in which you live in a purpose-built room for a week. You have no idea what the time is because there are no windows, clocks or other cues, and there is only artificial light. As the week progresses, it is most likely that your bedtime will:

A become later and later each day.
B become earlier and earlier each day.
C remain very close to your normal bedtime.
D become later each day for a day or two, and then rebound towards your normal bedtime.

2 The cluster of brain cells that controls the circadian rhythm is the:

A hypothalamus.
B pineal gland.
C suprachiasmatic nucleus.
D optic chiasm.

3 The evidence from a number of studies indicates that the effects of jet lag can be reduced by:

A taking melatonin.
B consuming caffeine.
C using a nicotine patch.
D stimulating the release of endorphins.

4 Where in the brain is the suprachiasmatic nucleus located?

A The hindbrain
B The thalamus
C The hypothalamus
D The pineal gland

5 What brain structure releases the hormone melatonin?

A The hindbrain
B The thalamus
C The hypothalamus
D The pineal gland

6 Sleep research reveals that adolescents should sleep for __________ hours per night.

A 5–6
B 9–9.5
C 8–8.5
D 10–11

7 Due to hormonal shifts in their sleep–wake cycle, adolescents are susceptible to developing:

A insomnia.
B sleep latency.
C advanced sleep phase disorder.
D delayed sleep phase disorder

8 Shift work disorder is a form of:

A hypersomnia.
B circadian rhythm disorder.
C parasomnia.
D total sleep deprivation.

9 Jet lag is:

A a dysomnia.
B a parasomnia.
C a delayed sleep phase disorder.
D None of the above

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10 Ahmed and Yousef both complain about being tired. Ahmed says he has difficulty falling asleep and he can't sleep for long enough to feel rested. Yousef says he falls asleep quickly but has difficulty waking up. It is likely that Ahmed is suffering from __________ and Yousef is probably suffering from __________.

A hypersomnia; night terror
B insomnia; sleep apnoea
C insomnia; hypersomnia
D hypersomnia; insomnia

11 The disorder characterised by sudden and irresistible onsets of sleep during normal waking periods is:

A obstructive sleep apnoea.
B narcolepsy.
C sleep-onset insomnia.
D circadian phase disorder.

12 All of the following are hazards of sleep deprivation except:

A reduced motor skills.
B increased motivation.
C increased irritability.
D reduced concentration.

13 Cataplexy is a characteristic of:

A narcolepsy.
B sleep-onset insomnia.
C sleepwalking.
D sleep apnoea.

14 A sleep disturbance that features snoring, short silences and gasping for breath is called:

A narcolepsy.
B insomnia.
C sleep apnoea.
D hypersomnia.

15 Bright light therapy:

A is a form of cognitive behavioural therapy.
B uses artificial light to stimulate the pineal gland.
C uses artificial light to stimulate the suprachiasmatic nucleus.
D is a form of psychotherapy for insomniacs.

SECTION B: SHORT-ANSWER QUESTIONS

1 Explain the role of the pineal gland in the sleep–wake cycle.

2 Discuss one biological and one social reason why adolescents experience sleep deprivation.

3 Explain two factors that might contribute to night-shift workers having an accident in the early hours of the morning.

4 What is insomnia?

5 What symptoms would a person diagnosed with central sleep apnoea display?

6 Identify the stage(s) of sleep when sleep apnoea and sleepwalking occur.

7 After 30 minutes of sleep, Stacey started to sweat, scream, sit up and run around the house. What sleep phenomenon is Stacey experiencing? What would be the best response her parents could make towards her at this time?

8 Identify one similarity and one difference between dysomnias and parasomnias.

9 Explain how cognitive behaviour therapy (CBT) can be used to help someone overcome insomnia.

10 Jarrod visits a sleep therapist because he suffers from insomnia. His therapist suggests that Jarrod purchase a light box, which he should sit at for 15 minutes each day at specified times. Explain how this would help Jarrod cope with his insomnia.

SECTION C: EXTENDED-RESPONSE QUESTION

Researchers interested in how sleep patterns affect academic performance analysed the sleep time and academic performance of 500 secondary school students aged 12–19 years over a 2-week period. Of the sample tested, 40 per cent were male and 60 per cent were female. Academic performance was measured in terms of the mean grade scored in common subjects. Participants answered two different questionnaires aimed at measuring the quality of sleep, level of sleepiness or tendency to sleep in different situations.

Results showed that participants with a nightly average of 7–9 hours of sleep scored significantly higher on mathematics than those who slept 6 hours or less, or 10 hours or more each night. This difference was more significant in physical education compared to other school subjects. Students who slept more or less than 7–9 hours per night showed significantly lower academic achievement in all common subjects. The results also showed that students who had a good sleep latency (less than 15 minutes) scored significantly higher in all common subjects.

Based on the results, the researchers suggest that sleep patterns influence academic performance.

You are required to draft the discussion section for a research report for this study. Your draft should:

- identify the aim of this study and the population of interest
- describe the results
- state whether a conclusion can be drawn from the results and explain why
- identify and explain an extraneous variable that may have affected the results and a suggestion about how this variable could be controlled in future research
- identify and explain the ethical considerations relevant to this study.

This question is worth 10 marks.

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SECTION D: ASSESSMENT TASK

MEDIA ANALYSIS

Read the following newspaper article. Then answer the questions on the right.

Starting times for secondary schools should be later

Studies show that most teenagers are sleep deprived and this has a negative impact on their daytime performance. Sleep-deprived adolescents experience an academic decline. They are more likely to have an accident, and they often suffer physical and mental health problems. But getting enough sleep each night can be difficult for teenagers.

The reasons for this are complex. Obviously, homework, part-time jobs, social and sporting commitments and the use of technology can all keep teenagers up late on weeknights. There probably isn't much we can do about this. But we can do something about the time we demand they start school.

We know that sleep is necessary for good physical and mental health. We also know that a teenager's natural sleep–wake cycle makes it difficult for them to fall asleep before 11 p.m. So, it seems a little unreasonable to expect them to be awake by 7 a.m. and at school by 8.30 a.m., alert and ready to learn.

Wouldn't it be more sensible to shift the starting times for secondary schools to 10 a.m. or 10.30 a.m.? If this happened, school schedules would be more aligned to the natural biological rhythms that drive teenagers' sleep and wake times, and they may not be sleep deprived during the day. Daytime napping, sleeping longer on weekends and caffeine consumption can temporarily counteract their daytime sleepiness, but these things do not restore their optimal alertness – nothing substitutes for regular, sufficient sleep.

QUESTIONS

1 What is sleep deprivation?

2 Identify three physical and three psychological effects of sleep deprivation.

3 How much sleep do adolescents require each night?

4 Explain why adequate sleep is necessary for physical and mental health.

5 Explain why the natural adolescent sleep–wake cycle makes it difficult for adolescents to fall asleep before approximately 11 p.m.

6 Explain why the use of electronic media before attempting to go to sleep contributes to an inability to fall asleep.

7 Why do adolescents tend to naturally sleep longer on the weekends? How can this contribute to their inability to have sufficient sleep during the week?

8 Explain how shifting the starting times for secondary schools to 10 a.m. or 10.30 a.m. would help overcome sleep deprivation in adolescents.

9 Identify three measures adolescents could take to improve their sleep experience. Explain how each measure could contribute to reducing their weeknight sleep deprivation.

CHAPTER 9

MENTAL HEALTH

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KEY KNOWLEDGE INCLUDES:

Defining mental health

- mental health as a continuum (mentally healthy, mental health problems, mental disorders) influenced by internal and external factors that can fluctuate over time
- the typical characteristics of a mentally healthy person, including high levels of functioning, social and emotional wellbeing and resilience to life stressors
- ethical implications in the study of, and research into, mental health, including informed consent and use of placebo treatments.

Factors that contribute to the development and progression of mental health disorders

- the distinction between predisposing risk factors (increase susceptibility), precipitating risk factors (increase susceptibility and contribute to occurrence), perpetuating risk factors (inhibit recovery) and protective factors (prevent occurrence or re-occurrence)
- the influence of biological risk factors including genetic vulnerability to specific disorders, poor response to medication due to genetic factors, poor sleep and substance use
- the influence of psychological risk factors including rumination, impaired reasoning and memory, stress and poor self-efficacy
- the influence of social risk factors including disorganised attachment, loss of a significant relationship and the role of stigma as a barrier to accessing treatment
- the concept of cumulative risk.

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DEFINING MENTAL HEALTH

Mental health is often defined as the psychological state of someone who is functioning at a satisfactory level of emotional and behavioural adjustment. This also means that they are functioning well in the usual domains of their everyday life: work, study and relationships.

However, we cannot function at optimal levels at all times, as our behavioural and emotional adjustment can be influenced by the world around us. As our mental health is influenced by many internal and external factors, it can fluctuate over time.

We could feel stressed because of a number of factors; for example, the pressures of VCE, part-time work, friends and parental expectations. We could feel low when our team loses in football or netball, or on top of the world when our team wins. These are very normal feelings. Feeling 'blue' or 'down' in itself does not constitute mental ill-health or a mental disorder.

It is common for people to experience mental health problems at some point in their lives; however, not all problems can be considered a mental disorder. Mental health problems indicate a disruption to an individual's usual level of social and emotional wellbeing, including when our abilities are negatively impacted (Hunter Institute of Mental Health, 2014). Mental health problems are generally not significant, nor do they last for a lengthy period of time, so they do not meet the criteria to make a diagnosis of a mental disorder. Mental health problems are often triggered by normal life experiences such as stress. Once the stressor is removed, many mental health problems are resolved and symptoms stop or are reduced. If the stressor is not removed or the individual is not able to overcome the symptoms, then it is possible for a mental health problem to develop into a mental disorder.

A person who has developed the ability to properly adapt to stress and cope with adversity (known as resilience) will be better protected from developing a mental disorder because they have the ability to bounce back during or following difficult times. They may be able to resolve these situations more quickly and positively because they can adapt and cope. Support from family, friends, a counsellor or other professionals can also lead to better outcomes when mental problems arise. Grief following the loss of a loved one and relationship issues are common triggers for mental health problems.

A mental disorder is a psychological state characterised by emotional difficulties that lead to emotional or behavioural impairment or disability serious enough to require psychiatric intervention. The term 'mental disorder' is often used interchangeably with the term 'mental illness'. Mental illness can be diagnosed by a mental health professional by determining if the combination of symptoms and severity of the symptoms over time meet certain criteria. It is important to recognise such an illness when it arises – we sometimes tend to minimise our problems for fear of stigma, or believe that there is no help available and fail to take the opportunity to talk about it with others.

The difference between mentally healthy, a mental health problem and a mental disorder may be represented on a continuum (see Figure 9.1).

A fundamental difference between mental health and a mental illness (disorder) is that everyone has some level of mental health all of the time, whereas it is possible to be without a mental illness. For this reason, mental health and mental illness can be depicted on two separate dimensions (see Figure 9.2). On one continuum, optimal mental health is found at one extreme and poor mental health at the other extreme, while on a separate continuum, mental illness is found at one extreme and no mental illness at the opposite end. This style of continuum is helpful to show that an individual can be mentally healthy with a mental illness and that someone can have poor mental health without a mental illness. For instance, a person who is diagnosed with bipolar disorder may have a diagnosed mental disorder, but also maintain good mental health (Hunter Institute of Mental Health, 2014).

When we learn about mental illness, we may be susceptible to developing the psychological equivalent of 'medical school syndrome'. Medical school syndrome is a form of hypochondria that affects some people in training to be a physician – as medical students learn about symptoms of physical illness, they may see such

mental health The psychological state of someone who is functioning at a satisfactory level of emotional and behavioural adjustment

mental health problems A disruption to an individual's usual level of social and emotional wellbeing, including when their abilities are negatively affected

resilience An individual's ability to properly adapt to stress and cope with adversity

mental disorder The psychological state of someone who has emotional or behavioural problems serious enough to require psychiatric intervention; also known as mental illness

Mentally healthy	Mental health problems	Mental disorders (illnesses)
Functioning at a satisfactory level of emotional and behavioural adjustment	Disruption to an individual's usual level of social and emotional wellbeing	Emotional difficulties that lead to emotional or behavioural impairment
• Psychological wellbeing • Able to cope with normal stressors • Able to form positive relationships • Able to manage feelings and emotions • Few sleep difficulties • Physically and socially active	• Mild to moderate stress • Temporary impairment • Difficulties in coping • Some changes in sleep patterns • Some changes in appetite • Experience a loss of energy • Difficulty concentrating	• Psychological dysfunction • Marked distress • Ongoing impairment • Excessive anxiety • Significant changes in sleep patterns and appetite • Withdrawal and avoidance from social functions

FIGURE 9.1 The mental health continuum

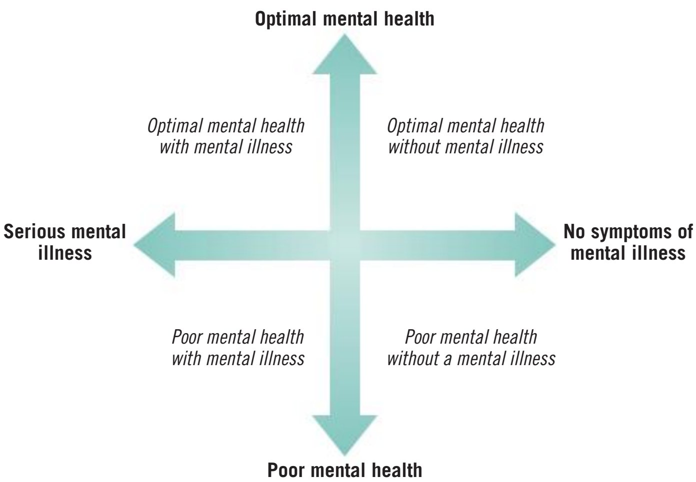

FIGURE 9.2 The mental health and mental illness (disorder) multi-axis continuum

symptoms in themselves and begin to think they are unwell. Hypochondria refers to a preoccupation with minor bodily problems and the presence of illnesses that appear to be imaginary.

The psychological equivalent may afflict VCE students learning about mental health and illness because students are always encouraged to apply what they learn to their own lives and experiences. However, this is one topic where doing so may cause confusion and unnecessary worry. It is quite natural to question whether or not you may have a mental illness. In all likelihood none may exist – it is absolutely acceptable and 'normal' to feel stressed and experience symptoms discussed within this chapter and the next because adolescence is a time filled with challenges and pressures. However, it is also equally important not to trivialise your experiences and feelings when feeling stressed for fear that you would 'look stupid' or that your friends will think of you as 'weak'. If you feel something is wrong, seek the help of a trusted teacher or school counsellor (see Figure 9.3), and also remember that many people experience symptoms of mental illness during their lifespan. In fact, research shows that almost one in two Australians will suffer a mental illness during their lifetime and one in five has experienced a mental illness in the last 12 months.

FIGURE 9.3 Talking about your worries with a school counsellor is a positive step towards maintaining good mental health.

Table 9.1 contains some common myths that may be used to justify negative feelings about people with mental illness.

9.1 CHECK YOUR UNDERSTANDING >>

1 Health is characterised by:
   A mental wellbeing.
   B physical wellbeing.
   C social wellbeing.
   D All of the above
2 Distinguish between mental health and mental disorder.
3 Indicate whether the following statements are true (T) or false (F).
   a If I think I have a mental illness, I probably do.
   b Mental illnesses are imagined; they are not real problems.

→

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TABLE 9.1 Mental illness: myth versus fact

MYTH:	FACT:	MYTH:	FACT:
Mental illness is fairly rare and doesn't affect average people.	Mental illness is quite common. According to the American Psychiatric Association, one in five Americans suffer from a mental disorder in any given year. Mental illness can strike people of any age, race, religion or income status.	People with mental illnesses are dangerous.	This powerful myth has been fed by the media. In fact, the vast majority of people with mental illnesses are not dangerous. They are much more likely to be the victims of violence and crime than the perpetrators.
If you have a mental illness, you can will it away. Being treated for a psychiatric disorder means an individual has in some way 'failed' or is weak.	A serious mental illness cannot be willed away. Ignoring the problem does not make it go away, either. It takes courage to seek professional help.	Depression and other illnesses, such as anxiety disorders, do not affect children or adolescents. Any problems they have are just a part of growing up.	Children and adolescents can develop mental illnesses. One in ten children or adolescents has a disorder severe enough to cause impairment.
Most people with a mental illness are receiving treatment.	Only 1 in 5 persons affected with a mental illness seeks treatment.	Mental illness is more like a weakness than a real illness.	Mental illnesses are as real as other diseases like diabetes or cancer. Some mental illnesses are inherited, just as some physical illnesses are. They are not the result of a weak will or a character flaw.
People with mental illnesses can never be normal.	Science has made great strides in the treatment of mental illness in recent decades. With proper treatment, many people with mental illnesses live normal, productive lives.		

Source: Mental Health Foundation of Australia (Victoria) (n.d.)

c Mental illness can have a physiological basis.
d Almost half of Australians will suffer from mental illness at some time in their lives.
e Mental illness cannot be cured.

4 The number of Australians who have suffered from a mental illness in the last 12 months is:
A one in two.
B one in five.
C one in 10.
D one in 100.

5 What is hypochondria?

CHARACTERISTICS OF A MENTALLY HEALTHY PERSON

What does the term 'health' mean to you? The World Health Organization (WHO) defines health as 'a state of complete physical, mental and social wellbeing and not merely the absence of disease or infirmity' (WHO, 1948). This holistic approach to health means that health is not simply the absence of physical illness – we also need to feel mentally, socially and spiritually well to have a complete sense of good health.

Maintaining health or wellness is a lifelong pursuit and people who attain optimal wellness are both physically and psychologically healthy (Figure 9.4). They engage in positive thinking, show emotional resilience and are optimistic and self-confident (Lightsey, 1996).

People who enjoy a sense of wellbeing also have supportive relationships with others, do meaningful work, and live in a clean environment. According to WHO, the characteristics of a mentally healthy person include being able to realise their own potential, cope with the normal stresses of life, work productively and fruitfully, and be able to make a contribution to their community. They engage in positive thinking, show emotional resilience and are optimistic and self-confident (Lightsey, 1996). The typical characteristics of a mentally healthy person include high levels of functioning, social and emotional wellbeing and resilience to life stressors.

hypochondria A preoccupation with minor bodily problems and the presence of illnesses that appear to be imaginary

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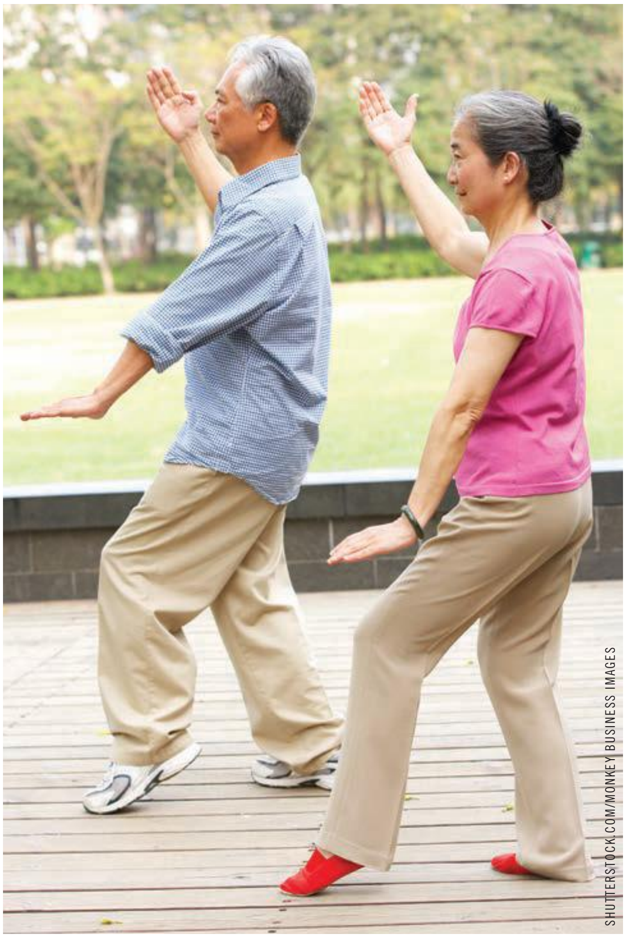
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FIGURE 9.4 Mental and physical health is a lifelong pursuit.

The American Institute for Preventive Medicine (2004) cites 10 characteristics of people who are mentally healthy:

1. They feel good about themselves.
2. They do not become overwhelmed by emotions, such as fear, anger, love, jealousy, guilt or anxiety.
3. They have lasting and satisfying personal relationships.
4. They feel comfortable with other people.
5. They can laugh at themselves and with others.
6. They have respect for themselves and for others even if there are differences.
7. They are able to accept life's disappointments.
8. They can meet life's demands and handle their problems when they arise.
9. They make their own decisions.
10. They shape their environment whenever possible and adjust to it when necessary.

HIGH LEVELS OF FUNCTIONING

People who enjoy good mental health also have high levels of functioning, social and emotional wellbeing and resilience to life stressors. A key characteristic of a mentally healthy person is having a high level of functioning, which can be demonstrated by being able to interact and involve oneself in society and to undertake everyday tasks such as personal hygiene, going to work or eating food. If a person did not regularly wash or eat, or was unable to hold a job, this would show a low level of functioning and may indicate the presence of a mental health problem or illness. Another example is if a person stays in bed all day. It is 'normal' to stay in bed all day every now or then, when you are sick or very tired, but to do it every day would indicate low levels of functioning.

Table 9.2 shows the different levels of functioning on a scale from 1 to 100, as defined by the *Diagnostic and Statistical Manual of Mental Disorders*, Edition IV, Text Revision (DSM-IV-TR). This scale is used to determine if a person's behaviour is considered normal or abnormal according to functionality.

SOCIAL AND EMOTIONAL WELLBEING

Mentally healthy people experience social and emotional wellbeing. Wellbeing is a positive state related to the enjoyment of life, feeling connected to others, the ability to deal with challenges, and having a strong sense of purpose and control (Response Ability, 2014). Social wellbeing is a sense of belonging to a community; this may involve having a job, being a member of a sporting team and making a contribution to society. Emotional wellbeing means to experience positive emotions such as happiness, joy or love, and feeling generally satisfied with life.

The promotion and protection of good mental health is a major societal concern. Good mental health is associated with greater economic success, better social relationships and reduced risk of physical illness. It has a significant impact on a person's performance in the labour market. Individuals with poor mental health are less attached to the labour force, work fewer hours, lose more work days, and earn lower wages (Cornwell, Forbes, Inder, & Meadows, 2009).

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TABLE 9.2 Levels of functioning

SCALE	LEVEL OF FUNCTIONING	EXAMPLES
91–100	Superior functioning in a wide variety of activities No symptoms	Life's problems never seem to get out of hand. This person is sought out by others because of his or her many positive qualities.
81–90	Absent or minimal symptoms, functioning well in all areas, no more than everyday problems	A student has mild anxiety before exams and occasional arguments with family members
71–80	If symptoms are present, they are brief and common reactions to stressors. No more than slight impairment in relationships, work or school	A student has difficulty concentrating after family arguments, is falling behind in schoolwork
61–70	Some mild symptoms or some difficulty with relationships, work or school	A student has wagged school and stolen things at home. The person's mood is depressed and he or she has mild insomnia.
51–60	Moderate symptoms or problems with relationships, work or school	A person's experiences are blunted and speech is evasive; they have occasional panic attacks, no friends, and are unable to keep a job or stay in school.
41–50	Serious symptoms or any social impairment in relationships, work or school	A person has suicidal thoughts, engages in obsessive rituals, shoplifts, has no friends, is unable to keep a job
31–40	Some impairment in grasp of reality or in communication, plus major impairments in work or school, relationships, judgement, thinking or mood	A person's speech is illogical, obscure or irrelevant. A person is depressed and avoids friends, neglects family and is unable to work.
21–30	Behaviour is consistently affected by delusions or hallucinations, or person is seriously impaired in communication or judgement, or is unable to function in most areas	A person is sometimes incoherent; acts grossly inappropriately; is preoccupied with suicide; stays in bed all day every day, has no home, job or friends
11–20	Some danger of hurting self or others, or sometimes fails to maintain minimal personal hygiene, or communication is grossly impaired	A person makes tentative suicide attempts, is frequently violent and manically excited, and is either incoherent or mute
1–10	Persistent danger of severely hurting self or others, persistent inability to maintain minimal personal hygiene, or engages in serious suicidal acts	A person is repeatedly violent or has made potentially lethal suicide attempts

Source: American Psychiatric Association (2000)

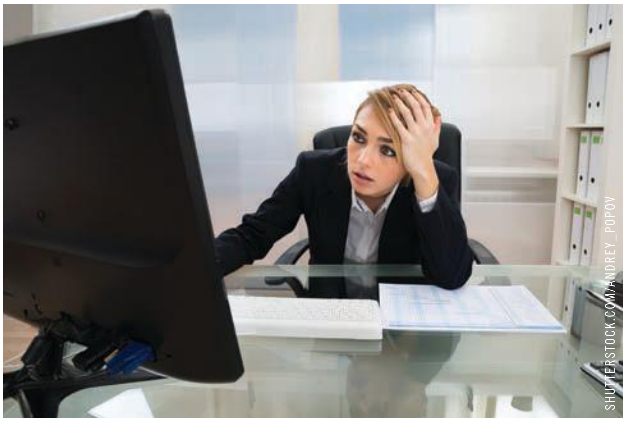

FIGURE 9.5 Resilience is a person's ability to adapt and cope with adversity. Adversity can come in the shape of family or relationship problems, health problems, or workplace and financial worries.

RESILIENCE TO LIFE STRESSORS

The ability for a person to adapt and cope with adversity is known as resilience. A resilient person is better able to cope with life's challenges such as negative life events and to maintain their social and emotional wellbeing. Resilience doesn't remove the stresses involved in negative events but it does enable a person to cope and better manage stress so they are able to function more effectively and enjoy good physical and mental health.

Resilience is influenced by a person's cognitions, behaviours and biology, and social and situational factors. Having supportive relationships is a key factor in resilience. Resilient people have skills and capacities that contribute to them maintaining positive social and emotional health and wellbeing. These include:

- *skills in communication* – including clear communication, the capacity to be assertive when required, the ability to negotiate and resolve conflict, and willingness to ask for help and support when needed
- *emotional understanding* – the ability to understand and talk about one's own emotions and the feelings of others, and a sense of caring and empathy toward others

- *social competence* – the ability to form and maintain positive and respectful relationships that are beneficial for both people, drawing on positive communication skills and understanding of people's emotions
- *problem-solving skills* – the capacity to calmly analyse a problem, understand the practical and personal implications, and develop and implement constructive solutions
- *a sense of self-belief and confidence in oneself* – the capacity to take responsibility for one's own actions, a certain amount of age-appropriate independence, and the ability to set realistic and rewarding goals and work towards them (Response Ability, 2014).

The Victorian State Government Better Health Channel (2013) suggests the following steps to boost wellbeing and stay mentally healthy.

- Connect with others. Develop and maintain strong relationships with people around you who will support and enrich your life.
- Take time to enjoy. Set aside time for activities, hobbies and projects you enjoy.
- Participate and share interests. Join a club or group of people who share your interests.
- Contribute to your community. Volunteer your time for a cause or issue that you care about.
- Take care of yourself. Be active and eat well – these help maintain a healthy body. Combine physical activity with a balanced diet to nourish your body and mind and keep you feeling good, inside and out.
- Challenge yourself. Learn a new skill or take on a challenge to meet a goal. Learning improves your mental fitness, while striving to meet your own goals builds skills and confidence and gives you a sense of progress and achievement.
- Deal with stress. Be aware of what triggers your stress and how you react. You may be able to avoid some of the triggers and learn to prepare for or manage others.
- Rest and refresh. Get plenty of sleep. Go to bed at a regular time each day and practice good habits to get better sleep. Sleep restores both your mind and body.
- Notice the here and now. Take a moment to notice each of your senses each day. Practising mindfulness, by focusing your attention on being in the moment, is a good way to do this.
- Ask for help. The perfect, worry-free life does not exist. Everyone's life journey has bumpy bits and the people around you can help.

9.2 CHECK YOUR UNDERSTANDING >>

1 What is the definition of health according to the World Health Organization (WHO)?

2 Which of the following characteristics is not a characteristic of a mentally healthy person?

A Self-confidence
B Optimism
C Lack of resilience
D Positive thinking

3 List five characteristics of a mentally healthy person.

4 The ability for a person to adapt and cope with adversity is known as:

A mental wellbeing.
B a mental illness.
C self-efficacy.
D resilience.

5 List three characteristics of a person that may indicate the presence of a mental health problem or illness.

6 Outline two actions as described by the Better Health Channel to boost wellbeing and stay mentally healthy.

ETHICAL IMPLICATIONS OF MENTAL HEALTH RESEARCH

Many treatments for mental illness are based on relieving short-term symptoms rather than providing a long-term cure. This can be the case when people use medications, which can also have potential side effects. It is therefore necessary to undertake further research to seek improved treatments and long-term cures.

The use of appropriate research skills and procedures in research is of utmost importance. When conducting research into mental health, it is crucial that researchers obtain voluntary participation and informed consent from all participants.

Where appropriate, before an experiment begins, the researcher must fully inform the participants of the true nature and purpose of the experiment, and obtain their written consent to participate. If a participant is under the age of 18 years or is legally unable to give consent, their parent, guardian or power of attorney should complete the informed consent form. A researcher must outline any foreseeable risks to the participant and inform participants of their rights, including their right to withdraw.

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FIGURE 9.6 The rights of research participants are of utmost importance in any psychological research.

The researcher must ensure that any psychologically or physiologically vulnerable person does not participate in the study. Most research using participants will involve some form of risk to participants. The ethical principle of beneficence states that researchers should maximise the benefits for the participant, while minimising any risk of harm to them. This risk may be greater when participants have a mental illness. Because of the symptoms of their mental illness, sufferers may lack the capacity to understand the research procedure and therefore the ability to provide informed consent. For example, a severely depressed person may not fully understand the risks involved in the research because of their mental state, feelings of hopelessness and lack of concern.

Placebo is Latin for 'I will please', and refers to any fake treatment. The use of placebo treatments are commonly used in research to test the effectiveness of newly developed treatments such as medications. For example, in a trial of a new drug to treat the symptoms of depression, one group of participants will be allocated to the experimental group and will take the drug (independent variable), while another group of participants will be allocated to the control group and will take a fake treatment such as a sugar pill. In a single blind procedure the participants will not know what condition they have been allocated, therefore they won't know if they are taking the active drug or the inactive sugar pill (placebo). The researcher will compare the results between the two groups to indicate the effectiveness of the drug. However, as past studies have demonstrated, participants in the control group who took the placebo may show improvement in the symptoms of their illness. This phenomenon is known as the placebo effect; that is, changes in behaviour are caused by the belief that one has been exposed to a treatment that will affect them in some way. Estimates vary, but approximately one-third of people taking placebos for complaints (including pain, headache and seasickness) will experience relief from symptoms. Belief in a treatment may be enough to change the course of a person's physical illness (Victoria. Better Health Channel, 2015c).

The major ethical implication in the study of, and research into, mental health using placebo treatments is that the researcher is deceiving the participants. This violates the participant's right to be honestly and fully informed of the research procedures employed. However, at the end of the study if the participants are fully debriefed, this negates the deception. Additional ethical concerns include that it is possible for placebo treatments to cause unwanted physical side effects such as nausea and drowsiness, and that they may stop people from receiving treatments that have proven medical value.

Mental health can be a very personal subject and, as such, the importance of confidentiality is always heightened when an individual's health is being analysed. As with any experimentation, it is vital that participants are aware of their right to withdraw and their right to debriefing.

9.3 CHECK YOUR UNDERSTANDING >>

1 __________ treatments for mental illness are based on relieving short-term symptoms rather than a long-term cure.
   A Behavioural
   B Psychological
   C Biological
   D Social
2 Why are risks greater for people participating in experimental research when they have a mental illness?
3 Approximately what percentage of people who take placebos (believing them to be medication) will experience an end to their symptoms?
   A 1 per cent
   B 20 per cent
   C 30 per cent
   D 50 per cent
4 What is the placebo effect?
5 What are the ethical implications of using placebo treatments in the study of mental health?

placebo A fake treatment that has no active effect, such as a fake pill or injection

placebo effect Changes in behaviour caused by the participant's belief that they have been exposed to a treatment that will affect them in some way

DEVELOPMENT AND PROGRESSION OF MENTAL HEALTH DISORDERS

RISK AND PROTECTIVE FACTORS

Health is not simply influenced by one or two factors. There are many determinants that can fluctuate over time and combine to influence the health of individuals and communities.

The 'four Ps' approach considers four different types of factors that contribute to the development and progression of mental health disorders. These factors are categorised as predisposing risk factors, precipitating risk factors, perpetuating risk factors and protective factors. Each of these different factors has a biological, psychological and social perspective, as summarised in Table 9.3. For professionals working in the mental health area, it is important to consider all different types of factors to enable an accurate assessment of the client's condition. This means that problems often associated with complex cases can be identified and addressed, reducing the risk of drop-out, poor engagement or treatment failure (Havighurst & Downey, 2009). The three different types of risk factors impede or have a negative effect on the health of an individual.

Risk factors

PREDISPOSING RISK FACTORS

Predisposing risk factors increase a person's vulnerability to developing a mental health problem. These factors can occur at conception or early in life (such as schizophrenia) and shape their personality. Predisposing risk factors include:

- *family history and genetic vulnerability* – Inheriting certain genes from a parent may increase a person's risk of developing a mental illness and research shows that mental illness is more common in people whose blood relatives also have a mental illness. However, while inherited traits may contribute to a person's susceptibility to mental illness they do not directly cause the illness. Multiple factors, including lifestyle and environmental factors unique to the individual, may also contribute. That is why a person may inherit a susceptibility to a mental illness but doesn't necessarily develop the illness.
- *physical illness* – There is a link between depression and other mental health issues and chronic physical illness such as cancer or arthritis. Research shows that more than 40 per cent of Australians living with mental health issues also have a chronic physical illness. People who are living with a chronic physical illness are more likely to develop depression than physically healthy people (Healthdirect Australia, 2015).
- *poor self-efficacy* – Self-efficacy is an individual's belief that they will be able to accomplish a specific task. Low self-efficacy is a good predictor of low mental health and high self-efficacy is a good predictor of high mental health. Self-efficacy is discussed later in this chapter.
- *neglect, abuse or trauma* – Being abused or neglected as a child or other traumatic life experiences, such as military combat or violent assault, can increase a person's susceptibility to developing a mental health disorder.
- *disorganised attachment* – Instability in a caregiving relationship can interfere with a child's sense of trust and security. This can increase a child's vulnerability to developing a mental illness.
- *environmental exposures before birth* – Exposure to environmental stressors, inflammatory conditions, toxins, alcohol or drugs while in the womb can sometimes be linked to mental illness. Some evidence suggests that a disruption of early foetal brain development or trauma that occurs at the time of birth – for example, loss of oxygen to the brain – may be a factor in the development of certain conditions, such as autism (Birth Injury Guide, 2016).

PRECIPITATING RISK FACTORS

Precipitating risk factors trigger the onset or exacerbation of a mental health problem. Precipitating factors are commonly known as triggers. These are events that occur shortly before the onset of a disorder and appear to have induced it. They include:

- *poor sleep* – Sleep and mood are closely connected; poor or inadequate sleep can cause irritability and stress, and may trigger the onset of a mood disorder, such as anxiety or depression.
- *substance use or misuse* – Substance abuse such as addiction to drugs or alcohol may trigger the first episode in what can be a lifelong mental illness such as schizophrenia. Substance use or misuse may make the symptoms of mental illnesses worse and treatment less effective.

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» *confronting news* – Confronting news such as television footage of terrorism attacks can trigger anxiety, depression and even symptoms of post-traumatic stress disorder. The footage can be distressing to many people, particularly if they have friends or relatives involved.

» *life event stress* – The way an individual reacts to stressful situations makes a difference in their overall wellbeing. Studies have shown that chronic stress has a significant effect on the immune system that ultimately can trigger the onset or exacerbation of a mental health problem (Salleh, 2008).

» *losing a job* – Job loss can be an extremely traumatic experience, often leading to a decrease in psychological wellbeing and despair and depression due to feelings of worthlessness, helplessness or guilt.

» *deterioration or loss of a significant relationship* – This can result in very strong emotional responses such as anger, mood swings and feelings of rejection. This loss and its emotional impact can also cause behavioural changes (for example, difficulty sleeping and substance abuse), which affect a person's wellbeing and trigger the onset of a mental health problem.

PERPETUATING RISK FACTORS

Perpetuating risk factors prolong the course of the disorder and inhibit recovery. Perpetuating factors are those that maintain the psychological problem and prevent resolution. They include:

» *poor response to medication* – Medications to treat mental illnesses may cause side effects such as drowsiness, blurred vision, rapid heart rate and dizziness. These symptoms may have a dramatic impact on the ability of a sufferer to lead a normal life. Sufferers may therefore choose not to continue medication plans, which can maintain the psychological problem.

» *substance use or misuse* – Substance abuse (such as drug and alcohol addiction) can make the symptoms of a mental health problem worse because this can maintain the disorder and prevent a solution.

» *rumination* – Obsessing about undesirable thoughts and feelings or life events, such as work or relationships, can prolong the course of the disorder, such as depression, because negative thoughts are replayed over and over.

» *impaired reasoning and memory* – Mental illness can prevent people from thinking rationally. Impairments in reasoning and memory may significantly affect daily functioning of sufferers of mental disorders because they result in a range of difficulties, including deficiencies in verbal fluency, language processing and interpretation of social situations.

» *avoidance behaviours* – These are behaviours that attempt to prevent exposure to the fear-provoking object, activity or situation. For a person with a specific phobia this may involve the complete avoidance or escaping from the feared object, activity or situation, which may prevent them resolving the fear response.

» *the role of stigma as a barrier to accessing treatment* – A lack of understanding of mental health disorders can cause negative attitudes, discrimination and stigma towards sufferers. Stigma can act as a barrier to accessing treatments. A lack of treatment can have a significant impact on a sufferer's wellbeing and prolong the course of the disorder.

» *lack of support* – Support networks, such as health professionals, friends and family, play a critical role in the care of mental illness sufferers. Support may take the form of providing accommodation, medication and engaging activities, all of which enable sufferers to cope with everyday functioning. If a person with a mental illness does not receive sufficient support, this may hinder the management of and recovery from their mental illness.

» *unemployment* – Unemployment may lead to feelings of helplessness, lack of control and self-doubt, which can lower a person's self-esteem and prolong the course of a mental illness, such as anxiety disorders and depression.

Protective factors

Protective factors have a positive effect on the health of an individual. These factors are positive forces in

risk factors Factors that impede or have a negative effect on the health of an individual

predisposing risk factors Factors that increase vulnerability to develop a mental health problem

precipitating risk factors Factors that trigger the onset or exacerbation of a mental health problem

perpetuating risk factors Factors that prolong the course of the mental health problem and inhibit recovery

protective factors Factors that enhance or have a positive effect on the health of an individual

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TABLE 9.3 Factors that contribute to the development and progression of mental health disorders

	BIOLOGICAL FACTORS	PSYCHOLOGICAL FACTORS	SOCIAL FACTORS
Predisposing risk factors	» Family history and genetic vulnerability » Physical illness	» Self-efficacy » Learnt behaviours	» Neglect, abuse or trauma » Disorganised attachment » Environmental exposures before birth
Precipitating risk factors	» Poor sleep » Substance use/misuse » Physical illness	» Confronting news » Life event stress	» Losing a job » Loss of a significant relationship
Perpetuating risk factors	» Poor response to medication due to genetic factors » Substance use/misuse	» Rumination » Impaired reasoning and memory » Avoidance behaviours	» Role of stigma as a barrier to accessing treatment » Lack of support » Unemployment
Protective factors	» Adequate diet and sleep » Physical exercise	» Resilient attitude	» Positive social group » Satisfying job » Suitable accommodation

a person's life that help minimise the occurrence or reoccurrence of mental health problems. Someone who maintains good physical and psychological health and a good social support network is promoting their own wellbeing. Protective factors include personal characteristics, and social and family circumstances, such as:

» *a resilient attitude* – Resilience involves people using their skills and strengths to cope or learning new skills to cope. Having a resilient attitude towards stresses encountered in everyday life will enable a person to perceive difficulties as challenges. This will increase a person's ability to cope and improve their mental health.

» *a positive social group* – A sense of connection is vital to enhance positive mental health. Staying connected to positive social groups such as sporting, community and support groups provide opportunities to get involved in fun and enjoyable activities, improve physical health and develop coping strategies for the stresses of everyday life.

» *a satisfying job* – Meaningful and enjoyable work can create a sense of wellbeing and contribute to good mental health. Employment can provide financial independence, social support networks and a sense of purpose, all of which will promote a person's wellbeing.

» *suitable accommodation* – Safe, secure and suitable accommodation will have a positive effect on a person's mental health. Accommodation provides a safe and secure environment, will improve access to social networks and employment, and is important for recovery and maintaining good mental health.

9.4 CHECK YOUR UNDERSTANDING >>

1 The factors that prolong the course of the disorder and inhibit recovery are known as:
  A predisposing risk factors.
  B precipitating risk factors.
  C perpetuating risk factors.
  D protective factors.

2 Distinguish between risk factors and protective factors.

3 The factors that trigger the onset or exacerbation of a mental health problem are known as:
  A predisposing risk factors.
  B precipitating risk factors.
  C perpetuating risk factors.
  D protective factors.

4 Having a good social support network such as a close family would be considered a:
  A predisposing risk factor.
  B precipitating risk factor.
  C perpetuating risk factor.
  D protective factor.

5 Using your own example, explain how biological, psychological and social protective factors could or have a positive effect on the health of an individual.

6 Distinguish between predisposing risk factors, precipitating risk factors and perpetuating risk factors.

BIOPSYCHOSOCIAL APPROACH TO PHYSICAL AND MENTAL HEALTH

The four Ps approach of (predisposing, precipitating, perpetuating and protective) factors that contribute to the development and progression of mental health have a biological, psychological and social perspective. The biopsychosocial model of health and illness

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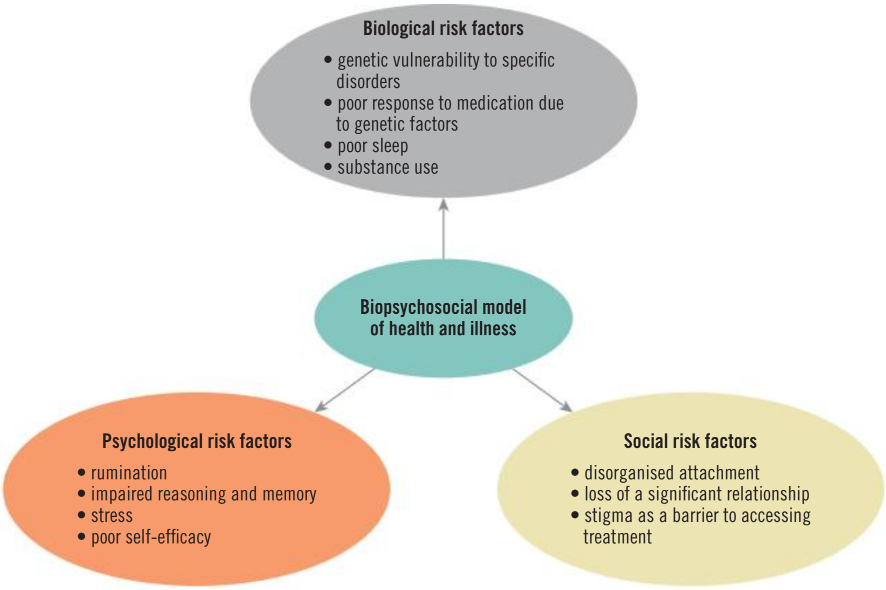

FIGURE 9.7 The biopsychosocial model of health and illness proposes that health and illness outcomes are a result of the interaction of contributing biological, psychological and social factors.

proposes that health and illness outcomes are a result of the interaction of contributing biological (internal), psychological (internal) and social (external) factors (see Figure 9.7).

This model provides a holistic view of health, taking into account the interactive nature of physical, mental and social aspects of a person's health to enable a more comprehensive and personalised diagnosis and treatment plan.

So how do these factors work together to affect mental health and illness? If we look at a physical health issue such as diabetes, the risk factors could be either biological (for example, a family history of diabetes or a history of having hypertension and a high body mass index), psychological (such as having a mental illness) or social (for example, not having a strong social network) (Strodl & Kenardy, 2006). Research also shows that having diabetes more than doubles the risk of developing depression, due to having to cope with biological and hormonal factors associated with having diabetes, as well as needing to manage the disease on a daily basis.

When investigating a mental health issue, if a person has a strong family history of mental illness and they then used illegal substances such as marijuana, ecstasy or speed, this interplay can put them at an increased risk of developing a mental illness. In this situation, an environmental or social behaviour (drug use) exploits the biological vulnerability (family history of mental illness) in a person to result in a mental disorder.

Similarly, a person may have a family history of mental illness, but maintain strong social networks and good physical and psychological health, which can help prevent the development of a mental disorder.

The biopsychosocial model has enabled more personalised treatment plans, but it does have limitations: not all disorders have equally relevant biological, psychological and social aspects; the model is vague about the boundaries of each category; and making a diagnosis and devising a treatment plan can be difficult when considering so many factors.

To maintain good psychological health it is important to understand some of the risk factors that we are exposed to or confronted with that can compromise our mental wellbeing.

9.1 TRY IT YOURSELF >>

EXPERIENCES OF DEPRESSION

Australian comedian and actor Garry McDonald – best known for his alter ego Norman Gunston and his role as 'Arthur' in the television series *Mother and Son* – has spoken publicly about his experiences with depression and anxiety. Australian tennis legend Pat Cash, a former Wimbledon champion, has also revealed his own battles with depression. There are many other people who share their experiences of depression so that other sufferers can see they are not alone and are given a sense of hope for their own recovery. Sharing these experiences also helps to remove the stigma that is associated with mental illness.

biopsychosocial model An approach that proposes that health and illness outcomes are determined by the interaction and contribution of biological, psychological and social factors

1 Go to the BeyondBlue website.
2 Read some personal experiences of people who have suffered depression.
3 How did these accounts make you feel? What sort of factors do you think have contributed to these people's experiences of depression? What sort of things may have helped, or did ultimately help, these sufferers?
4 Discuss these ideas with your classmates.

9.5 CHECK YOUR UNDERSTANDING >>

1 What is the biopsychosocial model?
2 What is the advantage of using a biopsychosocial model in the diagnosis and in the treatment of a person's mental health?
3 Suggest one biological factor, one psychological factor and one social factor that may influence a person's mental health.
4 Use an example to explain how the biological, psychological and social factors may interact to influence a person's mental health.
5 Biological factors that commonly enhance (or reduce) an individual's risk of, or vulnerability to, developing a particular condition are known as:
A social factors.
B cognitive factors.
C emotional factors.
D genetic factors.

THE INFLUENCE OF BIOLOGICAL RISK FACTORS

Biologically, there are many genetic factors that contribute to the development and progression of mental health disorders. Genetic factors are those biological factors that can enhance (or reduce) an individual's risk of, or vulnerability to, developing a particular condition. Predetermined genetic risk factors cannot be directly controlled, but some non-genetic risk factors that affect our biology are well within our control. These factors include personal behaviours that affect our biological condition such as smoking, drinking alcohol, using or not using illicit substances, keeping active and eating healthily (WHO, 2001).

In this section we discuss the influence of genetic vulnerability to specific disorders, poor response to medication due to genetic factors, poor sleep and substance use as biological risk factors that contribute to the development and progression of mental health disorders.

The influence of genetic vulnerability to specific disorders

A genetic vulnerability (sometimes also called genetic susceptibility or predisposition) is an increased likelihood of developing a particular disease based on a person's genetic make-up. Genetic vulnerability results from specific genetic variations that are often inherited from a parent. These genetic changes contribute to the development of a disease but do not directly cause it. Some people with a predisposing genetic variation will never get the disease while others will, even within the same family (Victoria. Better Health Channel, 2015d).

Genetic studies such as family studies and adoption studies have shown a clear link between genetics and the development of mental disorders such as schizophrenia, autism, manic depressive illness, attention deficit hyperactivity disorder and anxiety disorders. Studies have found that genetic factors underpinning the neurotransmitter serotonin appeared to influence the effect of stressful life events on depression (Caspi et al., 2003). Other studies have found that the first degree relatives (for example father, mother or siblings) of someone with a depressive illness are two to three times more likely to develop a mood disorder themselves. As the degree of relationship widens, the risk decreases (Kelsoe, 2000). For example, a cousin of someone with major depression is less likely to be affected than a brother or sister. It is important to realise that an individual with a family member who has a major depressive disorder will not automatically develop the disorder themselves.

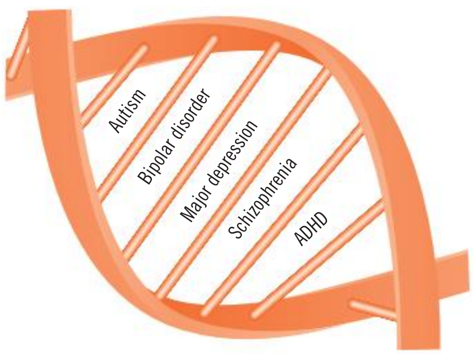

FIGURE 9.8 Genetic studies have shown a clear link between genetics and the development of mental disorders such as schizophrenia and anxiety disorders.

Studies of twins, as well as natural and adoptive families, suggest that genetic factors play an important role in the development of schizophrenia. For example, the child who has one parent with schizophrenia has approximately a 10 per cent chance of developing the disorder, whereas a child with two afflicted parents has a 40 per cent chance of developing schizophrenia. As one in 100 people will suffer schizophrenia in their lifetime, the risk of developing schizophrenia in the general

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population, with no afflicted relatives, is approximately 1 per cent. Table 9.4 indicates the chances of developing schizophrenia over the course of a lifetime, depending on an individual's relationships with afflicted people. The statistics are based on the findings of Gottesman (1991) and Susser and Susser (1987).

TABLE 9.4 The chance of developing schizophrenia

RELATIONSHIP WITH SOMEONE WITH SCHIZOPHRENIA	CHANCE OF DEVELOPING SCHIZOPHRENIA DURING LIFETIME
General population (no relationship)	1%
Sibling (either sex) with schizophrenia	8–10%
One parent with schizophrenia	10–15%
Two parents with schizophrenia	40%
Non-identical (fraternal) twin with schizophrenia	14%
Identical twin with schizophrenia	50%

While there appears to be a genetic link in schizophrenia, the specific genes involved have not been found. Several genes have been implicated, including the gene DISC1. New research involving non-embryonic stem cells has allowed scientists more insight into the genes implicated in schizophrenia and presents a way to potentially develop a biological model for the disease, which may lead to its treatment and – some day – possibly a cure. Focus on research 9.1 explores this further.

9.1 FOCUS ON RESEARCH

NEW HOPE ON BRAIN ILLNESS CURE

Melbourne scientists will transform skin biopsies taken from schizophrenia patients into stem cells in an effort to shed light on the cause and pathology of the disease. The cutting-edge science, which could eliminate the need to use human embryos, was pioneered in Japan. Like embryonic stem cells, induced pluripotent stem (IPS) cells can be engineered to produce any kind of cell, including neural cells.

Now, in what is believed to be a world first, scientists at Melbourne's O'Brien Institute will use the technique to investigate schizophrenia, which affects about one in 100 people. Their work is aimed at showing how the disease alters the brain and could lead to better treatments or a cure.

The scientists have ethics approval to recruit a dozen schizophrenia patients, who will provide skin biopsies of 5 millimetres cubed. They will isolate skin cells (known as fibroblasts) from the biopsies, then genetically reprogram them to become stem cells.

The research will build on work already done at the O'Brien Institute, taking stem cells from the post-mortem brain tissue of healthy people and modifying them so they behave more like stem cells from people with schizophrenia. The work has allowed researchers to isolate a gene important in brain development – DISC1 – which is impaired in some schizophrenia patients.

Schizophrenia is underpinned by a handful of abnormal genes, and the aim is to work out their individual role in the disease and how they interact with environmental factors such as maternal infections.

It is hoped that analysing stem cells from live schizophrenia patients – cells that already have all the coding for the disease – will develop understanding. Researchers will also compare their findings with data from other sources, including brain imaging of the patients.

The O'Brien Institute's director of stem cell medicine, Dr Jeremy Crook, said human stem cells were a powerful tool and using them – rather than mice – for the first time to investigate schizophrenia would create a biologically relevant model of the disease.

Source: Hagan, K. (2010, June 12). New hope on brain illness cure. *The Age*.

QUESTIONS

1 What was the aim of this study?
2 What was the population and sample used in this study?
3 Identify the independent variable.
4 Identify the dependent variable.
5 What are the ethical issues in using stem cells to evolve therapies for medical and psychiatric illnesses?

In people with a genetic predisposition to a mental disorder, the risk of developing the disorder can depend on multiple factors in addition to an identified genetic change. These include other genetic factors as well as lifestyle and environmental factors. Although a person's genetic make-up cannot be altered, some lifestyle and environmental modifications (such as having more frequent disease screenings and maintaining a healthy weight) may be able to reduce disease risk in people with a genetic predisposition (Victoria. Better Health Channel, 2015d).

genetic factors Biological factors that commonly enhance (or reduce) an individual's risk of, or vulnerability to, developing a particular condition

genetic vulnerability An increased likelihood of developing a particular disease based on a person's genetic make-up

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The influence of resistance to taking or poor response to medication on mental health disorders

Medications are used to treat the symptoms of mental disorders such as schizophrenia, major depression and anxiety disorders. Many people with mental disorders live fulfilling lives with the help of these medications. Without them, people with mental disorders might suffer serious and disabling symptoms.

Choosing the right medication, medication dose and treatment plan should be based on a person's individual needs and medical situation, and always under a doctor's care (National Institute of Mental Health, 2016).

For these medications to be effective, it is important that the person suffering the disorder comply with the medication treatment prescribed. However, only about half the people who leave a doctor's office with a prescription take the drug as directed (Hussar, 2013). If a person does not take their medication as directed by their health professional, symptoms may not be relieved and the person may experience serious health consequences.

A number of factors may influence a person to not take their medication. Sometimes, having to take medication is a constant reminder of the disorder, or the side effects of the medication affect the person's life, resulting in a reluctance to follow their treatment plan. Side effects may include drowsiness, blurred vision, rapid heart rate and dizziness. These symptoms may have a dramatic impact on the ability of a sufferer to lead a normal life because it could affect their ability to drive a car or operate machinery and therefore hold down a job.

For some people, atypical antipsychotic medications can also cause major weight gain and changes in their metabolism. This may increase their risk of developing diabetes and high cholesterol. For these reasons, a person's weight, glucose levels and lipid levels should be monitored regularly by a doctor while taking an atypical antipsychotic medication.

Medications also work differently for different people. Some people get very positive results from medications and only need them for a short time. For example, a person with depression may feel much better after taking a medication for a few months, and may never need it again. However, people with disorders such as schizophrenia or bipolar disorder, or people who have long-term or severe depression or anxiety, may need to take medication for a much longer time (Mental Health Foundation of Australia (Victoria), 2016).

Some people may experience a poor response to medication due to genetic factors and their medication may be ineffective in reducing the disabling symptoms associated with their mental illness. For example, some anti-depression medications may not alleviate the symptoms of feeling irritable and overwhelmed. In this case, sufferers need to seek alternative treatments such as psychotherapy.

FIGURE 9.9 For some people medication may be ineffective in reducing the disabling symptoms associated with their mental illness.

The influence of poor sleep on mental health disorders

Sleep is important for restoring physical and mental health and it increases our ability to deal with the demands of a busy life (see Chapter 7). The necessary amount of sleep for individuals to function effectively during the daytime and cope with normal daily stress will differ between individuals depending on age, physical activity levels and general health. Studies have shown that sleep deprivation occurs when we do not have adequate sleep and that this has a significant effect on mood. For example, University of Pennsylvania researchers found that subjects who were

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limited to only 4.5 hours of sleep a night for 1 week reported feeling more stressed, angry, sad and mentally exhausted. When the subjects resumed normal sleep, they reported a dramatic improvement in mood. (Dinges et al., 1997).

FIGURE 9.10 Sleep problems increase the risk of developing mental illnesses such as mood and anxiety disorders.

More than 70 types of sleep disorders exist. The most common problems are insomnia (difficulty falling or staying asleep), obstructive sleep apnoea (disordered breathing that causes multiple awakenings), various movement syndromes (unpleasant sensations that prompt night fidgeting) and narcolepsy (suddenly falling asleep during the day). While these sleep disorders are common, it is important to note that not all sleep disorders are linked to mental disorders. The type of sleep disorder, its prevalence and its impact vary by psychiatric diagnosis. However, the overlap between sleep disorders and various psychiatric problems is so great that researchers have long suspected both types of problems may have common biological roots (Harvard Health Publications, 2009). A study published in the journal *Sleep* found people with insomnia were nearly 10 times more likely to have clinically significant depression than others (Taylor, Lichtstein, Durrence, Reidel, & Bush, 2005). Research findings such as these suggest that if a person with a mental disorder also has a sleep disorder, treating the sleep disorder may help alleviate symptoms of their mental health problem/disorder.

There are many simple ways to improve sleep. The first step for many people is to improve their sleep habits. A regular bedtime and waking time are essential, as are avoiding stimulants before going to bed (for example, cigarettes and caffeine), having enough exercise during the day (not too close to bedtime), eating well, and ensuring that the bedroom is quiet and dark and the bed is comfortable. Removing all electronic screens from the bedroom is difficult for some people, but mobile phones, computers and televisions in the bedroom are a major cause of sleep disruption. Some people with a sleep disorder may need to seek the assistance of a sleep scientist and very occasionally the short-term use of medication may be helpful (Sleep Health Foundation, 2013).

9.2 FOCUS ON RESEARCH

SLEEP DEPRIVATION TRIPLES RISK OF MENTAL ILLNESS: STUDY

New research suggests young people getting less than five hours sleep per night are tripling their chances of developing a mental illness. The George Institute for Global Health surveyed almost 20 000 Australians aged between 17 and 24 for the research. Researchers found those sleeping fewer than five hours a night are three times more likely to become mentally ill than those sleeping for eight or nine hours. The results also linked sleep deprivation with cardiovascular disease and weight gain.

The study's lead author, Professor Nick Glozier, says the average amount of sleep for a young adult is eight to nine hours a night. But he says that is decreasing, especially over the past decade. 'There's a whole bunch of gadgets that kids and young adults now have in their bedrooms that they never used to have,' he said.

'Yet of course they've got to get up and go to school or go to college or go to uni at exactly the same time. So there's a group of them who are becoming more and more sleep-deprived.'

Professor Glozier says it is important to prevent mental health problems where possible. 'It's those chronic mental health problems when you're an adolescent or you're a young adult, that lead on to the more important adult forms of the disorders, like major depressive disorder or bipolar disorder,' he said. 'So if we can do something around that group of people when they're beginning to become chronic, or preventing those chronic, persistent problems then we may have a really good target for an early intervention.'

Hall, A. (2010, September 1). Sleep deprivation triples risk of mental illness: study. *ABC News*.

QUESTIONS

1. What was the population and sample used in this study?
2. Identify the independent variable.
3. Identify the dependent variable.
4. Write a possible research hypothesis for this study.
5. State the results of the experiment.
6. How could you use the findings of this study to benefit your academic progress?

The influence of substance use on mental health disorders

Addiction, or the inability to resist a recurring urge to behave in a certain way despite knowing the potentially harmful consequences, is common in people with mental health problems. Addiction can manifest itself in a number of behaviours including gambling, eating and physical exercise. Abuses of substances such as alcohol and recreational drugs are also common forms of addiction in today's society. It has been reported that approximately 50 per cent of individuals with severe mental disorders are affected by substance abuse (Drake, Mueser, & Brunette, 2007). Substance abuse refers to the harmful or hazardous use of psychoactive substances, including alcohol and illicit drugs.

Alcohol use disorders, such as alcohol dependence, abuse and hazardous and harmful use, affect approximately 30–40 per cent of people diagnosed with schizophrenia and a lifetime prevalence of up to 48 per cent (Fowler, Carr, Carter, & Lewin, 1998). The use of illicit drugs such as cannabis and psychostimulants such as amphetamines and cocaine is also higher among young adults with severe mental illness compared to either the general population or to other psychiatric comparison groups (Regier et al., 1993).

Although substance abuse and mental health disorders such as depression and anxiety are closely linked, one does not directly cause the other. Alcohol or drugs are often used to self-medicate the symptoms of depression or anxiety. Unfortunately, substance abuse causes side effects and in the long term worsens the very symptoms it was initially intended to numb or relieve. Mental disorders are caused by a complex interplay of genetics, the environment and other outside factors. Substance abuse can make the symptoms of a mental health problem worse or increase an underlying risk of developing a mental disorder because it may sharply increase symptoms of mental illness or trigger new symptoms. Alcohol and drug abuse also interact with medications such as antidepressants, anti-anxiety pills and mood stabilisers, making them less effective (HelpGuide.org, 2016).

FIGURE 9.11 Research has shown that roughly 50 per cent of individuals with severe mental disorders are affected by substance abuse.

9.6 CHECK YOUR UNDERSTANDING >>

1 Which of the following biological factors that may influence mental health are within our control?
  - A Brain chemistry
  - B Eating healthily
  - C Our immune system
  - D Genetic vulnerability

2 What is meant by the influence of genetic vulnerability to specific disorders?

3 Approximately what percentage of people who leave a doctor's office with a prescription take the drug as directed?
  - A 0 per cent
  - B 25 per cent
  - C 50 per cent
  - D 100 per cent

4 Outline two factors that may influence a person to not take their medication.

5 How can the quality of sleep influence a person's mental health?

6 List four ways to improve the quality of sleep.

7 What is substance abuse and how can it influence a person's mental health?

THE INFLUENCE OF PSYCHOLOGICAL RISK FACTORS

In addition to substance abuse, a range of behaviours an individual engages in and their personal attributes can also have a large influence on their mental health. Although some people are more susceptible to mental disorders because of certain inherited factors or personality factors, there are many ways to promote good psychological health. Engaging in stress management techniques, taking time out for ourselves, trying meditation and sharing and discussing feelings and concerns are all ways to try to achieve positive psychological wellbeing.

In this section we discuss the influence of rumination, impaired reasoning and memory, stress and poor self-efficacy as psychological risk factors that contribute to the development and progression of mental health disorders.

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The influence of rumination on mental health disorders

Rumination is the compulsively focused attention on the symptoms of one's distress, and on its possible causes and consequences, as opposed to its solutions (Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008). When people ruminate, they over-think or obsess about undesirable thoughts and feelings or life events, such as work or relationships. This becomes a vicious cycle of negative thoughts and restricts problem-solving. Commonly, people will ruminate about the problem so much so that they never take time to formulate a solution.

FIGURE 9.12 The vicious cycle of replaying negative events over and over in our mind can severely affect our mental health.

Three forms of rumination have been proposed by Mikulincer (1996):

- *state rumination*, which involves dwelling on the consequences and feelings associated with a failure. State rumination is more common in people who are pessimistic, neurotic (a mild functional disorder characterised by excessive anxiety or distress), and who have negative attributional styles (negative ways to explain life events)
- *action rumination*, which consists of task-oriented thought processes focused on goal achievement and correction of mistakes
- *task-irrelevant rumination*, which uses events or people unassociated with the blocked goal to distract a person from the failure.

Rumination increases stress levels because it involves a person continuously thinking about the various aspects of an upsetting situation. It has been implicated in the development and maintenance of a variety of mental health disorders such as depression, general anxiety, post-traumatic stress, binge drinking and eating disorders. Research by American psychologist Susan Nolen-Hoeksema et al. (2008) found that 'when people ruminate while they are in a depressed mood, they remember more negative things that happened to them in the past, they interpret situations in their current lives more negatively, and they are more hopeless about the future'. She also suggested that rumination leads to the person becoming so preoccupied with the distressing situation that it paralyses their problem-solving skills and this leads them to feeling helpless. In addition, rumination can have negative social consequences because, if engaged in for an extended time, family members and friends who may have been able to help develop positive coping strategies may become so frustrated they may withdraw their support. To overcome rumination and prevent its negative consequences, Nolen-Hoeksema suggests strategies such as engaging in activities that foster positive thoughts and focusing on problem-solving.

The influence of impaired reasoning and memory on mental health disorders

For an individual to function successfully in everyday life and experience good mental health and a sense of wellbeing, it is critical that their cognitive skills, such as reasoning and memory, operate effectively. Reasoning is a cognitive process that involves thinking about information in a logical way in order to understand it and form a realistic conclusion or judgement that will help us solve problems and make decisions. Reasoning is connected to memory in a number of ways. When we are reasoning or thinking about information, we rely on retrieving information we have previously learnt and stored in our long-term memory. If our ability to form, store or retrieve a memory is impaired,

addiction The inability to resist a recurring urge to behave in a certain way despite knowing the potentially harmful consequences

substance abuse The harmful or hazardous use of psychoactive substances, including alcohol and illicit drugs

rumination The compulsively focused attention on the symptoms of one's distress, and on its possible causes and consequences, as opposed to its solutions

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our ability to think in a reasoned manner will also be impaired. (To refresh your understanding of how the memory system works, revisit Chapter 5.)

There are many factors that can influence a person's reasoning and memory abilities, such as genetic factors, level of education, injuries, life experiences, disease and lifestyle. For example, increased levels of physical activity have been associated with higher levels of cognitive functioning (Dustman, Emmerson, & Shearer, 1994). Heavy alcohol consumption and abuse of drugs have been associated with impairments in cognitive performance (National Institutes of Health, 2005).

Impairments in reasoning and memory are prevalent among people diagnosed with mental disorders, such as schizophrenia. These impairments significantly impact on the day-to-day functioning of sufferers of mental disorders because they result in a range of difficulties, including deficiencies in verbal fluency, language processing, interpretation of social situations and the development of delusions.

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FIGURE 9.13 Impairments in reasoning and memory significantly affect the day-to-day functioning of sufferers of mental disorders.

The influence of stress on mental health disorders

As we learnt in Chapter 2, stress refers to a state of mental or physical tension that occurs when an individual must adjust or adapt to their environment but they do not feel they have the capacity to do so. Therefore, stress is thought to occur when the demands on an individual exceed the perceived ability of that individual to cope. Stress is the state experienced when an individual is exposed to a stressor. A stressor is the object or the event that causes stress, such as an exam, the death of a family member or financial difficulties.

Stress is experienced in the form of distress whenever a stressor produces a negative psychological response or psychological state (for example, anxiety, fear or feelings of hopelessness). Distress is considered to be a negative form of stress because it impedes our ability to perform and cope at an optimal level.

Stress reactions consist of a set of physical or psychological reactions that are set in motion when faced with threatening situations; they are the body's way of dealing with pressure. This set of reactions helps the body and mind to function at their optimal levels. Short-term stress (acute stress) enables us to harness all necessary resources to help combat the stressor. However, if stress is prolonged, the heightened arousal level produced by the sympathetic nervous system results in chronic stress, which can result in negative physical and psychological effects. Chronic stress can make us more susceptible to developing a mental disorder or it can contribute to the perpetuation of an existing disorder.

The continued release of adrenalin into the bloodstream causes the heart to beat at a faster than normal rate, which can cause damage to the heart, leading to heart palpitations and heart disease. Abnormal levels of internal activity can also lead to ulcers and stroke. Other physical effects of prolonged arousal are a weakened immune system, leading to an increased susceptibility to infection and disease. Skin irritations (including rashes and acne) and fatigue are also physiological effects of long-term stress.

EMOTIONAL, COGNITIVE AND BEHAVIOURAL EFFECTS OF CHRONIC STRESS

The many psychological effects of stress can be divided into three distinct categories: emotional effects, cognitive effects and behavioural effects.

Emotional effects may range from feeling increased levels of frustration, depression, anxiety, tension, irritability, anger and aggression, to feeling unable to cope with normal activities.

Our cognitive functions, or the way we process information and think about things, may also be affected by prolonged arousal. For example, we may find it difficult to focus our attention and direct our concentration. Our thoughts may be dominated by whatever is stressing us, and we may become confused, forgetful and unable to make rational decisions or solve problems. Our ability to think in a logical manner may also be negatively affected.

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Prolonged stress also results in negative behavioural changes. Our normal sleeping patterns may be interrupted, causing us to experience excessive tiredness during the day. Eating habits may change too, as we may restrict food intake or indulge in more food or high-calorie food more often. Generally, we may experience a negative feeling about ourselves and feel that we are in conflict with our life situation but powerless to change it. As a result, we may withdraw from social contact. Some individuals may also indulge in a range of harmful behaviours, including drug abuse or excessive exercise.

There are several factors associated with stress that can cause or exacerbate depressive cognitions such as feelings of worthlessness, helplessness and hopelessness. Although mild forms of depression may be normal during times of stress, major depression can result from excessive stress. In such situations, we may find that the person was unprepared to cope with the current stress, perhaps because of a series of previous disappointments. The triggering stressor is often the 'last straw' that reveals an underlying emotional disturbance.

As we know, if an individual has no sense of being able to control a situation, this can lead to feelings of helplessness. Therefore, appraisal of stressors can have an impact on whether an individual is able to gain mastery over them. In Chapter 2 we learnt about the transactional model of coping with stress, which focuses on how a person interacts with their external environment. The model proposes that stress occurs after a person appraises a potential stressor and finds that their abilities and resources to cope with it are inadequate. If that stressor becomes overwhelming, the person feels helpless and may develop depression. When the depression sufferer experiences additional stressors, they would continue to appraise themselves as having no ability to cope.

When chronic stress goes untreated, it may turn into a mental illness. Stress-related disorders are often linked to abnormal responses to acute or prolonged anxiety, and can include obsessive-compulsive disorder, post-traumatic stress disorder and mood disorders such as anxiety disorders and depression. The release of stress hormones (such as cortisol) over an extended period of time interferes with mood regulation and cognitive processes such as memory and decision-making. Research indicates that people who suffer from chronic stress may experience long-term changes in their brain that may make them more susceptible to mood disorders and anxiety (Beyond Blue, 2015b).

The human brain is made up of 'grey matter' and 'white matter'. Grey matter is composed mainly of two types of cells: neurons, which process and store information, and glia, cells that support the neurons. White matter is composed of myelinated axons, which form a network of fibres to connect the neurons so that information can be transmitted between the cells. Many people who have a stress-related mental illness (for example post-traumatic stress disorder (PTSD)) have more white matter in some areas of the brain than grey matter compared with other people. Although scientists have not been able to explain why these differences occur, they suggest that chronic stress may cause more myelin-producing cells to be generated, causing the 'delicate balance' of the brain to be disrupted, causing communication between brain cells slipping out of their normal timing (McNamee, 2014).

Researchers studying the impact of stress on the hippocampus (the brain structure involved in explicit memory formation and storage) found that chronic stress causes the brain to generate fewer neurons and more myelin-producing cells than normal. Stress also causes the release of chemicals that impair the function of the prefrontal cortex, the brain area responsible for higher level thinking. When we experience acute stress, these chemicals – including cortisol and norepinephrine – heighten our reactive tendencies by muting our reflective tendencies. If they remain at high levels for a prolonged period, they may contribute to the development of a mental disorder, such as anxiety or depression (National Center for Biotechnology Information, 2007).

The influence of poor self-efficacy on mental health disorders

Self-efficacy refers to an individual's belief in their capacity to execute behaviours necessary to produce specific performance attainments (Bandura, 1977, 1986, 1997). This can be seen as the ability to persist and a person's ability to succeed in reaching a specific goal, for example, quitting smoking or losing weight.

According to Albert Bandura, the American psychologist noted for his social learning theory and concept of self-efficacy, self-efficacy beliefs help people

self-efficacy An individual's belief in their capacity to execute behaviours necessary to produce specific performance attainments

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to interpret potentially threatening expectations as manageable and to feel less stressed in such situations. Thus, by reducing the negative thoughts and concerns of potential threats, they can regulate their emotional states. Bandura found low self-efficacy was a good predictor of poor mental health, and high self-efficacy was a good predictor of good mental health.

Clearly, a sense of high self-efficacy can help people to manage themselves when they are exposed to stressful situations. As a result, they are protected against many psychological problems. Conversely, poor self-efficacy prevents individuals from effectively dealing with stressful situations. Therefore, a person may feel inefficient and unable to control themselves when faced with stressful situations, which will influence their mental health and may make them more susceptible to developing a mental disorder.

9.7 CHECK YOUR UNDERSTANDING >>

1 In the context of mental health, what is rumination?

2 Which type of rumination consists of task-oriented thought processes focused on goal achievement and correction of mistakes?

A State rumination
B Action rumination
C Task-irrelevant rumination
D None of the above

3 What two strategies can be used to overcome rumination and prevent its negative consequences?

4 What is reasoning and how may an impairment in reasoning influence a person's mental health?

5 A state of mental or physical tension that occurs when an individual must adjust or adapt to their environment but they do not feel they have the capacity to do so is known as:

A mental wellbeing.
B physical wellbeing.
C stress.
D a mental disorder.

6 Outline one emotional, one cognitive and one behavioural effect of chronic stress.

7 Discuss how high levels of prolonged stress may contribute to the development of a specific mental disorder.

8 What is self-efficacy and how can it influence a person's mental health?

THE INFLUENCE OF SOCIAL RISK FACTORS

Social factors, or factors related to culture and environment that impact on behaviour, play a significant role in a person's health. For example, an accepting society and social network can be a great support to a person's health state. Feelings of acceptance and worth play an important role in the development of an individual's self-worth. That is why a positive public perception of mental illness and a reduction of social stigma is important to encourage those suffering from mental illness to seek treatment.

In this section we discuss the influence of disorganised attachment, loss of a significant relationship and the role of stigma as a barrier to accessing treatment as social risk factors that contribute to the development and progression of mental health disorders.

The influence of disorganised attachment on mental health disorders

Attachment refers to a relationship between two people who feel strongly about each other so that they exhibit behaviours to continue the relationship. In developmental psychology, attachment refers to the close emotional bond or relationship between an infant and the mother or primary caregiver. Attachment theory suggests that a number of important factors contribute to attachment, including that attachment is universal to all humans, as it appears in all cultures across all races of people. Attachment theory also suggests that attachment has a biological basis because its main function is to increase chances of survival by helping the child seek proximity to someone who will take care of their physical and emotional needs so that they feel secure.

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FIGURE 9.14 Positive and secure relationships in childhood have a long-lasting impact on children's emotional development.

John Bowlby (1907–1990), the British developmental psychologist notable for his work in attachment theory, found that the first year of life and the responsiveness of the caregiver were important elements to a child's social behaviour later in life (Santrock, 1997). Bowlby suggested that if the infant

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is comfortable with and finds security in a stable and routine attachment to their mother or primary caregiver, then an infant is able to organise other elements of development in a coherent way. The infant will feel assured that their caregiver will support them and trusts in the relationship. If the opposite occurs and there is instability in the caregiving relationship – whether physical distance, erratic patterns of parental behaviour or even physical or emotional abuse – then this may interfere with the child's sense of trust and security. This is referred to as disorganised attachment. Potentially, disorganised attachment may give rise to anxiety and psychological problems later in childhood or even decades later in life.

Early attachment experiences form an important foundation for our social and emotional development and future mental health. The attachment style that a person develops in early childhood often remains with them into adulthood, becoming a model for adult social interactions. Attachment experiences help us to shape how we see ourselves and the expectations we have of others. A disorganised attachment style increases the risk of children displaying behaviour problems and the development of mental illness later in life, such as low self-esteem, difficulty in trusting others and managing their feelings (Response Ability, 2010).

The influence of loss of a significant relationship on mental health disorders

Healthy relationships with friends, families and partners are vitally important to our physical and mental health. Positive relationships can promote self-esteem and confidence, provide a sense of belonging and assist in the development of coping and social skills. People who have healthy significant relationships are more likely to feel happy and satisfied with their lives, and are less likely to have physical and mental health problems.

However, maintaining healthy relationships with people who are significant to us requires a great deal of commitment. Challenges and problems within relationships are inevitable. There will be differences in ideas and expectations and, at times, conflict and strong expression of feelings. Relationships with friends, family and partners can provide a great support network but they can also become overwhelming and stressful. During childhood and adolescence, significant personal relationships can undergo major change and this can be challenging and difficult for young people to navigate.

At any time throughout the lifespan the loss of a significant relationship can result in very strong emotional responses such as anger, mood swings and feelings of rejection. This loss and its emotional impact can also cause behavioural changes (for example, difficulty sleeping and substance abuse), which affect a person's ability to cope with the everyday demands of their life, such as the demands of school and work commitments.

The emotional hurt that results from the loss of a significant relationship can lead to ongoing anxiety and unhappiness affecting our physical as well as mental health.

FIGURE 9.15 The loss of a significant relationship can result in feelings of rejection and ongoing anxiety.

Headspace, the National Youth Mental Health Foundation, outlines the following tips in dealing with the loss of a significant relationship:

- Whatever you're feeling now won't last forever. It may take time before you feel you have 'moved on', but you will. Take it one day at a time and realise that there will be good and bad days.
- If it was your decision to end the relationship it doesn't necessarily make the break-up any easier to deal with. It's still normal (and okay) to feel upset and to miss the other person.
- The end of a relationship doesn't mean that there is anything wrong with you. Try not to take it personally – relationship break-ups are common.

social factors Factors related to culture and environment that impact on behaviour

attachment A relationship between two people who feel strongly about each other so that they exhibit behaviours to continue the relationship

disorganised attachment Instability in a caregiving relationship that interferes with the child's sense of trust and security

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- You don't have to be in a relationship to feel happy. It's better to not be in a relationship than to be in a bad one.
- It's okay to feel angry or hurt, but be sure you are safe in how you express your feelings. Don't act out your anger or do spiteful things. Don't follow your ex around, call them all the time or harass them online. This sort of behaviour is not acceptable and will make you feel worse in the long run.
- Try not to feel embarrassed or to worry about how the situation will look to others.
- Remember that break-ups can have a positive side. You can learn more about yourself and what you want from future relationships. You can develop coping skills, become more independent, have more time to spend with friends and do the things that you enjoy.
- It is important to remember that with time and support most people pull through relationship break-ups, sometimes coming out stronger at the other end.
- Look after yourself. Try to eat healthily, and keep to regular sleep and exercise routines.
- Be realistic when thinking about your ex and the relationship. It's common to remember only the good things about the person and the relationship. But be honest with yourself – it's rare for a relationship or a person to be perfect. Remembering the things that weren't so great will make it easier to move on.
- Try to limit how much you think about your ex by finding things that will distract you. Think positively and try some new things.
- Give yourself some space. You don't need to shut your ex out of your life but it might be helpful to try to avoid him or her for a while after the break-up.
- Keep busy. You might find yourself with too much free time on your hands, especially at weekends. Plan ahead and do things that you usually enjoy.
- Take time out for you. Do things that you find relaxing, like going to a movie, playing or listening to music, meditating, reading or playing sport.
- Talk to friends and family and others who can support you. It's okay to want some time to yourself but being with supportive people can also be a big help. You can also get a different perspective by talking things through with others.
- Don't use drugs or alcohol to deal with the pain. Alcohol and drugs might help you feel better at first but the after-effects will leave you feeling much worse.
- Give it time. Allow yourself some time to cope with the change. (Headspace, n.d.)

9.8 CHECK YOUR UNDERSTANDING >>

1. Which of the following would not be considered a social factor that may impact on a person's health?
   - A Being a member of a netball club
   - B The type of school attended
   - C Coping skills
   - D Having access to mental health services
2. Define attachment.
3. From a biological point of view what is the main function of attachment?
4. What is disorganised attachment and what are the potential impacts on a person who is exposed to it?
5. Which of the following is a possible outcome of a positive relationship on a person's mental health?
   - A Coping and social skills
   - B A sense of belonging
   - C Self-esteem and confidence
   - D All of the above
6. How could the loss of a significant relationship influence a person's mental health?

Stigma as a barrier to accessing treatment for mental health disorders

Stigma refers to social disapproval of an individual's personal characteristics or beliefs, or social disapproval of a type of behaviour. Stigma arises because people are often uncomfortable or embarrassed by behaviour that is different, and often the mentally ill are incorrectly stereotyped as being violent, unpredictable or scary. As a result of this negative stereotype, people who have been labelled mentally ill are less likely to be hired for a new job, tend to be denied housing and are more likely to be falsely accused of crime (Hocking, 2003). **Labelling** occurs when a certain characteristic an individual possesses is used as a name or brand to describe them. For example, some people are labelled based on physical characteristics – such as 'tall', 'short', 'thin' or 'fat' – or characteristics of personality, such

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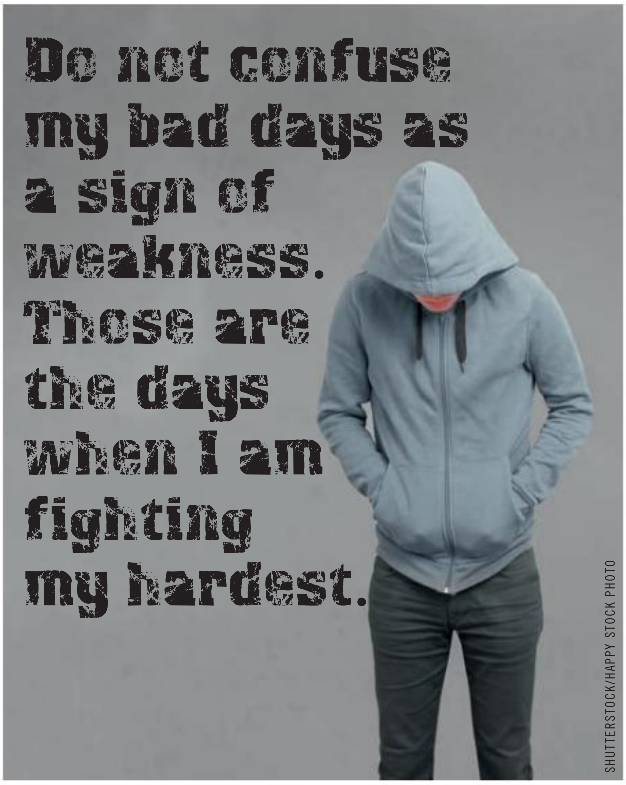

FIGURE 9.16 A lack of awareness and understanding of mental health disorders can cause stigma. Stigma can act as a barrier to accessing treatments. A lack of treatment can have a significant impact on a sufferer's wellbeing.

as 'arrogant', 'reliable', 'caring' or 'selfish'. Some of these labels have a negative connotation, while some may be seen as positive. For people suffering from mental illness, however, labels are generally derogatory, and may include 'psycho', 'nuts', 'schizo' or 'crazy'. Of course, when we have a broken leg we are not automatically labelled as 'limpy', so why should mental illness carry such labels? Read Focus on research 9.3 to see how a label can change perceptions of individuals.

A community consultation of carers and mental health consumers in Australia in 2000 (*SANE Australia's Have Your Say* report) identified a reduction in stigma and an increase in awareness and understanding as having the greatest potential to improve the lives of people affected by mental illness (Hocking, 2000). Respondents also considered it important to have better-trained health professionals and more available information and education for people with mental illness and their carers. Respondents wanted healthcare workers to 'treat them more respectfully' and the community to understand that they are not 'lazy' or 'weak' (Hocking, 2000).

FOCUS ON RESEARCH 9.3

THE EFFECTS OF LABELLING

A fascinating study undertaken by David Rosenhan and his colleagues of Stanford University illustrates the impact of psychiatric labelling. Rosenhan and several colleagues had themselves committed to mental hospitals with a diagnosis of 'schizophrenia' (Rosenhan, 1973). After being admitted, each of these pseudo-patients dropped all pretence of mental illness. Yet, even though they acted completely normally, none of the researchers was ever recognised by hospital staff as a phoney patient. Real patients were not so easily fooled. It was not unusual for a patient to say to one of the researchers, 'You're not crazy, you're checking up on the hospital!' or 'You're a journalist'.

To record their observations, Rosenhan and his colleagues took notes by carefully jotting things on small pieces of paper hidden in their hands. However, they soon learnt that secrecy was totally unnecessary – they then simply walked around with a clipboard, recording observations and collecting data. No one questioned this behaviour. The note-taking was just regarded as a symptom of the 'illness' the psuedo-patients allegedly had. This observation clarifies why staff members failed to detect the fake patients. Because they were in a mental ward, and because they had been labelled schizophrenic, anything the pseudo-patients did was seen as a symptom of **psychopathology**.

As Rosenhan's study shows, it is far better to label problems than to label people. Think of the difference in impact between saying 'You are experiencing a serious psychological disorder' and saying 'You are a schizophrenic'.

QUESTIONS

1. Write a possible hypothesis that Rosenhan may have been testing.
2. What sort of sampling technique was used in this study?
3. What is one advantage and one disadvantage of this sampling technique?
4. What data collection method was used in this study? Identify one advantage and one limitation of this method.
5. What does this study suggest about the effect that labelling has on how people respond to those with a mental disorder?

stigma Social disapproval of an individual's personal characteristics or beliefs, or social disapproval of a type of behaviour

labelling When a certain characteristic of an individual is used as a name or brand to describe them

psychopathology The scientific and systematic study of abnormal experience, cognition and behaviour; also a term used to refer to psychologically unhealthy behaviour

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The consequences of negative and unhelpful stereotypes are profound for people with a mental illness. They not only impair help-seeking behaviours, but affect medication adherence, overall recovery and, most importantly, impair self-esteem of the sufferer (Stuart, 2006).

Stigma about mental illnesses has an important role to play in the belief systems of society. Stereotypical views of mental illness begin in childhood and intensify in adulthood. Researchers believe that children learn from a very early age that mental problems are seen as a failure of character, and admitting such problems is looked down upon by their peers. Thus, people who are grappling with mental illness can be harmed as much by social stigma as they are by their immediate psychological problems (Corrigan & Penn, 1999).

If the person with the mental illness also accepts the stigma it can lead to feelings of shame, hopelessness and distress that cause sufferers to hide the symptoms of their illness. As a result, many people with a mental illness fail to seek readily available support from friends, family and professional services for fear that they will be viewed in a negative way.

In 2005, an Australian Senate Select Committee on Mental Health inquiry found only 38 per cent of people with a mental health problem get any treatment in a 12-month period (Parliament of Australia, 2005).

DEALING WITH SOCIAL STIGMA

How can we improve community attitudes about mental illness? In recent years, our understanding of how to improve community attitudes has become more sophisticated. There is now awareness that we need long-term strategies to combat stigma by disengaging mental illness from associated fears and anxieties and by improving knowledge and attitudes. Two important ways of doing this are improving mental-health literacy (knowledge and awareness about mental health) and stopping the constant reinforcement of negative stigma by the media (Jorm et al., 1997).

In 2006, a website called Headspace was launched by the Australian Government (see Figure 9.17). Part of the National Youth Mental Health Foundation, the initiative aims to provide important information and services to young people and their families across Australia, and also reduce stigma surrounding mental illness by raising community awareness. It provides support for mental health and wellbeing, and information that young people may not seek elsewhere because they feel intimidated or uncomfortable. Headspace employs a range of youth-friendly health professionals who can help young people with general health, mental health and counselling, education, employment services, and alcohol and other drug services. Headspace workers reinforce the fact that getting help early is the key to resolving mental health issues quickly (Headspace, 2006). Complete Try it yourself 9.2 to brainstorm ideas that may help reduce stigma associated with mental illness at your school.

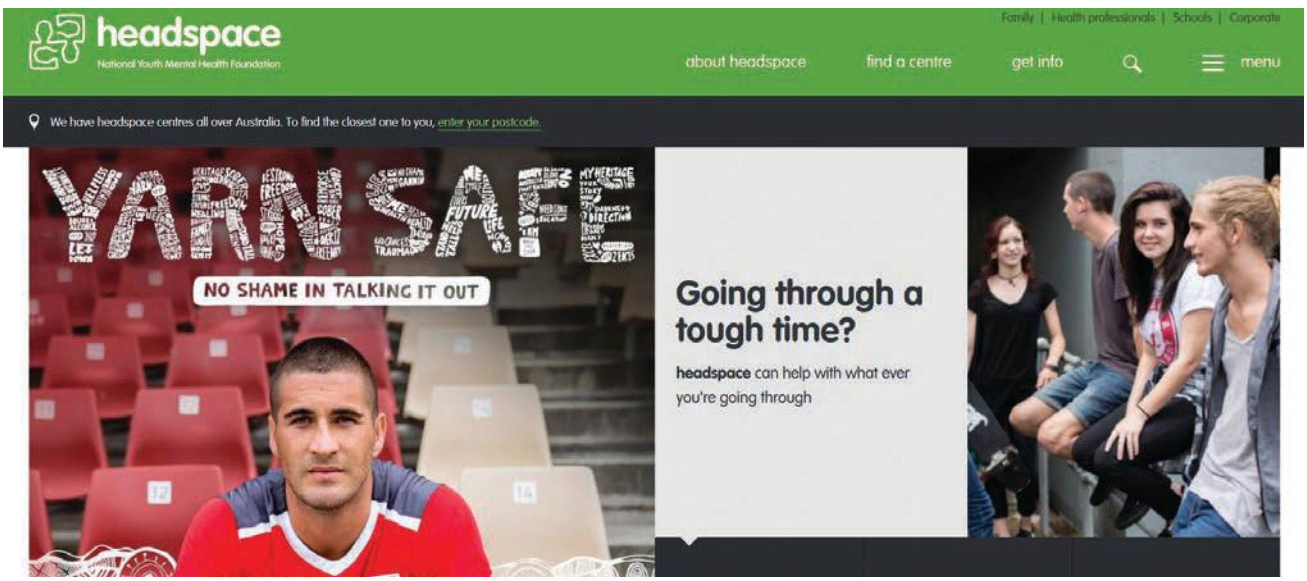

FIGURE 9.17 Organisations such as Headspace raise awareness and provide support and assistance to individuals experiencing a range of mental health issues.

9.2 TRY IT YOURSELF >>

BRAINSTORMING AGAINST STIGMA

One of the ways that social stigma attached to mental illness can be reduced is through raising knowledge and awareness about mental health. Form a group of three or four students and imagine that you are on the student representative council. Brainstorm ideas to help reduce the social stigma surrounding mental health in your school. Share these ideas with the class. Can any of them be practically implemented to raise awareness of mental illness at your school?

9.9 CHECK YOUR UNDERSTANDING >>

1 Distinguish between labelling and stigma.

2 Why are people who have been labelled mentally ill subjected to stigma?

3 Negative and unhelpful stereotypes directed towards people with a mental illness may:
   - A affect medication adherence.
   - B impair help-seeking behaviours.
   - C impair self-esteem.
   - D All of the above

4 The Australian Senate Select Committee on Mental Health inquiry found that __________ of people with a mental health problem seek treatment in a 12-month period.
   - A 8 per cent
   - B 18 per cent
   - C 28 per cent
   - D 38 per cent

5 Outline three ways in which the stigma attached to mental illness can be reduced.

CUMULATIVE RISK

As noted earlier in this chapter, there are many biological, psychological and social risk factors that contribute to the development and progression of mental health disorders. Sufferers of mental disorders commonly experience multiple risk factors, such as isolation, addiction and serious health issues. The biopsychosocial framework highlights the interactive nature of factors that combine and interact to contribute to the development of mental health problems. For example, a biological factor such as a serious illness may influence the social factor of isolation because someone is not able to attend social activities, and has started at a new school, which may in turn influence psychological factors such as feeling lonely and emotional. The addition of one risk factor to another intensifies the impact of each factor and increases the chance of psychological harm. This accumulation of and exposure to multiple risk factors is known as cumulative risk.

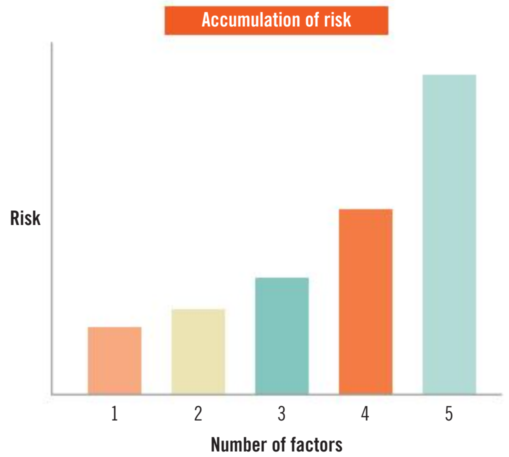

FIGURE 9.18 The accumulation and exposure to multiple risk factors is known as cumulative risk.

Risk factors are accumulative in nature. The risk of poor life outcomes rises sharply as the number of risk factors increases. Research examining cumulative risk has consistently found that the accumulation of risk factors increases the likelihood of mental health problems. Research shows that it is the presence of a number of mental health risk factors rather than the presence of a single risk factor that will have a greater effect on the development and progression of mental health disorders (Appleyard, Egeland, van Dulmen, & Sroufe, 2005). This research also suggests that while children who experience more risk factors are at increased risk of problems, there does not appear to be a particular threshold beyond which their outcomes become worse. This finding is important because it suggests that there does not exist a 'point of no return' beyond which services for children are hopeless.

Research also suggests that older people are at greater risk of developing mental health conditions because of the cumulative effect of numerous risk factors, including chronic illness and isolation. However, there is no evidence that ageing itself is a risk factor for depression later in life. While the exact cause of depression isn't known, a number of things can be associated with its development. Generally, depression does not result from a single event, but from a combination of recent events and other long-term or personal factors (Victoria. Better Health Channel, 2015e).

cumulative risk The accumulation of and exposure to multiple risk factors that increase susceptibility to developing a mental disorder or perpetuates an existing mental disorder

FIGURE 9.19 Sufferers of mental disorders commonly experience multiple risk factors, such as isolation, addiction and serious health issues.

Some of the cumulative risk that might be associated with the development of depression include:

- serious physical health problems
- abusive or uncaring relationships
- family history of depression
- past experiences
- side effects from medications
- losses such as relationships, independence, work and income, self-worth, mobility and flexibility
- social isolation or loneliness
- significant change in living arrangements such as moving from living independently to a care setting
- admission to hospital
- personality factors (for example, if the person is self-critical or negative, worries a lot, is a perfectionist)
- drug and alcohol use (Victoria. Better Health Channel, 2015e).

Cumulative risk focuses on the number of risk factors; however, it is also important to take into account the severity of these factors in influencing a person's mental health. For example, the loss of a loved one has the capacity to affect a person's mental health more than many other factors. The importance of cumulative impact from a combination of factors also appears to apply to protective factors. With an increasing number of protective factors, there is likely to be an increase in positive outcomes (Rutter, 2007).

9.10 CHECK YOUR UNDERSTANDING >>

1 What is cumulative risk?

2 Why may older people be at greater risk of developing mental health conditions than younger people?

3 Using an example, explain how the accumulation and exposure to multiple risk factors may influence a person's mental health.

4 Identify three examples of cumulative risk factors that might be associated with the development of depression.

5 With an increasing number of protective factors, there is likely to be an increase in:

A negative outcomes.

B positive outcomes.

C mental health problems.

D cumulative risk.

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CHAPTER SUMMARY

Mental health as a continuum

- Mental health is characterised as the psychological state of someone who is functioning at a satisfactory level of emotional and behavioural adjustment.
- Mental health problems indicate a disruption to an individual's usual level of social and emotional wellbeing, including when their abilities are negatively impacted.
- A mental disorder is a psychological state characterised by emotional difficulties that lead to emotional or behavioural impairment or disability serious enough to require psychiatric intervention.
- On one continuum, optimal mental health is found at one extreme and poor mental health at the other extreme, while on a separate continuum, mental illness is found at one extreme and no mental illness at the opposite end.
- Hypochondria refers to a preoccupation with minor bodily problems and the presence of illnesses that appear to be imaginary.

Characteristics of a mentally healthy person

- According to the World Health Organization the characteristics of a mentally healthy person include being able to realise their own potential, cope with the normal stresses of life, work productively and fruitfully, and be able to make a contribution to their community.
- People who enjoy good mental health also have high levels of functioning, social and emotional wellbeing and resilience to life stressors.
- A key characteristic of a mentally healthy person is having a high level of functioning, which can be demonstrated by being able to interact and involve oneself in society and to undertake everyday tasks such as personal hygiene, going to work or eating.
- A resilient person is better able to cope with life's challenges such as negative life events and to maintain their social and emotional wellbeing.

Ethical implications of mental health research

- When conducting research into mental health, it is crucial that researchers obtain voluntary participation and informed consent from all participants.
- Where appropriate, before an experiment begins, the researcher must fully inform the participants of the true nature and purpose of the experiment, and obtain their written consent to participate.
- A researcher must outline any foreseeable risks to the participant and inform participants of their rights, including their right to withdraw.
- The researcher must ensure that any psychologically or physiologically vulnerable person does not participate in the study.
- Because of the symptoms of their mental illness, sufferers may lack the capacity to understand the research procedure and therefore the ability to provide informed consent.
- The ethical implications of using placebo treatments in the study of mental health is that the researcher is deceiving the participants. This is overcome when the participant is fully debriefed at the end of the study.

Factors that contribute to the development and progression of mental health disorders – risk and protective factors

- The 'four Ps' approach considers four different types of factors that contribute to the development and progression of mental health disorders: predisposing risk factors, precipitating risk factors, perpetuating risk factors and protective factors.
- Predisposing risk factors increase a person's vulnerability to developing a mental health problem.
- Precipitating risk factors trigger the onset or exacerbation of a mental health problem.
- Perpetuating risk factors prolong the course of the disorder and inhibit recovery.
- Protective factors enhance or have a positive effect on the health of an individual.

Biopsychosocial approach to physical and mental health

- The biopsychosocial model of health and illness proposes that health and illness outcomes are a result of the interaction of contributing biological and psychological (internal) and social (external) factors.
- This model provides a holistic view of health, taking into account the interactive nature of physical, mental and social aspects of a person's health to enable a more comprehensive and personalised diagnosis and treatment plan.

The influence of biological risk factors

- A genetic vulnerability (also called genetic susceptibility or predisposition) is an increased likelihood of developing a particular disease based on a person's genetic make-up.
- Genetic studies such as family studies and adoption studies have shown a clear link between genetics and the development of mental disorders such as schizophrenia, autism, manic depressive illness, attention deficit hyperactivity disorder and anxiety disorders.
- Some people may experience a poor response to medication due to genetic factors, and their medication may be ineffective in reducing the disabling symptoms associated with their mental illness.

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- Studies have shown that sleep deprivation occurs when we do not have adequate sleep and that this has a significant effect on mood.
- Substance abuse can make the symptoms of a mental health problem worse or increase an underlying risk of developing a mental disorder because it may sharply increase symptoms of mental illness or trigger new symptoms.

The influence of psychological risk factors

- Rumination is the compulsively focused attention on the symptoms of one's distress, and on its possible causes and consequences, as opposed to its solutions.
- Rumination increases stress levels because it involves a person continuously thinking about the various aspects of an upsetting situation and it has been implicated in the development and maintenance of a variety of mental health disorders such as depression, general anxiety, post-traumatic stress, binge drinking and eating disorders.
- To overcome rumination and prevent its negative consequences, research suggests strategies such as engaging in activities that foster positive thoughts and focusing on problem-solving.
- For an individual to function successfully in everyday life and experience good mental health and a sense of wellbeing, it is critical that their cognitive skills, such as reasoning and memory, operate effectively.
- Stress-related disorders are often linked to abnormal responses to acute or prolonged anxiety, and can include obsessive-compulsive disorder, post-traumatic stress disorder and mood disorders such as anxiety disorders and depression.
- Self-efficacy refers to an individual's belief in their capacity to execute behaviours necessary to produce specific performance attainments.

The influence of social risk factors

- Attachment theory suggests that attachment has a biological basis because its main function is to increase chances of survival by helping the child seek proximity to someone who will take care of their physical and emotional needs so that they feel secure.
- A disorganised attachment style increases the risk of children displaying behaviour problems and the development of mental illness later in life, such as low self-esteem, difficulty in trusting others and managing their feelings.
- Positive relationships can promote self-esteem and confidence, provide a sense of belonging and assist in the development of coping and social skills.
- At any time throughout the lifespan the loss of a significant relationship can result in very strong emotional responses such as anger, mood swings and feelings of rejection.
- Stigma refers to social disapproval of an individual's personal characteristics or beliefs, or social disapproval of a type of behaviour.
- If the person with the mental illness also accepts the stigma it can lead to feelings of shame, hopelessness and distress that cause sufferers to hide the symptoms of their illness. As a result, many people with a mental illness fail to seek readily available support from friends, family and professional services for fear that they will be viewed in a negative way.
- There is now awareness that we need long-term strategies to combat stigma by disengaging mental illness from associated fears and anxieties and by improving knowledge and attitudes.

Cumulative risk

- Sufferers of mental disorders commonly experience multiple risk factors, such as isolation, addiction and serious health issues.
- Cumulative risk is the accumulation of and exposure to multiple risk factors that increase susceptibility to developing a mental disorder or perpetuates an existing mental disorder.
- Research examining cumulative risk has consistently found that the accumulation of risk factors increases the likelihood of mental health problems.

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APPLY YOUR KNOWLEDGE AND SKILLS

SECTION A: MULTIPLE-CHOICE QUESTIONS

Answer the following questions by writing the correct letter in your workbook. Only one answer is correct for each question.

1 A disruption to an individual's usual level of social and emotional wellbeing, including when their abilities are negatively affected, is known as:

A a mental health problem.
B mental wellbeing.
C physical wellbeing.
D a mental disorder.

2 Resilience is:

A the ability to dismiss any stress and cope by avoiding adversity.
B the ability to cope with stress by avoiding support from friends and family.
C the inability to adapt to stress by seeking support from friends and family.
D the ability to properly adapt to stress and cope with adversity.

3 A fundamental difference between mental health and a mental illness (disorder) is that everyone has some level of __________ all of the time, whereas it is possible to be without a __________.

A mental illness; mental health
B mental health; mental illness
C physical illness; mental illness
D mental health; physical illness

4 A preoccupation with minor bodily problems and the presence of illnesses that appear to be imaginary is known as:

A pseudoscience.
B resilience.
C hypochondria.
D acculturation.

5 Which of the following are characteristics of a mentally healthy person?

A Comfortable with other people
B Laugh at themselves and with others
C Make their own decisions
D All of the above

6 On a level of functioning scale of 1–100, which of the following scores would best represent a person with a persistent inability to maintain minimal personal hygiene?

A 100
B 50
C 25
D 5

7 Which of the following does not describe a person with good wellbeing?

A A person who has a sense of belonging to a community, has a job and is a member of a sporting team
B A person who experiences positive emotions such as happiness, joy or love, and feels generally satisfied with life
C A person who lacks a sense of humour and finds it difficult to cope with everyday needs
D A person who has the ability to deal with challenges, and has a strong sense of purpose and control

8 When conducting research into mental health, it is crucial that researchers follow which of the following ethical considerations?

A Voluntary participation
B Confidentiality
C Informed consent
D All of the above

9 Exposure to environmental stressors, inflammatory conditions, toxins, alcohol or drugs while in the womb would be considered to be a __________ that may influence mental health disorder.

A predisposing risk factor
B precipitating risk factor
C perpetuating risk factor
D protective factor

10 Having safe, secure and suitable accommodation would be considered a __________ that may influence mental health disorder.

A predisposing risk factor
B precipitating risk factor
C perpetuating risk factor
D protective factor

11 If John's parents both have diabetes, but neither of Sam's parents have diabetes, John's risk of developing diabetes is higher than Sam's. Which of the determinants of health does this represent?

A Social
B Cultural
C Biological
D Environmental

12 An increased likelihood of developing a particular disease based on a person's genetic make-up is known as:

A immunochemistry.
B psychoneuroradiology.
C genetic resistance.
D genetic vulnerability.

13 Dwelling on the consequences and feelings associated with a failure is known as:

A action rumination.
B task-irrelevant rumination.
C state rumination.
D event rumination.

14 The scientific and systematic study of abnormal experience, cognition and behaviour (and also a term used to refer to psychologically unhealthy behaviour) is known as:

A psychopharmacology.
B psychoneuroradiology.
C psychoneuroimmunology.
D psychopathology.

15 With an increasing number of __________ factors, there is likely to be an increase in positive outcomes for a person with a mental disorder.

A protective
B negative
C risk
D adverse

SECTION B: SHORT-ANSWER QUESTIONS

1 Distinguish between mental health and mental disorder.

2 List four characteristics of a mentally healthy person.

3 How can resilience influence a person's mental health?

4 Describe three actions that can be used to boost wellbeing and stay mentally healthy.

5 Why is it important to consider informed consent in the study of, and research into, mental health?

6 Name and provide an example of each of the four different types of factors that contribute to the development and progression of mental health disorders.

7 How may genetic vulnerability to specific disorders influence mental health?

8 How may a poor response to medication due to genetic factors influence mental health?

9 What is rumination and how may it influence mental health?

10 Discuss the role cumulative risk plays in the development and progression of mental health disorders.

SECTION C: EXTENDED-RESPONSE QUESTION

Read the following article and complete the task below.

THREE HOURS IS ENOUGH TO HELP PREVENT MENTAL HEALTH ISSUES IN TEENS

The incidence of mental health issues among 509 British youth was reduced by 25 to 33 per cent over the 24 months following two 90-minute group therapy sessions, according to a study led by Dr Patricia Conrod of the University of Montreal and its affiliated Sainte-Justine Hospital Research Centre. 'Almost one in four American 8 to 15-year-olds has experienced a mental health disorder over the past year. We know that these disorders are associated with a plethora of negative consequences,' Conrod said. 'Our study shows that teacher-delivered interventions that target specific risk factors for mental health problems can be immensely effective at reducing the incidence of depression, anxiety and conduct disorders in the long term.'

Nineteen schools in Greater London participated in the study, which included a control group of schools in which students did not receive any interventions. Students were evaluated for their risk of developing mental health or substance abuse problems using an established personality scale. The scale measures different personality factors that are known to be correlated strongly with behavioural issues: for example, a person with high level of impulsivity is more than five times likely to develop severe conduct problems within the next 18 months. The researchers looked for impulsivity, hopelessness, anxiety sensitivity and sensation seeking. The schools in the intervention condition were trained to deliver interventions to their high-risk students. The control schools were not. The two-session interventions included cognitive-behavioural strategies for managing one's personality profile. The interventions included real-life 'scenarios' shared by the high-risk youths within their focus group. The groups discussed thoughts, emotions and behaviours within the context of their personality type – identifying situational triggers, for example – and with the guidance of the teacher, explored ways to manage their issues.

In the two years that followed the interventions, students completed questionnaires every six months that enabled the researchers to establish the development of depression, anxiety, panic attacks, conduct problems and suicidal thoughts. The effects were clinically significant, with a 21–26 per cent reduction in severe depression, anxiety and conduct problem symptoms over the course of the trial. Teenagers high in impulsivity had 36 per cent reduced odds of reporting severe conduct problems. Similarly, teenagers high in anxiety sensitivity reported 33 per cent reduced odds of severe anxiety problems. Teenagers high in hopelessness exhibited similar decreases in severe depressive symptoms (23 per cent) as compared to youth with similar personality profiles who did not receive interventions. 'The interventions were run by trained educational professionals, suggesting that this brief intervention can be both effective and sustainable

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when run within the school system,' Conrod said. 'We are now leading a similar study in 32 high schools in Montreal to further test the efficacy of this kind of program.'

Source: Université de Montréal. (2013, October 3). Three hours is enough to help prevent mental health issues in teens. *ScienceDaily*.

Write a discussion section for a research report on this investigation. Your report must follow the usual convention for report writing:

- State the aim of the study.
- Give a description of the results.
- Provide a statement that explains whether the results support the hypothesis.
- State whether a conclusion can be drawn from the results and explain why.
- Identify and explain an extraneous variable that may have affected the results and a suggestion about how this variable could be controlled in future research.
- Identify and explain the ethical considerations relevant to this study.

This question is worth 10 marks.

SECTION D: ASSESSMENT TASK

A RESPONSE TO A SET OF STRUCTURED QUESTIONS

Answer the following set of structured questions based on your study of the influences of mental wellbeing.

1. What is meant by the mental health continuum?
2. Discuss three typical characteristics of a mentally healthy person.
3. What are the ethical implications in the study of, and research into, mental health?
4. Using examples, distinguish between predisposing risk factors and protective factors.
5. Discuss the influence of biological risk factors in the development and progression of mental health disorders.
6. Discuss the influence of psychological risk factors in the development and progression of mental health disorders.
7. Discuss the influence of social risk factors in the development and progression of mental health disorders.
8. Using examples, discuss the concept of cumulative risk in the development and progression of mental health disorders.

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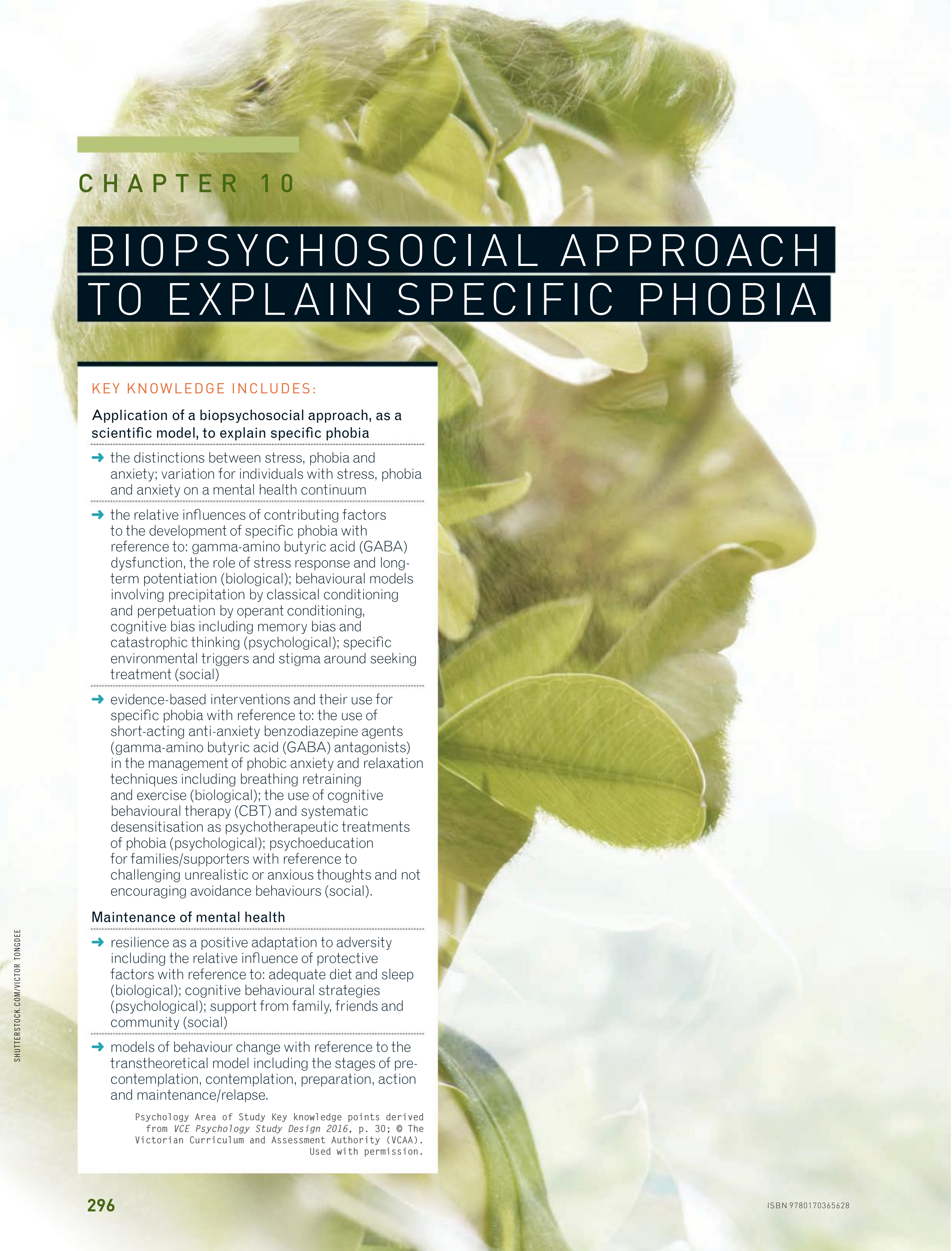

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CHAPTER 10

BIOPSYCHOSOCIAL APPROACH TO EXPLAIN SPECIFIC PHOBIA

KEY KNOWLEDGE INCLUDES:

Application of a biopsychosocial approach, as a scientific model, to explain specific phobia

- the distinctions between stress, phobia and anxiety; variation for individuals with stress, phobia and anxiety on a mental health continuum
- the relative influences of contributing factors to the development of specific phobia with reference to: gamma-amino butyric acid (GABA) dysfunction, the role of stress response and long-term potentiation (biological); behavioural models involving precipitation by classical conditioning and perpetuation by operant conditioning, cognitive bias including memory bias and catastrophic thinking (psychological); specific environmental triggers and stigma around seeking treatment (social)
- evidence-based interventions and their use for specific phobia with reference to: the use of short-acting anti-anxiety benzodiazepine agents (gamma-amino butyric acid (GABA) antagonists) in the management of phobic anxiety and relaxation techniques including breathing retraining and exercise (biological); the use of cognitive behavioural therapy (CBT) and systematic desensitisation as psychotherapeutic treatments of phobia (psychological); psychoeducation for families/supporters with reference to challenging unrealistic or anxious thoughts and not encouraging avoidance behaviours (social).

Maintenance of mental health

- resilience as a positive adaptation to adversity including the relative influence of protective factors with reference to: adequate diet and sleep (biological); cognitive behavioural strategies (psychological); support from family, friends and community (social)
- models of behaviour change with reference to the transtheoretical model including the stages of pre-contemplation, contemplation, preparation, action and maintenance/relapse.

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STRESS, PHOBIA AND ANXIETY

> 'The greatest weapon against stress is our ability to choose one thought over another.'
>
> William James (1842–1910), American psychologist

We saw in Chapter 9 how the medley of issues in everyday life could cause us to become stressed. We also saw that stress is a normal response to any kind of pressure situation. However, repetitive, recurrent and ongoing stress can sometimes lead to the development of a psychological disorder such as anxiety, which is commonly experienced by many people. Anxiety can be helpful in preparing for challenges that lie ahead, but when its symptoms include excessive and irrational worry and interfere with a person's daily functioning, it may indicate the presence of a psychological disorder.

Learning to recognise the difference between stress, anxiety and a mental disorder is important because management strategies and treatments vary. We *manage* stress and anxiety (because they are normal phenomena), whereas we *treat* psychological disorders. If left untreated, anxiety disorders may affect relationships with family and friends, job performance and the overall quality of life.

For most people, the word 'treatment' probably conjures up images of pills and capsules. Yet interestingly, taking medications is only one part of a good treatment plan available to Australians suffering from mental illness. In this chapter, we will learn more about the different types of treatments such as medications, talking therapies and behavioural modification treatments.

In Chapter 9, we also saw that health and disease could be understood from a biopsychosocial perspective. The biopsychosocial model considers health and illness in the context of biological, psychological and social determinants. In this chapter we will continue to explore how a biopsychosocial approach can be used to explain how biological, psychological and social factors are involved in the development and management of the mental disorder, specific phobia. This chapter also explores the concepts of resilience and coping and investigates the psychological basis of strategies that contribute to mental wellbeing.

DISTINCTIONS BETWEEN STRESS, PHOBIA AND ANXIETY

In Chapter 2 we learnt that stress is your body's reaction to a challenge or demand. Stress refers to a state of mental or physical tension that occurs when an individual must adjust or adapt to their environment but they do not feel they have the capacity to do so. Stress is experienced when the demands on an individual exceed the perceived ability of that individual to cope. Stress is a subjective experience, which means it is an individual's interpretation of the object, situation or event that determines the extent of stress experienced. Some people perceive certain events as more stressful than others. The very same situation can be experienced differently depending on the individual. For example, a shy person may perceive a loud party as stressful, whereas a more outgoing person may perceive very little stress in this situation. Although stress can be positive, such as when it helps you avoid danger or perform at your optimal level, if it lasts for a long time, it may harm your health.

Imagine the feeling of waiting to take an important test for which you are unprepared, waiting to give a speech to a large audience of strangers or being followed by a police car while you drive. You've almost certainly felt anxiety in one of these situations. **Anxiety** refers to feelings of apprehension, dread or uneasiness and it is a response to an unclear or ambiguous threat. As you may have noticed, the physical reactions that accompany anxiety are similar to those that accompany fear and stress.

Feeling anxious is a very normal emotion, and you probably feel it often. (Complete Try it yourself 10.1 to see which objects, events and situations give you a feeling of anxiety.) Moderate levels of anxiety will improve performance, and sometimes high levels of anxiety will be appropriate when they are consistent with the demands of the situation (see Figure 10.1). However, there is a marked difference between feeling anxious some of the time and actually suffering from an anxiety disorder – Figure 10.2 shows these differences. Additionally, people respond to different situations in different ways, so if one person feels anxiety in a particular situation while another person does not, this is not evidence that the anxious person is suffering from an anxiety disorder.

anxiety A feeling of apprehension, dread or uneasiness in response to an unclear or ambiguous threat

FIGURE 10.1 Short periods of higher than normal levels of anxiety can be beneficial. For example, snowboarders who challenge themselves to go faster may experience anxiety while also improving their performance.

So, if fear and anxiety are normal emotions, when do they signify a problem? When anxiety is out of proportion to a situation, it may be detrimental to an individual's wellbeing, and result in an **anxiety disorder**. A problem exists when intense or persistent anxiety prevents people from doing what they want or need to do. Their anxieties mean they struggle to preserve control (Zinbarg, Barlow, Brown, & Hertz, 1992) – they simply cannot stop worrying. An anxiety disorder may rob us of the capacity to learn new information, plan an appropriate response to an issue, or carry out complex activities that we routinely do in everyday life, thereby revealing a problem (Treatment Protocol Project, 2004).

Individuals with anxiety disorders are known to have specific, recurring fears that they recognise as irrational, unrealistic and intrusive (Treatment Protocol Project, 2004). Typically, people with anxiety-related problems feel threatened, but may not be

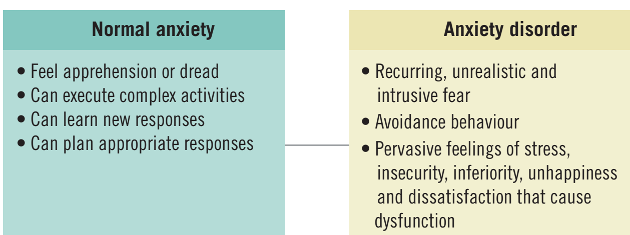

FIGURE 10.2 Feeling anxious at times is a very normal emotion – there is a difference between feeling anxious in some situations and actually suffering from an anxiety disorder

able to do anything constructive about it. In general, anxiety-related problems involve:

- high levels of physical signs of anxiety
- restrictive, self-defeating behaviour patterns
- a tendency to use elaborate defence mechanisms or avoidance responses to get through the day
- pervasive feelings of stress, insecurity, inferiority, unhappiness and dissatisfaction with life.

The 2007 National Survey of Mental Health and Wellbeing found that of the 16 million Australians aged 16–85 years, almost half (45 per cent, or 7.3 million) experienced a mental disorder at some point in their life. Anxiety is the most common mental condition in Australia. On average, one in four people – one in three women and one in five men – will experience anxiety. In any one year, approximately 2 million Australian adults have anxiety (Australian Bureau of Statistics, 2008).

TABLE 10.1 Prevalence of anxiety disorders in the Australian population

	Males %	Females %	Persons %
Panic disorder	2.3	2.9	2.6
Agoraphobia	2.1	3.5	2.8
Social phobia	3.8	5.7	4.7
Generalised anxiety disorder	2.0	3.5	2.7
Post-traumatic stress disorder	4.6	8.3	6.4
Obsessive-compulsive disorder	1.6	2.2	1.9
Any anxiety disorder	10.8	17.9	14.4

Note: Totals are lower than the sum of disorders as people may have had more than one type of anxiety disorder in the 12 months.
Source: Australian Government. Department of Health (2009)

The *Diagnostic and Statistical Manual of Mental Disorders*, Fifth Edition (*DSM-5*), published by the American Psychiatric Association, offers a common language and standard criteria for the classification of mental disorders. It contains a listing of diagnostic criteria for a vast range of mental disorders.

There are several individual disorders that fall under the major heading of anxiety disorders (see Table 10.2); these include generalised anxiety disorder, panic disorder, specific and social phobias, post-traumatic stress disorder, obsessive-compulsive disorder and anxiety disorders due to general physical illnesses or substance use. Phobias are the most common of all anxiety disorders.

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TABLE 10.2 The six most common anxiety disorders in Australia

Type of anxiety disorder	Symptoms
Generalised anxiety disorder (GAD)	A person feels anxious on most days, worrying about lots of different things, for a period of six months or more.
Social phobia	A person has an intense fear of being criticised, embarrassed or humiliated, even in everyday situations, such as speaking publicly, eating in public, being assertive at work or making small talk.
Specific phobias	A person feels very fearful about a particular object, activity or situation and may go to great lengths to avoid it, for example, having an injection or travelling on a plane. There are many different types of phobias.
Obsessive-compulsive disorder (OCD)	A person has ongoing unwanted or intrusive thoughts and fears that cause anxiety. Although the person may acknowledge these thoughts as silly, they often try to relieve their anxiety by carrying out certain behaviours or rituals. For example, a fear of germs and contamination can lead to constant washing of hands and clothes.
Post-traumatic stress disorder (PTSD)	This can happen after a person experiences a traumatic event (e.g. war, assault, accident, disaster). Symptoms can include difficulty relaxing, upsetting dreams or flashbacks of the event, and avoidance of anything related to the event. PTSD is diagnosed when a person has symptoms for at least a month.
Panic disorder	A person has panic attacks, which are intense, overwhelming and often uncontrollable feelings of anxiety combined with a range of physical symptoms. A person having a panic attack may experience shortness of breath, chest pain, dizziness and excessive perspiration. Sometimes, people experiencing a panic attack think they are having a heart attack or are about to die. If a person has recurrent panic attacks or persistently fears having one for more than a month, the person is said to have panic disorder.

Source: Beyond Blue (2015c)

10.1 TRY IT YOURSELF >>

A FEELING OF ANXIETY

The items in the table below are objects and experiences that may cause fear and unpleasant feelings.

1 Copy or photocopy the table.

2 Use the rating scale to write a number (next to each item) that describes how anxious you feel about the object or experience.

3 Discuss these ratings with your classmates. Have you scored high and low for the same items? What may account for these differences in ratings?

Level of anxiety rating scale: 1 = no anxiety; 2 = a little bit of anxiety; 3 = a fair amount of anxiety; 4 = much anxiety; 5 = very much/extreme anxiety					
Going to sleep at night	Travelling by car	Worms	Large dogs	Being interviewed	Studying for exams
Being criticised	Large open spaces	Being introduced to someone	Failure	Crawling insects	Dating someone for the first time
Being alone	Mice	People in authority	Enclosed spaces	Crowds	Giving a class presentation
Feeling rejected by others	Being asked a question in class	Travelling by plane	Spiders	Non-venomous snakes	Being in high places
Flying insects	Darkness	Cats	Speaking in public	Dirt	Making mistakes
Small dogs	Climbing up ladders	Being in water	Being late to an appointment	Large social gatherings	Being watched while you are working

anxiety disorder A mental disorder that involves feelings of extreme anxiety, accompanied by physical and psychological symptoms, which prevents a sufferer from normal functioning

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10.1 CHECK YOUR UNDERSTANDING >>

1 A state of mental or physical tension that occurs when an individual must adjust or adapt to their environment but they do not feel they have the capacity to do so is known as:
A a phobia.
B a mental illness.
C anxiety.
D stress.

2 One anxiety disorder that is characterised by irrational and persistent fear and avoidance of a certain object, situation or experience is known as:
A a phobia.
B a mental illness.
C anxiety.
D stress.

3 The experience of feelings of apprehension, dread or uneasiness that is a response to an unclear or ambiguous threat is known as:
A a phobia.
B a mental illness.
C anxiety.
D stress.

4 List five physical reactions that accompany anxiety.

5 Explain the difference between stress, phobia and anxiety. Provide an example of each to demonstrate your understanding.

6 What percentage of the Australian population suffers from an anxiety disorder?
A 1 per cent
B 7 per cent
C 14 per cent
D 50 per cent

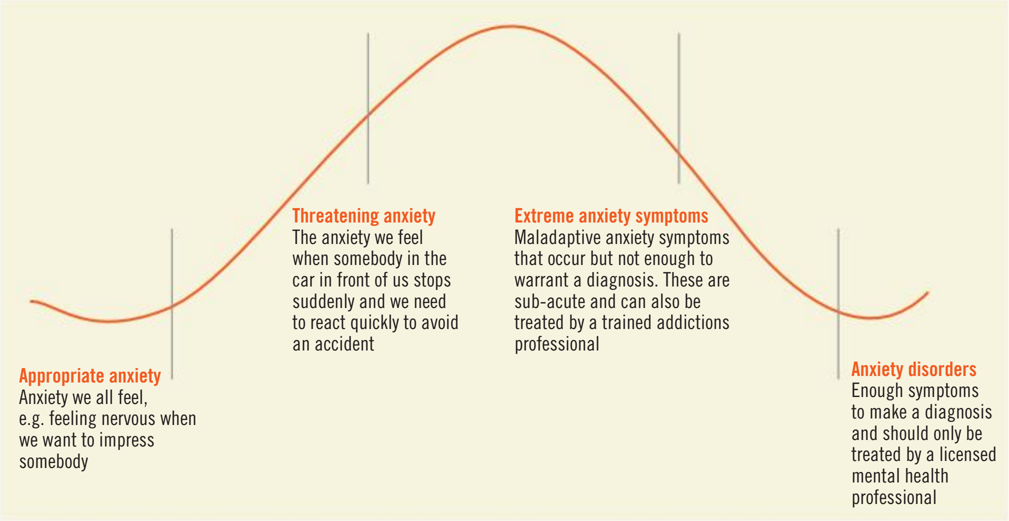
VARIATIONS OF STRESS, PHOBIA AND ANXIETY ON A MENTAL HEALTH CONTINUUM

We all experience stress in everyday life. This stress can result from the demand of needing to get up early and to school on time to the demands associated with completing oral presentations and examinations. The degree of stress experienced can differ greatly between

FIGURE 10.3 An individual's phobia about injections can be so intense and frightening that they avoid medical treatment.

individuals. Because anxiety is a normal response to stress, the degree of anxiety experienced also varies. Anxiety includes feelings of apprehension, uneasiness and uncertainty to more extreme feelings of dread and dismay.

Just as there are varying degrees of physical health, a person's levels of anxiety can be presented on a continuum (see Figure 10.4), ranging from normal feelings of being nervous to extreme feelings that can be diagnosed as symptoms of a mental disorder, such as a phobia. A phobia is a persistent, irrational and



Source: Adapted from Duncan (2012)

FIGURE 10.4 Anxiety on a continuum

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intense fear of a specific object, activity or situation. Frequently a person can identify what triggers their phobia and they understand that their reaction is irrational. However, they feel powerless to control their fear and they may not know why it originated.

Common phobias include fear of heights, snakes, social situations and needles. How we respond to stress can differ over time. Therefore, depending on our particular life circumstances and availability of coping strategies, it is expected that we will move through the continuum at various times throughout our life. Mental health lies on a continuum from having no symptoms to having a severe mental disorder. Not every person will experience the extremes of the continuum; however, research suggests that over 14 per cent of the population will experience an anxiety disorder at some stage in their lives (Harris et al., 2015).

TABLE 10.3 Levels of anxiety

Anxiety type	Description
Mild anxiety	Mild anxiety is commonly experienced when presented with challenging situations and circumstances. You may feel nervous about an upcoming test or oral presentation but these feelings are not overwhelming. Mild anxiety is anxiety that is usually manageable and you can cope and participate in everyday activities. Mild anxiety can have positive effects; e.g. it can help to solve problems, motivate to succeed and engage in goal-directed activity.
Moderate anxiety	Moderate anxiety is the disturbing feeling that something is wrong. It is considered normal when experienced in short-term periods in response to difficult life experiences. You may feel nervous, agitated and find it difficult to concentrate on the task at hand. Moderate anxiety and its consequences interfere with a normal lifestyle.
Severe anxiety	A person experiencing severe anxiety will feel restless, irritable and angry. The person will experience the fight–flight–freeze response (increased heart rate, breathing and blood pressure). Cognitive skills decrease significantly, with feelings of being totally overwhelmed. Severe anxiety interferes significantly with a person's ability to cope with everyday needs.

Source: Adapted from Videbeck (2010)

A specific phobia is an intense, irrational fear and avoidance of a particular object (such as needles, spiders or snakes), activity (such as swimming) or situation (such as enclosed spaces). People affected by phobias recognise that their fears are unreasonable and excessive, but they cannot control them. A phobia

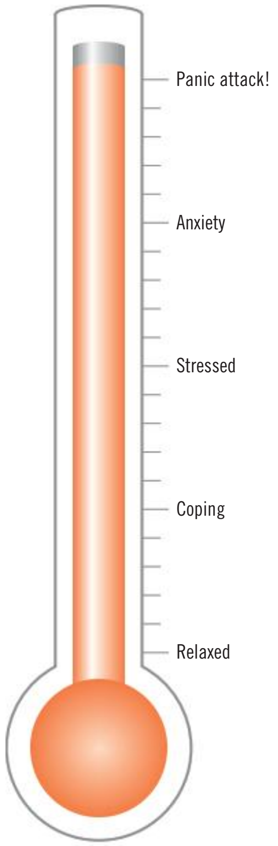

FIGURE 10.5 A panic attack is a sudden surge of extreme anxiety.

is considered to be a mental disorder because it interferes with a person's ability to function normally in everyday situations. For example, someone with agoraphobia (fear of open spaces) finds it very difficult, if not impossible, to go to the movies or go shopping; someone who fears needles may avoid seeking medical treatment.

Phobias can be classified according to the type of object, activity or situation that is feared. The most common types are:

- animal type – fear of a specific type of animal such as a dog, spider or snake
- natural environment type – fear of things in the environment such as heights, storms, the ocean or caves
- blood/injection/injury type – fear of blood, injections, injuries and medical procedures
- situational type – fear of specific situations, such as flying in a plane or being in an enclosed or open space.

phobia A persistent, irrational and intense fear of a specific object, activity or situation

specific phobia An intense, irrational fear and avoidance of a particular object, activity or situation

Phobias can be associated with nearly any object, activity or situation, so this is not a comprehensive list – it only begins to suggest the possibilities of all the different types of phobias people can experience.

Almost everyone has a few mild fears: fears of heights, enclosed spaces or insects are common. A phobic disorder differs from such common fears in that it generates overwhelming anxiety, producing symptoms including nausea, vomiting, shaking, fainting, sweating uncontrollably, increased heart rate and hot flushes. For a phobic disorder to exist, the fear experienced must fit certain criteria, such as being uncontrollable and disrupting the phobic person's daily life. Phobic persons are so threatened that they will go to almost any length to avoid the feared object, activity or situation, even if they cannot necessarily explain the reason for their fear. Phobias are most likely to begin in late childhood and continue into adulthood if left untreated. Women have twice the prevalence of most phobias than men (Virtual Medical Centre, 2015).

What causes phobias? There is no single cause of phobias, but people often 'learn' to be afraid of particular objects – this was the case with Little Albert, discussed in Chapter 4. Some people develop a fear even if they have not experienced a dangerous situation, or when they have simply perceived a situation to be dangerous when there was no real threat. Below is an account from a person who was diagnosed with a phobia of snakes, describing the development of their fear response.

> When I was about 3 years old, I watched a documentary about Australian snakes on TV. That night I had a nightmare. I dreamt that a snake was in the bottom of my bed. I woke up screaming and crying, still believing a snake was in my bed. From that day on I have not been able to watch a snake on TV, look at a photo of a snake in a book, or walk through ankle-length grass in the summer without experiencing intense anxiety.

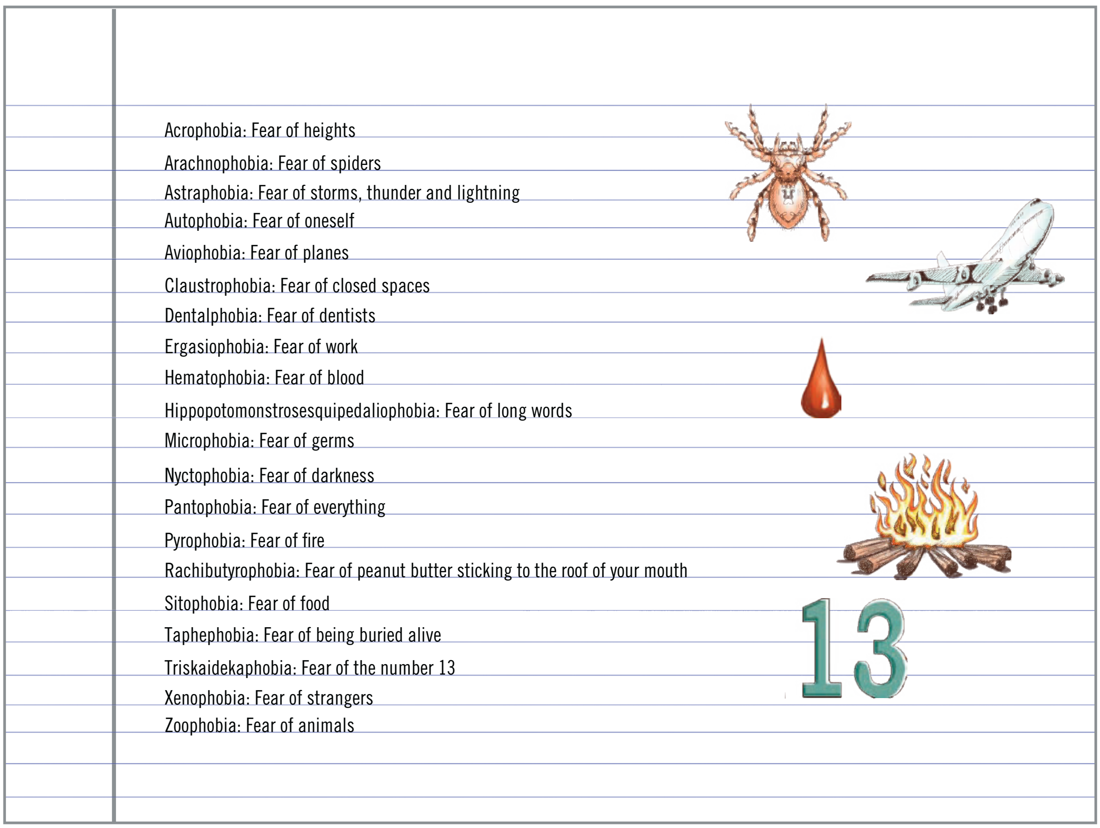

FIGURE 10.6 Common and strange phobias

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Checklist: Specific phobia

- Intense fear ✓
- Irrational fear ✓
- Avoids fear object, activity or situation ✓
- Cannot control fear ✓
- Fear interrupts daily functioning ✓
- Overwhelming anxiety ✓

FIGURE 10.7 A fear must fit certain criteria to be diagnosed as a specific phobia.

Many factors lead to the development of a phobic disorder, and no single factor can determine whether someone will experience phobic anxiety. The experience of a phobia can be explained through the biopsychosocial approach to understanding and treating mental disorders.

10.2 CHECK YOUR UNDERSTANDING >>

1 Explain two ways mild levels of anxiety can help us in everyday life.

2 What is meant by a specific phobia?

3 Provide an example of a specific phobia and explain how this example fits the criteria for an anxiety disorder.

4 Women have __________ the prevalence of most phobias than men.

A half
B twice
C three times
D four times

5 Phobias can be classified according to the type of object, activity or situation that is feared. List four common types of phobias.

DEVELOPMENT OF SPECIFIC PHOBIA

Phobic disorders epitomise how the interaction of biological, psychological and sociocultural factors can result in an anxiety disorder (see Figure 10.8). The **biopsychosocial model** suggests that biological factors such as the autonomic nervous system's (ANS) response to a perceived threat, the impact of neurotransmitters and a person's physical health state contribute to the development of anxiety disorders such as a phobia. In addition, genetic factors,

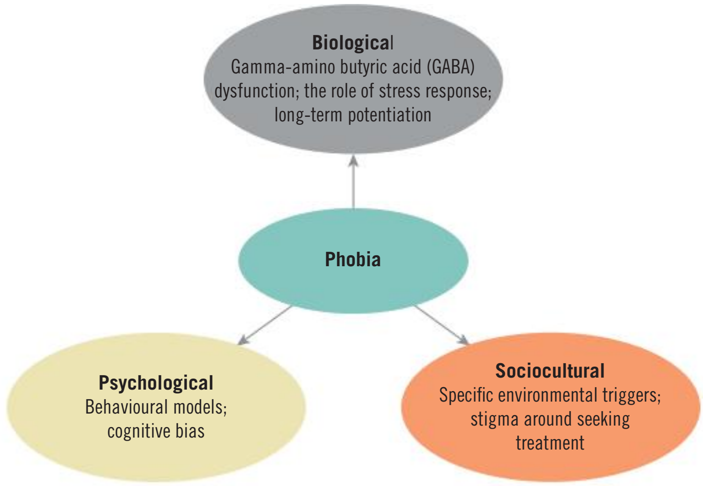

FIGURE 10.8 Phobias are the result of the interaction between biological, psychological and social factors.

or inherited biological factors, predispose some individuals to develop and sustain an anxiety disorder. Medications targeted to increase the release of specific inhibitory neurotransmitters may help a person regulate their ANS activity and manage their disorder more effectively, but sufferers also need to learn to recognise and control their stress response so the ANS can naturally reduce the effects of the sympathetic nervous system.

The biopsychosocial approach suggests that psychological factors (for example, memory bias) also contribute to anxiety disorders such as phobias. Management involves therapy that focuses on identifying the cause of the conflict and learning to think in a more rational way. This approach also considers the role that learning plays in anxiety disorders. It suggests that if we learn a faulty association between two or more stimuli, or we learn a phobic reaction by observing the reaction of others to specific stimuli, we may develop an anxiety disorder. Treatments such as cognitive behavioural therapy and systematic desensitisation focus on using learning to extinguish the stress response to the specific stimulus and replacing it with a non-stressful response.

The biopsychosocial model also focuses on the nature of communication between parents or caregivers and children, which, in turn, is dependent on the societal norms that are learnt and how they are learnt. Social factors – such as the culture a person

biopsychosocial model
An approach that proposes that health and illness outcomes are determined by the interaction and contribution of biological, psychological and social factors

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is raised in, the social experiences they have and the style of parenting they experience – are also considered to contribute to a learnt response that results in an incorrect appraisal of a situation as threatening.

BIOLOGICAL FACTORS

A range of biological factors contribute to the development of specific phobia. These include the impact of heredity, neurotransmitters, automatic physiological responses and the biological basis of learning. Emerging evidence about the role of the neurotransmitter gamma-amino butyric acid (GABA), the stress response and long-term potentiation has contributed greatly to our understanding and management of phobic anxiety.

Role of the neurotransmitter gamma-amino butyric acid (GABA)

Neurotransmitters are chemicals that are released into the synapse between neurons. They act as messengers that carry signals and information about stimuli (originating in the external world or in internal organs) from the pre-synaptic neuron to the post-synaptic neuron and impact on the activity level of the receiving neuron. There are several neurotransmitters known to be influential in anxiety disorders, including gamma-amino butyric acid (GABA), noradrenaline (also called norepinephrine) and serotonin. GABA is one of the neurotransmitters most strongly implicated.

As we learnt in Chapter 1, when released, some neurotransmitters (such as adrenaline) have an excitatory effect, preparing the body to fight or flee (the fight–flight response); other neurotransmitters (such as GABA) have an inhibiting effect, and therefore calm or slow the body's response. Studies have shown that when GABA activates its receptors, the cells that have those receptors are inhibited, and the system becomes calm or slows down to counteract the excitability of the neurons (through the glutamate or noradrenergic system). This means that the specific features of the stress response – such as the increased heart rate, respiration or blood pressure – are reduced. Therefore, an individual with naturally low levels of GABA may not be able to regulate anxiety, so they have a greater chance of developing a phobia. A deficiency in GABA may also lead to insomnia, depression, mood disorders, excessive stress and hypertension.

Role of the stress response

The experience of stress results in activation of the sympathetic nervous system. This leads to the occurrence of several physiological events, including increased heart rate, blood pressure and respiration. Research has shown that the autonomic nervous systems of people with a phobic disorder show increased stress response – sufferers adapt slowly to repeated stressors and respond excessively even to simple stimuli that would not provoke anxiety in many other people. When these symptoms present, they can lead to considerable dysfunction, such as avoiding usual activities (for example, going to work or shopping). If these symptoms persist, they can have a highly detrimental effect on an individual's physical and mental health.

Learning to recognise the stress response can help sufferers gain control over it. For example, if you recognise that your breathing rate has increased, you can consciously try to slow it down, which can help the body return to homeostasis and decrease the feelings of dread associated with phobic anxiety. Active methods of reducing the stress response will aid the body's natural automatic system of reducing stress.

Role of long-term potentiation

Fear plays a vital role in our survival; however, we are not born with a fear of spiders and snakes – they are learnt responses. When we associate fear with a specific stimulus, such as a spider, a new memory circuit with connections within the amygdala (the brain area responsible for adding the emotional content to a memory) is thought to be made.

The strengthening of synapses based on recent patterns of activity is known as **long-term potentiation (LTP)**. Because LTP strengthens the connections between neurons, it enables them to transmit information more efficiently and at a faster rate. LTP is necessary for learning to take place, including the establishment of a fear response. Exposure to the fear stimulus will strengthen the memory circuit and, via communication with the amygdala, activate multiple brain regions that then produce a variety of symptoms of fear and anxiety such as changes in blood pressure and heart rate, and sweating (National Institute of Mental Health, 2015). For example, the first time a young child is exposed to a stimulus such as spider it will not be afraid. However, the young child may learn to fear spiders as they can be dangerous. According to

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the consolidation theory, this initial learning will form a new memory circuit with established connections within the amygdala. Each time the child encounters a spider, the synapses within the memory circuit for this information are strengthened and, via the amygdala, lead to physiological changes associated with fear such as an increase in heart rate. In this way, LTP contributes to the development of specific phobia via the strengthening of synapses within neural circuits that communicate with the amygdala.

10.3 CHECK YOUR UNDERSTANDING >>

1 According to the biopsychosocial model, which type of factors contribute to the development of anxiety disorders?

A Sociocultural
B Psychological
C Biological
D All of the above

2 _________ factors predispose some individuals to develop and sustain an anxiety disorder

A Sociocultural
B Psychological
C Biological
D All of the above

3 Explain the role of two different types of neurotransmitters in influencing the development of anxiety disorders.

4 The influence of the stress response on the development of an anxiety disorder involves the activation of the _________ nervous system.

A somatic
B parasympathetic
C sympathetic
D voluntary

5 What is the strengthening of the synapses within a memory circuit known as?

PSYCHOLOGICAL FACTORS

The origin of a phobia is unique to every individual. During times of high emotion, the links we form with stimuli can in turn form powerful memories. An individual who suffers from a phobia pays more attention to threat information about that specific phobia, therefore our psychological state can perpetuate a phobia as well as contribute to its development.

The behavioural model and the cognitive model explain the contributing factors to the development and perpetuation (maintenance) of a specific phobia from a psychological perspective.

Behavioural model

The behavioural model proposes that phobic anxiety could be the result of learning. Just as we have learnt to associate feelings of joy when we hear a song that has been associated with happy memories, it is possible to explain the precipitation (acquisition) of a phobia as a learnt association between two stimuli (classical conditioning) and its perpetuation (maintenance) due to rewards and punishment (operant conditioning).

CLASSICAL CONDITIONING AND THE DEVELOPMENT OF A SPECIFIC PHOBIA

As we noted in Chapter 4, classical conditioning is a form of learning where two normally unrelated stimuli are repeatedly linked so that existing reflex responses are elicited by new stimuli that normally would not produce this response. Because phobias are learnt fears, the consistent pairing of a neutral stimulus with an unpleasant stimulus can cause phobic reactions.

The role of classical conditioning in the development of a specific phobia can also be seen in the case of Little Albert (see Chapter 4). Little Albert's phobia of white fluffy objects was presumably the result of repeatedly pairing the white rat (neutral stimulus) with an unpleasant stimulus (the loud noise). Once learnt, Little Albert's fear was then generalised to other similar stimuli such as a rabbit, seal-skin coat and cotton balls.

To explain how classical conditioning contributes to the development of a phobia, let's look at an everyday example of a young girl, Jazmin, becoming phobic about dogs. When she was growing up, Jazmin's neighbour's large dog chased her through a public playground, barking loudly. At the time, Jazmin experienced extreme fear including a rapid pulse, sweating palms and an increase in breathing. Ten years later, whenever Jazmin is approached by a dog, she experiences the same reactions (sweating palms and increases in heart rate and breathing). Jazmin will now avoid areas where dogs may be present and in doing so she feels more comfortable and relaxed.

In the example above, the development of Jazmin's phobia can be explained through the process of classical conditioning. Being approached by a dog was initially a neutral stimulus; however, this became

long-term potentiation (LTP) A form of neural plasticity that leads to an increase in the efficacy of synaptic transmission

consolidation theory Proposes that structural changes to neural circuits occur with the formation of long-term memories

behavioural model Proposes that phobic anxiety could be the result of learning

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associated with the unpleasant experience of the angry dog (unconditioned stimulus), which led to the involuntary fearful response of sweating palms and increases in heart rate and breathing (unconditioned response). The perpetuation of the learnt fear response can be explained through the process of operant conditioning.

OPERANT CONDITIONING AND THE PERPETUATION OF A SPECIFIC PHOBIA

In Chapter 4 we saw that operant conditioning is a learning process in which the likelihood of a behaviour being repeated is determined by the consequence of that behaviour. In the earlier example, Jazmin's avoidance of places where dogs may be present acts as a negative reinforcer because it prevents her from feeling frightened. Because Jazmin's behaviour results in a pleasant consequence for her the likelihood of that behaviour being repeated is strengthened. The positive consequence of reduction of fear is reinforced by the removal of the negative stimulus (sight of a dog). As a result of this negative reinforcement, Jazmin's avoidance of places where dogs may be present maintains her phobic response (see Figure 10.9).

Cognitive model

The cognitive model of psychology is a perspective that investigates internal mental processes, thoughts and memories and their influence on behaviour. This model examines the influence that inaccurate mental processes have in the development and maintenance of phobias.

Our cognitions are the psychological result of perception, learning and reasoning. We attempt to correctly perceive objects, situations and events so that our understanding of a particular object, situation or event is helpful in our everyday functioning. However, we may sometimes pair faulty reasoning and rationale with fearful stimuli from the environment; hence, a new, faulty cognition is formed. This is known as a cognitive bias.

A cognitive bias is a type of error in thinking that occurs when people are interpreting information. Cognitive biases may sometimes lead to an inaccurate judgement or illogical interpretation of a situation. There are many cognitive biases that are associated with the development and maintenance of specific phobias. These include memory bias and catastrophic thinking.

For example, if you faint when you are having a blood sample taken, you may etch that experience wrongly in your memory as, 'Oh, no! Needles are dangerous and drawing blood is frightening – I must keep away from needles and blood'. This can develop into a phobia where you experience a panic attack at the sight of blood or a needle, or simply at the thought of a blood sample being drawn from you. Part of the treatment of the phobic illness therefore revolves around 'correcting' these cognitions biases.

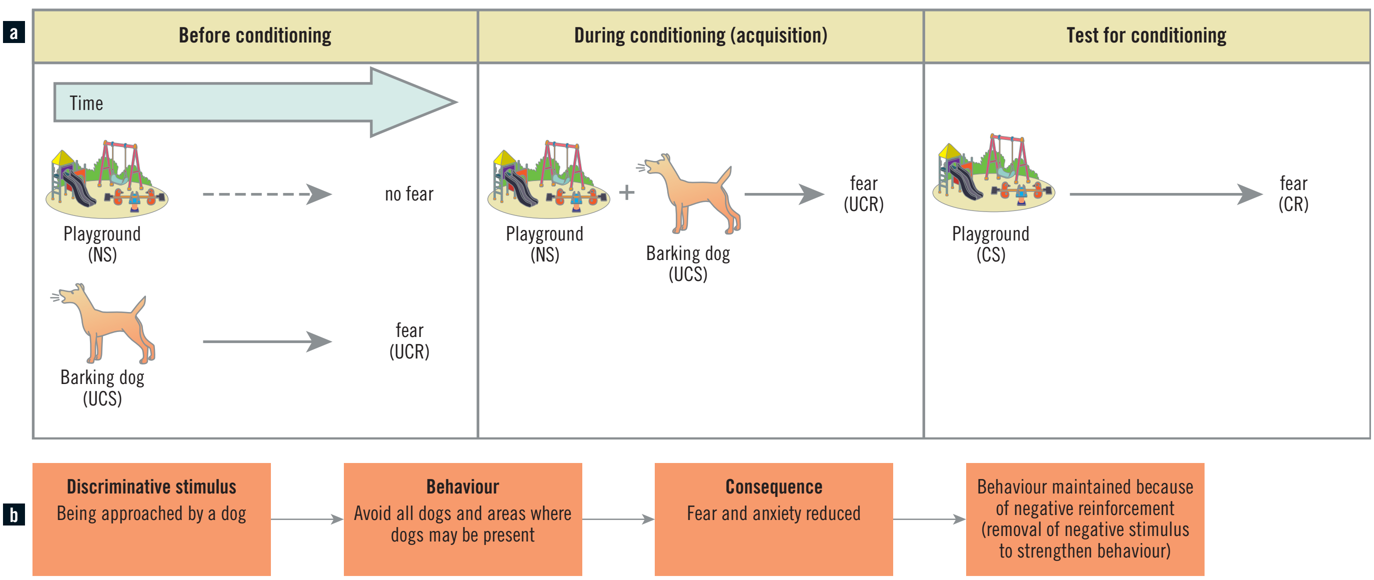

FIGURE 10.9 The behavioural model proposes that phobic anxiety is precipitation by classical conditioning (a) and perpetuation by operant conditioning (b).

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MEMORY BIAS

A memory bias, or preferential memory, is a type of error in thinking that may either enhance or impair the recall of memory, or it may alter the content of what we report remembering. Research suggests that memory biases for threatening information may contribute to the development of a phobia because they cause a person to recall negative information more readily than positive information about a specific object, situation or event they have experienced in the past (Coles & Heimberg, 2002). Memory bias can also alter recalled memories so that they are different from what actually happened. For example, a person who has developed a phobia of dogs because of one negative experience with an aggressive dog will tend to recall this experience as the dog being overly aggressive more readily than all other positive experiences with dogs.

CATASTROPHIC THINKING

Catastrophic thinking occurs when an individual repeatedly overestimates the potential dangers of an object or event and assumes the worst. Catastrophic thinking relates to thinking about, or predicting, the potential dangers and outcome of future events. The catastrophic thinker predicts an outcome of a future event that others would consider unrealistic and irrational. When this occurs, the person will typically experience heightened levels of distress and anxiety, and underestimate their ability to cope with the situation. For example, a person with a spider phobia may think that every spider they encounter is poisonous and will bite them. The physical symptoms they experience with catastrophic thinking, such as increased heart rate and sweating, act to reinforce their irrational thoughts. An individual's catastrophic thoughts may even extend to their family members, such as not wanting a sibling to learn to drive because they will definitely be involved in a serious car accident.

FIGURE 10.10 A person suffering from glossophobia (fear of public speaking) may have irrational catastrophic thoughts that the audience will dislike them so much that they will walk out mid speech.

10.4 CHECK YOUR UNDERSTANDING >>

1 According to the biopsychosocial model, the influence of emotions, memories and learning would be considered to be __________ factors.
   - A sociocultural
   - B psychological
   - C biological
   - D All of the above

2 Explain how the acquisition of a phobia occurs through classical conditioning and the perpetuation of the phobia occurs through operant conditioning.

3 A type of error in thinking that occurs when people are interpreting information is known as a __________ bias.
   - A cognitive
   - B irrational
   - C thinking
   - D filtering

4 Explain how memory bias may influence the development of an anxiety disorder.

5 What is catastrophic thinking? Provide an example to demonstrate your understanding.

SOCIAL FACTORS

Suffering a traumatic experience in response to a specific stimulus is a common contributing factor in the development of a specific phobia. This specific event in the environment has triggered a fearful response, such as a dog attack, being bitten by a spider or nearly drowning. We classify these specific environmental triggers as social factors.

A significant reason for the maintenance (perpetuation) of anxiety disorders in society is due to the social factor of stigma. With the lack of

cognitive model A psychological perspective that is interested in investigating internal mental processes, thoughts and memories, and their influence on behaviour

cognitive bias A type of error in thinking that occurs when people are interpreting information

memory bias A type of error in thinking that may either enhance or impair the recall of memory, or it may alter the content of what we report remembering

catastrophic thinking Occurs when an individual repeatedly overestimates the potential dangers and assumes the worst of an object or event knowledge and understanding surrounding mental illness in general by a large proportion of society, stigma associated with having a mental illness is one of the biggest barriers that prevents people from getting treatment.

Specific environmental triggers

Several factors in the environment can predispose an individual to the development of specific phobias. Traumatic events – for example, being attacked by a dog or being trapped in a closet – can result in the development of a phobic reaction, but phobic reaction can also result from having unexpected anxiety attacks in situations that are perceived to be threatening, but in reality present no threat.

Albert Bandura (1977) formulated the social learning theory, aspects of which are helpful in understanding how certain responses are learnt in the social context, where the trauma of unexpected incidents becomes paired with a fear response or anxiety attack. Consider the example of a child who pats a neighbour's dog that appears docile, but that dog unexpectedly attacks (see Figure 10.11). The trauma of this unexpected incident may become paired with the fear response and the child may develop an irrational belief that all dogs are dangerous and unworthy of affection.

The process of learning by observing another person's behaviour and the consequences of the behaviour is known as modelling. Models are people in our lives who we admire and whose behaviour we consciously or unconsciously tend to replicate. For example, if we observe a parent or other model responding to a stimulus with fear, then we may also learn to fear this stimulus.

Learning by modelling can maintain an association between an object and the emotions that a person experiences. This may occur by observing a reaction in other people (for example, when children start crying when they see another child cry after receiving an injection) or by being taught or warned about particular objects (for example, being warned about the serious consequences of speeding by way of television advertisements) (Sadock & Sadock, 2003). Negative events and information that we are exposed to via the media could result in learning that these things are potentially threatening (even though we haven't experienced them directly) and this could lead to the development of a phobia.

FIGURE 10.11 Being frightened by a dog as a child may lead to a phobia of all dogs later in life.

Stigma around seeking treatment

Individuals who experience mental illness such as a specific phobia are often faced with stigma that results from a lack of understanding about their illness. Stigma is social disapproval of an individual's personal characteristics or beliefs, or social disapproval of a type of behaviour. Because phobias involve irrational and unrealistic emotions and behaviours, it is often difficult for other people to empathise with the sufferer. People who do not have a phobia often apply a negative stereotype to the phobic person. As a result, a stigma about the illness develops and the sufferer may even encounter discrimination.

If the person with the mental illness also accepts the stigma it can lead to feelings of shame, hopelessness and distress that cause sufferers to hide the symptoms of their illness. As a result, many people with a mental illness fail to seek readily available support from friends, family and professional services for fear that they will be viewed in a negative way.

In 2005, an Australian Senate Select Committee on Mental Health inquiry found that only 38 per cent of people with a mental health problem get any treatment in a 12-month period.

Some of the harmful effects of stigma associated with anxiety disorders can include:

- reluctance to seek help or treatment
- a lack of understanding by family, friends, co-workers or others you know
- fewer opportunities for work, school or social activities or trouble finding housing
- bullying, physical violence or harassment
- the belief that you'll never be able to succeed at certain challenges or that you can't improve your situation (Mayo Clinic, 2014).

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FIGURE 10.12 A lack of understanding about mental illnesses can lead to stigma, which can compound symptoms for sufferers.

10.5 CHECK YOUR UNDERSTANDING >>

1 Which of the following are sociocultural factors that may contribute to the development of an anxiety disorder?
   A Life events
   B Culture
   C Environmental conditions
   D All of the above
2 Explain how a specific environmental trigger could contribute to the development of an anxiety disorder.
3 Explain how certain environmental triggers learnt in a social context become paired with a fear response.
4 Define stigma.
5 Identify three harmful effects of stigma associated with anxiety disorders.

EVIDENCE-BASED TREATMENT OPTIONS

Evidence-based interventions are treatments that have been proven effective based on the integration of clinical research and expertise aimed at changing target behaviour. The treatments try to maximise the chance of benefit and minimise the risk of harm to the patient. Empirical methods have been applied to gather the evidence – the treatments are based on clinical research that demonstrates their positive outcomes. Intervention refers to all direct services rendered by healthcare professionals, including assessment, diagnosis, prevention, treatment, psychotherapy and consultation.

This approach to treatment stems from understanding the framework behind how a mental disorder develops. Every individual brings with them a unique set of experiences, personality attributes and genetic make-up. It is this individual set of characteristics that makes the experience, and treatment, of mental illness different for every sufferer. Just as it is important to consider how the biological, psychological and social factors combine and interact to influence a person's physical and mental health (biopsychosocial model), it is also important to consider each of these three domains when devising a treatment plan for sufferers of mental illnesses such as a specific phobia.

The management and treatment of specific phobias focuses on the phobic person learning to manage their anxiety as well as change unrealistic thoughts and behaviours associated with the phobic stimulus.

FIGURE 10.13 Psychotherapists help clients to understand their maladaptive behaviours and learn new ways to cope with their disorder.

social learning theory Proposes that behaviour is learnt from the environment through the process of observational learning

modelling The process of learning by observing another person's behaviour and the consequences of the behaviour

stigma Social disapproval of an individual's personal characteristics or beliefs, or social disapproval of a type of behaviour

evidence-based interventions Treatments that have been proven effective based on the integration of clinical research and expertise aimed at changing target behaviour

BIOLOGICAL INTERVENTIONS

Biological interventions used to manage the anxiety or stress response associated with a specific phobia include medications such as the use of short-acting anti-anxiety benzodiazepine agents and relaxation techniques including breathing retraining and exercise.

Short-acting anti-anxiety benzodiazepine agents: Managing anxiety

Medications can relieve symptoms of anxiety; however, their use is not a long-term solution because they do not treat the underlying cause of the anxiety disorder. Anti-anxiety medications work by slowing down the central nervous system. These medications are known as beta blockers and work by blocking the stimulating effects of adrenaline on the body, such as an increased breathing rate, elevated blood pressure and a pounding heart that are caused by anxiety.

Other medications used in the treatment of phobic anxiety are closely related to the role of the neurotransmitter gamma-amino butyric acid (GABA) and its effects on the body. GABA functions as an inhibitory neurotransmitter – meaning that it blocks nerve impulses, calming nervous activity.

Biological treatments often target the enhancement of GABA neurotransmission, in order to inhibit the hyper and overexcited bodily responses seen in anxiety. A group of short-acting anti-anxiety benzodiazepine medications can be used in the short-term treatment of phobic anxiety, because they enhance the GABA-induced inhibition of overexcited neurotransmitters (Lydiard, 2003). Benzodiazepines stimulate the GABA neurotransmitters activity (act as an agonist), thereby reducing physiological arousal. An antagonist would inhibit a neurotransmitter's activity.

Benzodiazepines are commonly known as tranquillisers and sleeping pills. By enhancing GABA's function, benzodiazepines bring about a state of calm as they reduce any over-activity in the brain. The calming effect of benzodiazepines make them an effective treatment for the management of specific phobias. For example, a person who has a phobia about boats may take a benzodiazepine medication such as Valium before getting on a boat. This will reduce the person's physiological arousal, promote relaxation and make the boat trip more manageable.

However, because of their high potential for addiction, benzodiazepines are typically prescribed for short-term use only (usually no longer than 4 weeks). People who take benzodiazepines for an extended time may report increased anxiety. This is because the body becomes accustomed to the drug and, unless the dose is increased, withdrawal symptoms are experienced (Beyond Blue, 2015b).

Benzodiazepines are the most common class of anti-anxiety drugs. They include Valium (diazepam), Ativan (lorazepam), Klonopin (clonazepam) and Xanax (alprazolam). Benzodiazepines are very effective when taken during an anxiety episode; however, they also come with side effects such as the risk of addiction; drowsiness, sleepiness and fatigue; slow reflexes; slurred speech; confusion and disorientation; impaired thinking and judgement; memory loss; nausea and loss of appetite; double or blurred vision; and mood swings and aggression (Australian Drug Foundation, 2015).

FIGURE 10.14 Short-term medications relax some of the physical symptoms of anxiety. They are not intended to be taken for long periods of time as they may be habit forming.

Relaxation techniques: Calming the body and mind

Relaxation techniques are methods that can be learnt to reduce physiological and psychological arousal associated with stress-related anxiety. Relaxation techniques, such as breathing retraining and exercise, can help individuals cope effectively with the stresses related to their specific phobia. Breathing and relaxation strategies are taught to minimise physical symptoms of anxiety and manage stress in general.

BREATHING RETRAINING

People suffering from anxiety disorders such as specific phobias may experience abnormal breathing patterns. A normal relaxed breathing rate for a healthy adult is

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12–20 breaths per minute, using the diaphragm rather than the shoulders to move air in and out of the lungs. When a person is under stress, their breathing patterns may change. An anxious person's breathing may consist of small, shallow breaths (hyperventilation), which may raise oxygen levels and reduce the amount of carbon dioxide in the blood. Carbon dioxide assists in the regulation of the body's reaction to anxiety and panic. This can prolong feelings of anxiety by making the physical symptoms of stress worse.

Breathing retraining is the process of identifying incorrect breathing habits and replacing them with correct ones. Symptoms of incorrect breathing includes loud, noisy, rapid or shallow breathing.

A person who suffers from anxiety should learn how to breathe from their diaphragm, rather than their chest, through their nose in a slow, even and gentle way. Correct breathing means the abdomen moves, rather than the chest. Holding your breath for a few seconds will help to boost carbon dioxide levels in the blood.

Deliberately copying a relaxed breathing pattern seems to calm the nervous system that controls the body's involuntary functions. Controlled breathing can cause physiological changes that include:

- lowered blood pressure and heart rate
- reduced levels of stress hormones in the blood
- balanced levels of oxygen and carbon dioxide in the blood
- improved immune system functioning
- increased physical energy
- increased feelings of calm and wellbeing.

Breathing retraining can help to correct breathing habits and help individuals have more control of their anxiety. The psychological benefits of reduced anxiety include:

- improved sleep, which in turn reduces stress
- an increased sense of control over shortness of breath
- increased self-confidence
- increased feelings of calm.

Learnt breathing techniques should be implemented at the first signs of anxiety. By changing breathing patterns, breathing retraining can help to correct breathing habits and help individuals have more control of their anxiety (Victoria. Better Health Channel, 2015f).

FIGURE 10.15 Breathing retraining improves oxygen supply to your body and helps you relax when you are anxious or stressed.

10.2 TRY IT YOURSELF >>

REACHOUT BREATHE APP

ReachOut Breathe is an app for managing anxiety via controlled breathing exercises. The app helps reduce symptoms of stress and anxiety by slowing down the heart rate with focused breathing exercises. Using the app on their iPhone or Apple Watch, the user is guided to undertake a controlled breathing exercise, and is able to get biofeedback on the impact of the exercise by measuring their heart rate before and after.

FIGURE 10.16 The ReachOut Breathe app

beta blockers Medication used to treat high blood pressure, congestive heart failure, abnormal heart rhythms and anxiety by reducing heart rate and blood pressure

benzodiazepines A group of medications used in the short-term treatment of phobic anxiety; they enhance the GABA-induced inhibition of overexcited neurotransmitters, resulting in calming nervous activity

agonist A substance that increases the release of a neurotransmitter or imitates its activity by causing the post-synaptic neuron to fire

antagonist A substance that inhibits the release of a neurotransmitter or blocks receptor sites, making the post-synaptic neuron less likely to fire

breathing retraining The process of identifying incorrect breathing habits and replacing them with correct ones

1. Download the ReachOut Breathe app from the Apple App Store. (There are similar Android apps available.)
2. Use the app to measure your heart rate.
3. Complete the breathing training exercise for 2 minutes.
4. Use the app to measure your heart rate a second time.
5. How did you feel during and after completing the breathing training?
6. Was there a difference in your heart rate before and after the breathing training? If so, why?

EXERCISE

It is well known that exercise has many physical health benefits, such as weight management, lowering blood pressure and cholesterol levels and reducing the risk of heart attack (see Chapter 2 for a more detailed account of the physical benefits of exercise). However, exercise has many psychological benefits too, including the reduction of stress.

When we experience stress, naturally occurring hormones such as adrenalin and cortisol are released by the adrenal glands as part of the fight–flight response. Elevated cortisol levels lower the functioning of the immune system. This makes a person more susceptible to illness, which can add to their level of anxiety. It can also lead to impaired cognitive performance, increased weight gain and increased blood pressure and heart disease (see Chapter 2 for more detail on the effects of cortisol).

FIGURE 10.17 In addition to the physical benefits, being active also helps your mental health, so you have increased quality of life.

Exercise burns up these natural chemicals that accumulate during stress. This can reduce anxiety and promote a positive mood.

Other mental health benefits of regular exercise include:

- an increase in alertness and concentration
- a boost in confidence and self-esteem
- a release of feel-good brain chemicals such as endorphins
- improved sleep, which in turn reduces stress
- distraction from worries and rumination, which may have a calming effect
- increased social interaction, which can create more support networks
- optimistic feelings and the ability to think more rationally.

10.1 FOCUS ON RESEARCH

REGULAR EXERCISE REDUCES PATIENT ANXIETY BY 20 PER CENT

The anxiety that often accompanies a chronic illness can chip away at quality of life and make patients less likely to follow their treatment plan. But regular exercise can significantly reduce symptoms of anxiety, a new University of Georgia study shows. The research team analysed the results of 40 randomised clinical trials involving nearly 3000 patients with a variety of medical conditions. They found that, on average, patients who exercised regularly reported a 20 per cent reduction in anxiety symptoms compared to those who did not exercise.

'Our findings add to the growing body of evidence that physical activities such as walking or weight lifting may turn out to be the best medicine that physicians can prescribe to help their patients feel less anxious,' said lead author Matthew Herring, a doctoral student in the department of kinesiology, part of the UGA College of Education.

Herring pointed out that while the role of exercise in alleviating symptoms of depression has been well studied, the impact of regular exercise on anxiety symptoms has received less attention. The number of people living with chronic medical conditions is likely to increase as the population ages, he added, underscoring the need for a low-cost, effective treatment.

The researchers limited their analysis to randomised controlled trials to ensure that only the highest quality

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data were used. The patients in the studies suffered from a variety of conditions, including heart disease, multiple sclerosis, cancer and chronic pain from arthritis. In 90 per cent of the studies examined, the patients randomly assigned to exercise had fewer anxiety symptoms, such as feelings of worry, apprehension and nervousness, than the control group.

'We found that exercise seems to work with just about everybody under most situations,' said study co-author Pat O'Connor, professor and co-director of the UGA Exercise Psychology Laboratory. 'Exercise even helps people who are not very anxious to begin with to become more calm.'

Exercise sessions greater than 30 minutes were better at reducing anxiety than sessions of less than 30 minutes, the researchers found. But surprisingly, programs with a duration of between 3 and 12 weeks appear to be more effective at reducing anxiety than those lasting more than 12 weeks. The researchers noted that study participants were less likely to stick with the longer exercise programs, which suggests that better participation rates result in greater reductions in anxiety.

'Because not all study participants completed every exercise session, the effect of exercise on anxiety reported in our study may be underestimated,' said study co-author Rod Dishman, also a professor of kinesiology. 'Regardless, our work supports the use of exercise to treat a variety of physical and mental health conditions, with less risk of adverse events than medication.'

Source: University of Georgia. (2010, February 28). Regular exercise reduces patient anxiety by 20 percent, study finds. *ScienceDaily*.

QUESTIONS

1. Write a possible hypothesis for this study.
2. Identify the independent variable.
3. Identify the dependent variable.
4. State the results of the experiment.
5. What conclusion can be drawn about the relationship between exercise and anxiety from the results of this study?

10.3 TRY IT YOURSELF >>

COLOURING THERAPY

FIGURE 10.18 Colouring therapy

1. Go to the http://kidscolouringpages.org website, which contains free downloadable colouring-in pages.
2. Click on the adult colouring-in category.
3. Choose and download one of the free colouring in images.
4. Spend some time completing this colouring-in activity.
5. How did you feel during and after colouring in?
6. Did you notice any physiological changes in your body while colouring in?
7. Do you think this is a suitable type of therapy for sufferers of anxiety disorders? Why or why not?

10.6 CHECK YOUR UNDERSTANDING >>

1. Medications can relieve symptoms of anxiety, but their use is not a __________ solution because they do not treat the underlying cause of the anxiety disorder.
   A beneficial
   B short-term
   C working
   D long-term
2. Anti-anxiety medications work by slowing down the __________ nervous system.
   A central
   B sympathetic
   C parasympathetic
   D somatic
3. Describe the influence of the neurotransmitter gamma-amino butyric acid (GABA) on neural transmission.
4. List three possible side effects of the use of benzodiazepines in the treatment of anxiety.
5. Which of the following is a physical symptom of anxiety that may be triggered by hyperventilation?
   A Feeling overwhelmed
   B An increase in oxygen levels
   C An increase in carbon dioxide in blood
   D Memory loss
6. What is breathing retraining and how can it help in the management of phobic anxiety?
7. Describe three mental health benefits of regular exercise.

PSYCHOLOGICAL INTERVENTIONS

In most cases, the answer to treating people with mental illness is some form of psychotherapy. Psychotherapy is any psychological technique used to facilitate positive changes in personality, behaviour or adjustment. Psychotherapy most often refers to verbal interaction between trained mental health professionals and their clients (see Figure 10.13). Many therapists also use learning principles to directly alter troublesome behaviours.

Psychotherapy is a vast field and there are several schools of thought based on learning theories and behavioural theories. A psychologist is educated extensively in the theories behind most of these therapies, but would then specialise in a few modes of treatment, particularly cognitive behavioural therapy. Mental health practitioners do not attempt to fit the patient to the therapies they are trained in; rather, they attempt to use treatments that fit the patient's needs.

Evidence now clearly shows that psychotherapies are as effective, if not more effective, than biological interventions such as medications alone in managing anxiety and phobias. Medications have several biological side effects, whereas psychotherapies do not. Psychotherapy, or 'talk therapy', is a way to treat people with a mental disorder by helping them understand their illness.

Education is often the first step in the management of any disorder, and access to quality information is often very important in helping to reduce our fears about what we are dealing with. As we saw previously, cognition is the psychological result of perception, learning and reasoning. Therefore, education about the disorder and how to deal with it is an important part of the treatment. Psychological interventions used in the treatment of a specific phobia include psychotherapies such as cognitive behavioural therapy and systematic desensitisation.

Cognitive behavioural therapy

Cognitive behavioural therapy (CBT) is a type of psychotherapy that uses a range of cognitive and behavioural therapies and learning principles to help people change unhelpful or unhealthy thought processes, feelings and behaviour. It is based on the premise that the way a person thinks about something determines how they feel about it and respond to it. Therefore, if they change the way they think about it, they can then change their behaviour.

FIGURE 10.19 Destructive, maladaptive behaviours – such as drinking, smoking and avoiding work – can be changed by using cognitive behavioural therapy, which teaches a person new, healthier ways to cope with their stress.

Using knowledge and information to overcome irrational thinking and replace it with reasonable, realistic thinking forms the 'cognitive' part of CBT. The behavioural component of the treatment involves modifying the unhelpful behaviours (such as avoidance) that have developed as a result of the faulty cognitions.

Research suggests that CBT is the most effective method of treating specific phobia. Wolitzky-Taylor, Horowitz, Powers and Telch (2008) carried out a review of a large number of clinical trials in the treatment of specific phobias and found that exposure-based treatments were the most successful and seen as the treatment of choice for specific phobias.

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Some common CBT techniques for the treatment of a specific phobia include:

- *relaxation training* – This method helps to calm the mind and body in the presence of the specific phobic stimulus. Techniques include meditation, guided imagery, progressive muscle relaxation and breathing exercises.
- *flooding* – This involves exposing a phobic person to the real feared stimulus all at once, usually with a buffer of a relaxation response to fall back on, and often in the presence of the therapist. This exposure is continued until the anxiety response disappears. If you had a fear of snakes, for example, your therapist may take you to the zoo on a therapy session, where the snake handler 'helps' you hold and touch a snake.
- *imaginal flooding* – Exposure to the feared stimulus is attempted in the imagination of the client rather than in a real-life situation. In this case, the therapist will describe the fearful situation in graphic detail, perhaps even with the use of pictures, while the client attempts to gain awareness of the components of their stress response such as heart rate, sweating and respiration. This technique can be used if there is an element of actual, not just perceived, danger involved in exposure to the feared stimulus.

The purpose of CBT in treating phobia is to challenge the irrational and negative thoughts, and replace them with realistic thoughts and examine related behaviours. To achieve this, psychotherapists often use systematic desensitisation.

Systematic desensitisation

Systematic desensitisation (also known as graduated exposure) is a type of behavioural therapy whereby an individual with a phobia or fear is exposed to the fear-producing object, activity, or situation very slowly, by degrees, under relaxed conditions until the fear response in extinguished. The target response is for the sufferer of the phobia to be relaxed and anxiety free in the presence of the feared stimulus. In this procedure, a relaxation technique is used to reduce the anxiety. Systematic desensitisation is based on **reciprocal inhibition**, a term coined by Joseph Wolpe (Wolpe & Plaud, 1997). In reciprocal inhibition, one emotional state is used to block another; that is, it is impossible to be anxious and relaxed at the same time.

Many phobias have their source in classical conditioning because they result from experience – they are learnt associations between object, activity or situation and unpleasant experiences. Systematic desensitisation uses classical conditioning principles to unlearn (or extinguish) the association the person has made and to learn a new relaxed response.

With repeated pairing of relaxation and the phobic stimulus, the stimulus loses its power to provoke anxiety. Systematic desensitisation can be used in a real setting (where the phobic stimulus is actually presented) or in an imagined setting (where the phobic stimulus is recalled using imagination), or in a combination of both.

This process takes a long time and relies on exposing sufferers gradually (or systematically) to the feared stimulus until they can remain relaxed in its presence (or desensitised) using a methodical step-by-step approach. For example, a person with a phobia of spiders would be exposed to stimuli that are progressively more threatening – initially, perhaps a picture of a spider, then a toy spider, then a dead spider, and finally a live spider (see Figure 10.20). During each step, the person tries to keep calm and relaxed, perhaps by trying to regulate their heart rate or breathing rate. They do not move to the next step until they have achieved this relaxed state. When this is achieved, the feared stimuli is said to have become extinct.

Note, however, that all phobias are different, so individual treatment plans need to be designed by qualified psychologists. For many fears, systematic desensitisation works best when people are directly exposed to the stimuli and situations they fear (Menzies & Clarke, 1993). For something like a simple spider phobia, this exposure can even be done in groups (Ost, 1996). Also, for some fears (such as fear of riding an elevator) desensitisation may be completed in a single session (Sturges & Sturges, 1998). However, often desensitisation treatment takes months to eliminate fear of the stimulus.

psychotherapy A psychological technique in the treatment of mental disorders, used to facilitate positive changes in personality, behaviour or adjustment

systematic desensitisation A type of behavioural therapy whereby an individual with a phobia or fear is exposed to the fear-producing object, activity or situation very slowly, by degrees, under relaxed conditions until the fear response is extinguished

reciprocal inhibition The concept that one emotional state is used to block another, as is the case in systematic desensitisation

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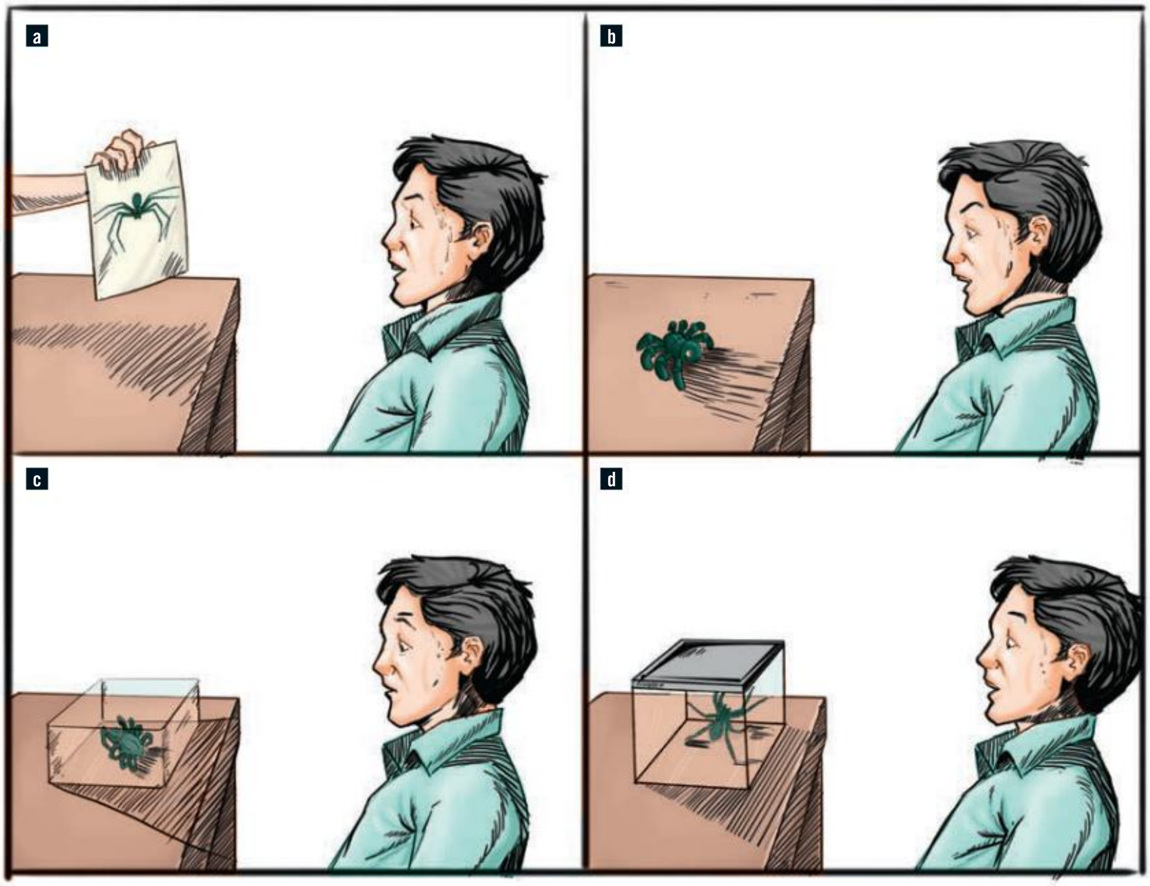

FIGURE 10.20 A person with a phobia of spiders is exposed to stimuli that are progressively more threatening. (a) The person is shown a picture of a spider. (b) The person is presented with a toy spider. (c) The person is presented with a dead spider in a glass case. (d) The person is presented with a live spider in a glass case. These progressions occur over a long period of time.

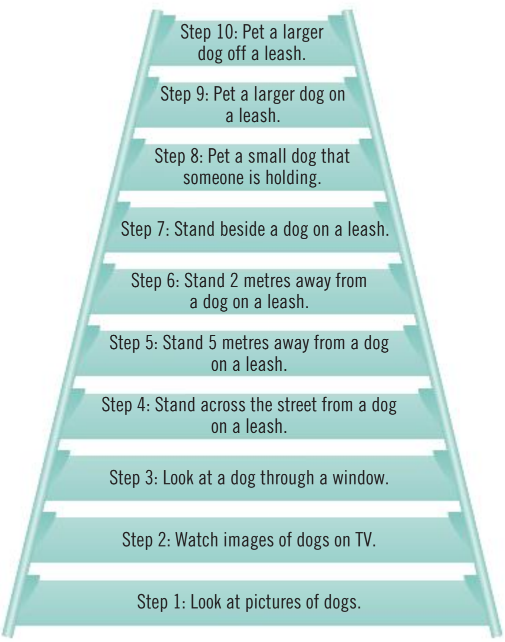

FIGURE 10.21 A sample fear hierarchy for a dog phobia. Dogs are the fear stimulus and petting a dog off a leash is the target response.

FOCUS ON RESEARCH 10.2

EXAM ANXIETY RELIEF FOUND: RESEARCH

A simple writing exercise can relieve students of exam anxiety and may help them get better scores than their less anxious classmates, a new study has found. The report … says students who spend 10 minutes before an exam writing about their thoughts and feelings can free up brainpower previously occupied by testing worries and do their best work. 'We essentially got rid of this relationship between test anxiety and performance,' said Sian Beilock, an associate professor in psychology at the University of Chicago and co-author of the study with graduate student Gerardo Ramirez.

Psychologists, educators and parents have known for a long time that the way students perform on a test does not necessarily indicate what knowledge they bring to the table. Test anxiety is fairly common in classrooms, especially in the US because of its 'increasingly test-obsessed culture,' Professor Beilock said. Test anxiety can lead to poorer grades and lower scores on standardised

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tests and college entrance exams, which can condemn talented students to inferior colleges.

The University of Chicago researchers found that students who were prone to test anxiety improved their test grades by nearly one grade point – from a B-minus to a B-plus, for example – if they were given 10 minutes before an exam to write about their feelings.

The researchers tested their hypothesis with college students in a lab setting and with high school students in the classroom, by first gauging the level of test anxiety and then offering the writing intervention to some students.

The researchers believe worrying competes for computing power in the brain's 'working', or short-term, memory. If working memory is focused on worrying, it can't help a person recall all the information his brain stored in preparation for the test. It also affects the working memory's ability to stay focused.

Professor Beilock said the idea for the writing exercise came from the use of writing to combat depression. Expressive writing, in which people write repeatedly about a traumatic or emotional experience over several weeks or months, has been shown to decrease worrying in people who are depressed. Professor Beilock believes this research is applicable to all kinds of performance anxiety – from giving a speech to interviewing for a job. 'There's a lot we can do to change how we think about the pressures and thus how we perform,' she said.

The next stage of the research project, which is supported by a grant from the National Science Foundation, will involve a look inside the anxious brain to see how it changes during stressful situations, Professor Beilock said. She also hopes to develop more interventions to help people perform better during stress.

Source: AP. (2011, January 14). Exam anxiety relief found - research. *The Australian*.

NEWSPIX/DAVID CROSLING

FIGURE 10.22 Students who spend 10 minutes before an exam writing about their thoughts and feelings can free up brainpower previously occupied by testing worries and do their best work.

QUESTIONS

1 What was the hypothesis for this study?

2 Identify the independent variable.

3 Identify the dependent variable.

4 State the results of the experiment.

5 How could you use the findings of this study to benefit your assessment preparation?

10.7 CHECK YOUR UNDERSTANDING >>

1 What are psychotherapies?

2 What is the major benefit of the use of psychotherapies over medications in the treatment of specific phobia?

3 Cognitive behavioural therapy (CBT) involves the application of what type of principles to change thought processes and human behaviour?

A Memory
B Biological
C Social
D Learning

4 What is the purpose of cognitive behavioural therapy in treating phobia?

5 When one emotional state is used to block another, this is known as:

A systematic desensitisation.
B reciprocal inhibition.
C classical conditioning.
D graduated exposure.

SOCIAL INTERVENTIONS

A supportive family and social environment is an important factor in the treatment of mental illnesses. A person with a specific phobia who is surrounded by a social network of people who understand the illness will more readily receive support to help manage their fears. The social interventions used in the treatment for a specific phobia include psychoeducation for families and supporters in challenging sufferers' unrealistic or anxious thoughts and not encouraging avoidance behaviours.

Psychoeducation

The education about a mental illness such as the nature of the illness, its treatment and management strategies is known as **psychoeducation**. Psychoeducation is offered to the phobic person as well as their families and supporters, and can be delivered individually or in groups, tailored to the needs of the specific individuals involved.

The goal of psychoeducation for the phobic person is to empower them to understand their illness and

psychoeducation The education about a mental illness such as the nature of the illness, its treatment and management strategies how to develop strategies to cope with it and recover from it. This is one of the first steps in cognitive behavioural therapy. For example, people tend to be less fearful of symptoms if they understand why and how their bodies respond to a threatening situation. Education of the naturally occurring symptoms of the fight–flight response in preparing our body to deal with a threat may assist the person in becoming less fearful of the symptoms themselves.

The goal of psychoeducation for the families and supporters of a phobic person is to help them understand the illness. This helps to reduce the stigma associated with the illness. Additional goals are to teach them the skills needed to help support the phobic person cope and recover, and to help themselves adapt to living with a person suffering from a phobia.

CHALLENGING UNREALISTIC OR ANXIOUS THOUGHTS

Families and those supporting a person with a specific phobia can play an important role in assisting the sufferer to challenge their unrealistic or anxious thoughts towards the phobic stimulus. Sufferers of specific phobias overestimate the dangers involved in a particular object, activity or situation and treat every negative thought as if it were fact. The specific phobia sufferer usually knows that their fear is excessive or unreasonable but feels powerless to control it. These irrational and pessimistic attitudes are known as cognitive distortions.

Cognitive distortions fall into the following categories:

- *fortune-telling* – For example, 'It's spring. All the bees are out. If I go outside I will get stung and have a really bad allergic reaction.'
- *overgeneralisation* – For example, 'I saw a person get bitten by a dog once. All dogs are dangerous.'
- *catastrophising* – For example, 'If this plane goes through turbulence, it is going to crash.'

Families and supporters can help a sufferer to challenge these unhelpful thoughts and develop a more balanced perspective. This can be done by family members and supporters encouraging the phobic person to consider the following questions:

- What's the probability of that actually happening?
- Is there any evidence to support that thought?
- What's happened in the past when presented with this object, activity or situation?
- Is there a more realistic way of looking at the situation?

Unhelpful thought
'I'm going to have a panic attack. I always panic on trains. I'll sweat and shake. Everyone will see I'm anxious and think I'm weird.'

↓

Physical symptoms
You start to sweat and shake

↓

Unhelpful thought
'I feel so sick, I must look terribly anxious. I'll pass out if this keeps up.'

↓

Physical symptoms
You sweat even more profusely and feel even more dizzy.

↓

Unhelpful thought
'I can't stay on the train. I've got to get off at the next stop.'

↓

Behaviour
You get off the train and as you exit the carriage, your anxiety decreases.

↓

Unhelpful thought
'I'm weird and stupid. Other people have no trouble travelling on trains.'

SOURCE: ANXIETY TREATMENT AUSTRALIA (2016)

FIGURE 10.23 This example of someone who fears having a panic attack on a train highlights the interaction between thoughts, physical symptoms and behaviour.

NOT ENCOURAGING AVOIDANCE BEHAVIOURS

Psychoeducation about a mental illness for the families and supporters of a person with a specific phobia may also focus on not encouraging **avoidance behaviours**. Avoidance behaviours are behaviours that attempt to prevent exposure to the fear-provoking object, activity or situation. For a person with a specific phobia this may involve completely avoiding or escaping from the feared object, activity or situation.

Avoidance behaviour can significantly restrict a sufferer's life. As a strategy to cope with the specific phobia, avoidance behaviour is considered **maladaptive**. This is because it does not attempt to remove the fear response to the phobic stimulus but it does assist in maintaining the disorder. Avoiding the phobic stimulus provides the person with negative reinforcement because they avoid the unpleasant fear symptoms associated with it. The absence of fear that results from their avoidance becomes a reward and reinforces the likelihood of the behaviour being repeated in the future. This is an example of operant conditioning in

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practice. For example, an individual with a phobia of dogs will feel a significant decrease in anxiety once they decide to avoid a location where dogs are present. This avoidance removes the unpleasant anxiety symptoms, thereby reinforcing their avoidance behaviour. The principles of operant conditioning and systematic desensitisation may be used in the treatment of an anxiety disorder.

A sufferer's family and supporters should not criticise or encourage the use of avoidance behaviours. Instead they can assist by providing more adaptive alternatives in a supportive environment. In addition, by providing gradual exposure to the feared object, activity or situation in a safe and reassuring manner, the maladaptive behaviours may become extinct.

For example, the family and supporters of an individual with a phobia of dogs may assist by encouraging the person to visit locations where they are likely to encounter dogs, such as parks.

10.8 CHECK YOUR UNDERSTANDING >>

1 The education about a mental illness such as the nature of the illness, its treatment and management strategies is known as:
   - A psychoeducation.
   - B systematic desensitisation.
   - C socioeducation.
   - D graduated exposure.

2 Why is the psychoeducation of family members and supporters of sufferers an important factor in the treatment of a mental illness?

3 What are avoidance behaviours?

4 What are cognitive distortions? Provide an example to demonstrate your understanding.

5 Behaviours that attempt to prevent exposure to the fear-provoking object, activity or situation are known as:
   - A avoidance behaviours.
   - B overt behaviours.
   - C prevention behaviours.
   - D evasion behaviours.

MAINTENANCE OF MENTAL HEALTH

As discussed in Chapter 2, there are many sources of stress and adversity, including daily pressures such as working long hours, and life events such as loss of a job, illness and moving to a new home. Stress is a normal part of life and it can motivate us to achieve our goals. However, if stress becomes chronic, or when we feel we're no longer able to cope, it can negatively affect our wellbeing and lead to mental health problems.

RESILIENCE AS A POSITIVE ADAPTATION TO ADVERSITY

Individuals who are able to overcome a particular stressful event or adversity increase their ability to cope with difficulties in the future. An individual's ability to properly adapt to stress and cope with adversity is known as **resilience**. Resilience involves people using their skills and strengths to cope or learning new skills to cope, which helps them adapt to a stressor. Resilience doesn't remove the stress, but it does enable a person to cope and better manage stress so they are able to function more effectively, and enjoy good physical and mental health.

A number of factors, known as **risk factors**, increase the likelihood that an individual will experience mental health problems. These risk factors include relationship difficulties and negative family circumstances. Conversely, there are also many factors that influence an individual's resilience and ability to recover from a negative experience and decrease the likelihood that they will develop mental health problems. These are known as **protective factors**. Protective factors include biological factors (for example, adequate diet and sleep), psychological factors (for example, cognitive behavioural strategies) and social factors (for example, support from family, friends and community).

BIOLOGICAL FACTORS THAT PROTECT MENTAL HEALTH

Diet

Brain functioning is very sensitive to what we eat and drink, therefore diet can play a vital role in maintaining mental health as well as physical health. There is growing evidence that diet plays an important contributory role in specific mental health problems,

avoidance behaviours Behaviours that attempt to prevent exposure to the fear-provoking object, activity or situation

maladaptive Not adjusting adequately or appropriately to the environment or situation

resilience An individual's ability to properly adapt to stress and cope with adversity

risk factors Factors that impede or have a negative effect on the health of an individual

protective factors Factors that enhance or have a positive effect on the health of an individual including attention deficit hyperactivity disorder (ADHD), depression, schizophrenia and Alzheimer's disease (Mental Health Foundation of New Zealand, 2006).

An adequate diet includes sufficient energy for a person's needs, including protein for growth and maintenance of body cells; minerals, vitamins and water for growth and regulation of body processes; and fats and carbohydrates for energy. A person's diet will not cause or prevent the development of a mental illness; however, it can help to promote good mental health and contribute to a person's level of resilience when presented with adversity. A balanced diet consists of adequate amounts of complex carbohydrates, essential fats, amino acids, vitamins, minerals and water in the correct proportions.


SHUTTERSTOCK.COM/VALENTYN VOLKOV

FIGURE 10.24 A healthy, balanced diet can directly contribute to your mental wellbeing.

Diet can affect our mental health both directly and indirectly: directly, through the nutrients that keep our body and brain physically healthy so they can function at optimal level, and indirectly, through the emotional impact of having a physical condition caused by an unhealthy diet. Eating a balanced diet can help improve mood, maintain healthy brain functioning and help people cope with a range of adversities, including mental illnesses such as anxiety disorders.

Diet contributes to resilience by protecting against diet-related diseases that affect physical and cognitive functions and by reducing vulnerability to stress and depression (Rocio Flórez, Shih, & Martin, 2014).

The following dietary guidelines from the National Health and Medical Research Council (2005) provides advice on the impact on mental health of specific foods.

- Drinking plenty of water helps prevent dehydration. Even mild dehydration can affect mood, causing irritability and restlessness.
- Wholegrain cereals (those with intact kernels) and many fruits, vegetables and legumes have a low 'glycaemic index', which means that the sugar in these foods is absorbed slowly into the blood stream. This helps to stabilise blood sugars and optimise mental as well as physical performance.
- For people who experience anxiety, avoiding caffeine is wise. Caffeine, especially for those who are particularly sensitive to it, increases anxiety and contributes to insomnia. Coffee, tea, energy drinks (such as Red Bull) and cola drinks all contain caffeine, as do cocoa and chocolate in lesser amounts.

Adequate sleep

As discussed in Chapter 6, sleep is vitally important to us for replenishing and revitalising the physiological processes that keep the mind and body functioning at an optimal level. NREM sleep plays a role in restoring the body and REM in the restoration of mental processes. Ensuring we get adequate sleep is essential in maintaining good physical and mental health.

Adequate sleep is the necessary amount for individuals to function effectively during the daytime and cope with normal daily stress. The amount of adequate sleep will differ between individuals depending on a range of factors such as age, physical activity levels and general health.

The Victorian Department of Health and Human Services Better Health Channel (2015g) suggests the following guidelines for adequate sleep:

- primary school children – 9 to 10 hours.
- teenagers – 9 to 10 hours.
- adults – approximately 8 hours.

One of the many effects that anxiety has on the body is that it can disrupt sleep patterns. Negative and anxiety-provoking thoughts can disrupt our sleep pattern by disrupting the onset and maintenance of sleep.

Scientists have found that a lack of sleep, common in anxiety disorders, may play a key role in activating brain regions that contribute to excessive worrying.

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The psychological repercussions of inadequate sleep include changes in emotions (being irritable, anxious, depressed and moody), difficulty concentrating, poor behaviour control and difficulty in social settings.

Strategies to promote sleep, such as setting aside time for problem-solving during the day, moderating caffeine intake and ensuring time to relax before bedtime, will contribute to increased energy levels, clearer and more rational thinking, and boost our resilience to cope with everyday stress more effectively.

10.3

FOCUS ON RESEARCH

REDUCED SLEEP QUALITY CAN AGGRAVATE PRE-EXISTING PSYCHOLOGICAL CONDITIONS

Disturbed sleep is a commonly reported symptom among individuals diagnosed with anxiety disorders. However, the direct cause of disrupted sleep is poorly understood. Proper sleep is critical for cognitive and daily functioning, and reduced quality of sleep has the potential to exacerbate pre-existing psychological conditions, according to new research.

To effectively evaluate differences in sleep architecture [the structure and pattern of sleep] after induced stress, Robert Ross MacLean, of Boston University, used an objective measure of anxiety and recorded subsequent sleep–wake behaviour in rats. In the rodent model, many previous studies had observed differences in sleep–wake behaviour after shock exposure, but the level of anxiety was merely assumed or absent.

MacLean's study exposed naïve rats [not previously subjected to experimentation] to one of three paradigms: escapable shock, inescapable shock or fear conditioning. Immediately after experimental manipulation, individual level of anxiety was assessed using the elevated-plus maze apparatus, and polygraphic signs of sleep–wake behaviour were recorded for 6 hours.

By measuring individual anxiety level before recording sleep, MacLean was able to make comparisons between sleep architecture and level of anxiety. In doing so, MacLean intended to establish a direct link between variation in sleep architecture and heightened anxiety in the rodent model.

'These changes could elucidate sleep–wake behaviour associated with the subjective complaint of disrupted sleep, thus creating the potential for new diagnostic and assessment criteria for anxiety disorders,' said MacLean. 'This information is relevant given the recent influx of psychological disorders in Iraq war veterans, particularly generalised anxiety and post-traumatic stress disorder.'

The amount of sleep a person gets affects his or her physical health, emotional wellbeing, mental abilities, productivity and performance. Recent studies associate lack of sleep with serious health problems such as an increased risk of depression, obesity, cardiovascular disease and diabetes.

Source: American Academy of Sleep Medicine. (2007, June 14). Reduced sleep quality can aggravate pre-existing psychological conditions. *ScienceDaily*.

QUESTIONS

1. Write a possible hypothesis for this study.
2. Identify the independent variable.
3. Identify the dependent variable.
4. How did MacLean assess the levels of anxiety displayed by the rats?
5. MacLean's results are not cited in this abstract. Given that disturbed sleep is commonly associated with anxiety disorders, what do you predict would be the results of this experiment?

PSYCHOLOGICAL FACTORS: COGNITIVE BEHAVIOURAL STRATEGIES

Cognitive behaviour strategies are structured psychological treatments that recognise that a person's way of thinking (cognition) and acting (behaviour) affect the way they feel. These collective strategies are commonly known as cognitive behavioural therapy (CBT) and are used by healthcare professionals in treating a person's physical and mental health and promoting resilience.

In cognitive behavioural therapy, a person works with a professional to evaluate and change unhelpful patterns of thinking that cause high levels of anxiety and lead to negative behaviours. Cognitive behavioural strategies aim to help a patient recognise these unhelpful patterns of thinking and use techniques to replace these patterns to reduce anxiety and improve their ability to cope.

Cognitive behavioural strategies used by health professionals will be tailored to a patient's individual needs. These strategies may include:

- educating patients about the body's natural reactions to threatening objects and situations
- helping patients recognise the difference between unhelpful and productive thoughts

adequate diet Food and water intake that includes sufficient energy for a person's needs

adequate sleep The necessary amount for individuals to function effectively during the daytime and cope with normal daily stress

cognitive behaviour strategies Structured psychological treatments that recognise that a person's way of thinking (cognition) and acting (behaviour) affects the way they feel

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- identifying situations that are often avoided and confronting these through gradual exposure
- teaching relaxation and breathing techniques to manage stress and anxiety
- helping patients establish effective daily routines that promote engaging in enjoyable activities and exercise.

One of the goals of cognitive behaviour strategies is to help patients develop or strengthen their resilience so that they have an increased capacity to cope with adversity when they encounter it.

SOCIAL FACTORS: SUPPORT FROM FAMILY, FRIENDS AND COMMUNITY

Social support refers to the close, positive relationships we develop with others (see Figure 10.25). It facilitates good health and morale (Greenglass, Burke, & Konarski, 1998). One reason for this is that support from family, friends and community groups serves as a buffer to cushion the impact of stressful events (Taylor, 1999). Talking about problems and expressing tensions can be extremely helpful. Research has shown that isolation can increase stress-related bodily changes, including hormones and anxiety symptoms, and that seeking social support to avoid isolation is an important method of coping with stress.

It may be difficult for family and friends to understand why specific objects and situations cause extreme levels of anxiety; however, these close relationships can help sufferers develop their inner resilience through engagement in daily activities with others.

A network of good friends is also a key to feeling supported. Friends often support us with unconditional positive regard and this enhances our trust that we can rely on them in times of crisis, thereby making the relaxation response accessible.

Social support is also found in other community-based activities – for example, at your local football or netball club. This has the double advantage of providing both physical exercise and social support.

A sense of belonging and self-confidence is often most effectively achieved through connection with a community of people with common conditions and experiences. Partnerships between professionals and consumers, and support and clinical services, will ensure that the experience and knowledge of people with mental health issues will be valued and heeded, and contribute to the development of appropriate and effective services (Anxiety Recovery Centre Victoria, 2009). Community support organisations such as Beyond Blue, the Black Dog Institute, Headspace and SANE Australia offer support, training and education for the families of and individuals with mental health problems and illnesses.

These protective factors are critical in building resilience and enhance the ability of individuals to cope with difficulties.

FIGURE 10.25 Families are often the main support for people affected by mental illness.

10.9 CHECK YOUR UNDERSTANDING >>

1 An individual's ability to properly adapt to stress and cope with adversity is known as:
   A spirit.
   B flexibility.
   C resilience.
   D rigidity.

2 The influences that increase the likelihood that an individual will experience mental health problems are known as:
   A hazard factors.
   B risk factors.
   C protective factors.
   D defensive factors.

3 The influences that decrease the likelihood that an individual will develop mental health problems are known as:
   A hazard factors.
   B risk factors.
   C protective factors.
   D defensive factors.

4 What are two ways an adequate diet and enough sleep benefit a person's mental health?

5 Describe three cognitive behavioural strategies used by health professionals in maintaining a person's mental health.

6 Identify three community support organisations that offer support, training and education in maintaining a person's mental health.

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MODELS OF BEHAVIOUR CHANGE

The main focus of treatments for mental disorders (for example, phobia treatments) is to change maladaptive behaviours through the application of learning principles. This change in behaviour is an extremely difficult process because it involves complex interactions between thoughts, emotions and unconscious behavioural reactions. This is compounded by the fact that many specific phobia sufferers experience a reappearance of the irrational fear response to the specific object, activity or situation after undergoing successful treatments.

Behavioural change models are attempts to explain the complexities of how and why behaviours change. The understanding of the different factors that influence behavioural change can be used to design more effective treatment strategies for sufferers of mental illnesses.

The best known models of behaviour change include learning theories and the Transtheoretical Model. Classical conditioning explains behaviour change in terms of the involuntary association between two stimuli; this is a process in which most specific phobias are acquired. Operant conditioning explains behaviour change being determined by the consequence of behaviour. Social learning theories describe behaviour change as occurring through the process of observation.

THE TRANSTHEORETICAL MODEL

The Transtheoretical Model of Behaviour Change (also known as the Stages-of-Change Model) was developed by James Prochaska and Carlo DiClemente in the early 1980s to explain the multi-staged process of intentional behaviour change.

The Transtheoretical Model was developed through research into theories on how people went about changing undesirable behaviours such as smoking, overeating and problem drinking. The model is based on the belief that behavioural change is a process that evolves over time that requires people to move through stages rather than a discrete, single event.

This model is particularly applicable for individuals with a specific phobia because the process of overcoming the fear will not occur quickly and requires a number of stages. The model has four main components: the stages of change, decisional balance, self-efficacy and the process of change.

The stages of change

The Transtheoretical Model proposes that individuals who are trying to change a behaviour move through stages of change: precontemplation, contemplation, preparation, action and maintenance/relapse (see Figure 10.26). Particular intervention strategies that draw on the biological, psychological and social influences of an individual's condition can be used at each stage to support the individual to succeed in making long-term behavioural changes. While progression through the stages in order often occurs, a non-linear progression is common.

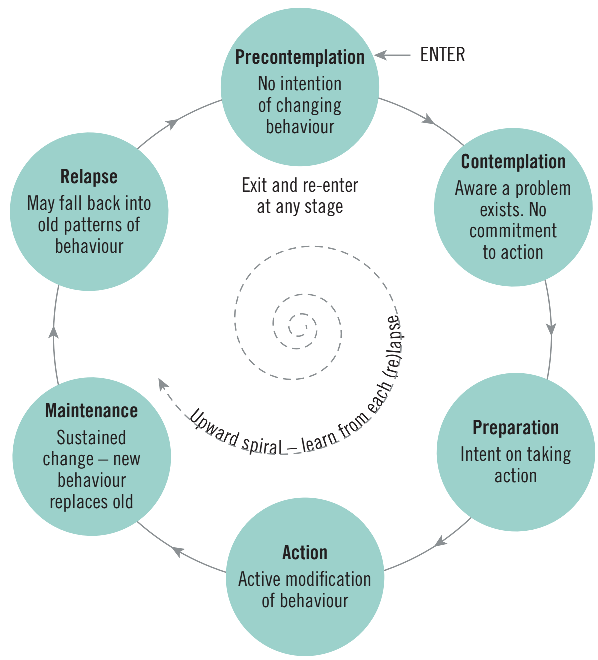

FIGURE 10.26 The Stages-of-Change Model

STAGE 1: PRECONTEMPLATION (NOT READY FOR CHANGE)

Individuals in this stage are not currently considering a behaviour change in the near future (within 6 months) and may be unaware of the need to change. This may be due to a lack of knowledge of the need to change and of the consequences of their behaviour.

Effective strategies at this stage focus on further education, being more mindful of their decision-making and encouraging a re-evaluation of their current behaviour.

STAGE 2: CONTEMPLATION (THINKING OF CHANGING)

At this stage, individuals are intending to change behaviour within the next 6 months. They are more aware of the benefits of changing. However, they are equally aware of the negatives of the change and this can make them uncertain about making the change and can cause them to keep putting off taking action for a long period of time.

An effective strategy at this stage is to identify new positive outcomes of the change; this may be achieved through focusing on others who behave in healthier ways.

STAGE 3: PREPARATION (READY TO CHANGE)

Individuals at this stage are ready to start taking action within the next 30 days. These individuals have devised a plan of action to make the significant behavioural change. This plan can include contacting health professionals and telling friends and family about their motivation to change.

Effective strategies at this stage include encouraging small initial steps, reassuring support from family and friends, and focusing on how they will feel once behavioural changes have been made.

STAGE 4: ACTION (MAKING CHANGE)

Individuals at this stage have made specific behaviour modifications in their lifestyles within the past 6 months. During this stage individuals need to learn how to strengthen their commitments to change and take actions against a relapse of the unwanted behaviour.

Effective strategies at this stage include education on techniques for keeping up their commitments, rewarding themselves for taking steps towards changing, and avoiding people and situations that tempt them to behave in unhealthy ways.

STAGE 5: MAINTENANCE/RELAPSE (STAYING ON TRACK)

In this stage, individuals have sustained their behaviour change for more than 6 months and intend to maintain the behaviour change into the long-term future. Individuals are less tempted to relapse into the unwanted behaviour and grow increasingly more confident that they can continue their changes.

Effective strategies that are suitable in this stage include encouraging individuals to seek support with people whom they trust, spend time with people who behave in healthy ways and engage in healthy activities to cope with stress.

If an individual does relapse (reappearance of unwanted behaviours) it is important to identify the trigger for the relapse, reassess their motivation and barriers, and implement stronger coping strategies.

After a relapse of unwanted behaviour it is possible for the individual to re-enter at any stage.

Decisional balance

Decisional balance was conceptualised by Janis and Mann (1977) as a balance sheet of weighing the pros (positives) and cons (negatives) of decision-making. Research studies on the Transtheoretical Model suggest that, in general, for people to succeed at behaviour change, the pros of change should outweigh the cons before they move from the contemplation stage to the action stage of change (DiClemente, 2003). The decisional balance is a measure of readiness for behavioural change.

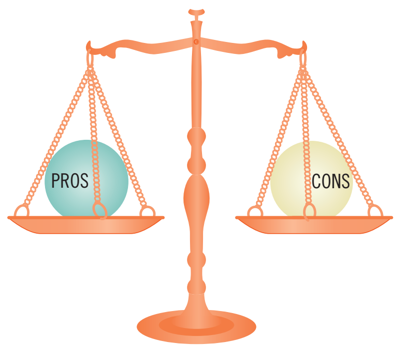

FIGURE 10.27 The process of weighing up the pros and cons of change is known as decisional balance.

Self-efficacy

Self-efficacy refers to 'people's beliefs in their capabilities to produce desired effects by their own actions' (Bandura, 1997, p. vii). Self-efficacy reflects an individual's confidence in maintaining their desired behaviour and ability to cope with high-risk situations without relapsing into their unwanted behaviours.

There is an old and frequently told story of a track coach who wanted to teach his team to run faster. No matter what the coach did, no-one seemed able to beat their best time. One night, unbeknown to the team, the coach moved the finishing line, effectively making the track 10 feet longer. The next day, the runners clocked slower times than they usually did (because the track was now 10 feet longer). Discouraged, because they knew they could do better, the runners practised and practised until they could again achieve their old times. At this point, the coach let them in on the secret that he had moved the finishing line and informed them that they were now running faster. The coach demonstrated that, when the runners thought they

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couldn't go any faster, they didn't, and when they knew they could do better, they did. The coach proved the power of self-efficacy (Study.com, 2016).

Processes of change

While the stages of the Transtheoretical Model of Behaviour Change indicate when particular shifts in intentions and behaviours occur, the processes of change describe how these shifts occur. They represent activities and experiences that individuals apply and engage in during the journey of attempting to change their behaviour (Prochaska, DiClemente, & Norcross, 1992; Velicer, Prochaska, Fava, Norman, & Redding, 1998).

Prochaska and DiClemente have identified 10 processes that can help individuals successfully progress through the stages of change and attain the desired behaviour change:

1. *consciousness-raising* – increasing awareness via information, education and personal feedback about the healthy behaviour
2. *dramatic relief* – feeling fear, anxiety or worry because of the unhealthy behaviour, or feeling inspiration and hope when they hear about how people are able to change to healthy behaviours
3. *self-reevaluation* – realising that the healthy behaviour is an important part of who they are and want to be
4. *environmental reevaluation* – realising how their unhealthy behaviour affects others and how they could have more positive effects by changing
5. *social liberation* – realising that society is more supportive of the healthy behaviour
6. *self-liberation* – believing in one's ability to change and making commitments and recommitments to act on that belief
7. *helping relationships* – finding people who are supportive of their change
8. *counter-conditioning* – substituting unhealthy ways of acting and thinking for healthy ways
9. *reinforcement management* – increasing the rewards that come from positive behaviour and reducing those that come from negative behaviour
10. *stimulus control* – using reminders and cues that encourage healthy behaviour as substitutes for those that encourage the unhealthy behaviour (adapted from Prochaska & Velicer, 1997).

Limitations of the Transtheoretical Model

The Transtheoretical Model of Behaviour Change has enabled more effective intervention to suit a person's stage readiness for change, but the model has limitations. These limitations include that the model focuses on one behaviour, while not considering the impact of other confounding behaviours; and that it does not address the biopsychosocial issues related to behavioural change.

10.10 CHECK YOUR UNDERSTANDING >>

1. What is the main focus of phobia treatments?
2. Why is it important to understand the different factors that influence behavioural change?
3. Which theory or model of learning explains behaviour change as being determined by the consequences of behaviour?
   A Classical conditioning
   B Operant conditioning
   C Social learning theory
   D The Transtheoretical Model
4. Which theory or model of learning explains behaviour change as occurring through the process of observation?
   A Classical conditioning
   B Operant conditioning
   C Social learning theory
   D The Transtheoretical Model
5. Name and provide a brief explanation of each of the stages of behaviour change according to the Transtheoretical Model.
6. What is decisional balance? Provide an example to demonstrate your understanding.
7. Name and describe three processes of change that could help an individual successfully progress through the stages of change.

decisional balance The process of weighing the pros and cons of decision-making

self-efficacy An individual's belief in their capacity to execute behaviours necessary to produce specific performance attainments

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CHAPTER SUMMARY

Distinctions between stress, phobia and anxiety

- Stress refers to a state of mental or physical tension that occurs when an individual must adjust or adapt to their environment but they do not feel they have the capacity to do so.
- A phobia is an intense, irrational fear and avoidance of a particular object, activity or situation.
- Anxiety refers to feelings of apprehension, dread or uneasiness and is a response to an unclear or ambiguous threat.
- When anxiety is out of proportion to a situation, it may be detrimental to an individual's wellbeing, and result in an anxiety disorder such as a specific phobia.
- Anxiety is the most common mental condition in Australia. On average, one in four people will experience anxiety. In any one year, approximately 2 million Australian adults have anxiety.

Variation for individuals with stress, phobia and anxiety on a mental health continuum

- There are varying degrees of a person's levels of anxiety. These can be presented on a continuum from normal feelings of being nervous to extreme feelings that can be diagnosed as a mental disorder such as a specific phobia.
- A phobic disorder differs from common fears in that it produces overwhelming anxiety, producing symptoms including nausea, vomiting, shaking, fainting, sweating uncontrollably, increased heart rate and hot flushes.

Biological contributing factors to the development of a specific phobia

- Genetic factors are inherited biological factors that can enhance (or reduce) an individual's risk of, or vulnerability to, developing a particular condition.
- Neurotransmitters such as gamma-amino butyric acid (GABA) can have an inhibiting response on the brain and can have a calming, dulling or slowing effect; there is a lack of this neurotransmitter in an anxiety-related response.
- The stress response – sufferers adapt slowly to repeated stressors and respond excessively, even to simple stimuli that would not provoke anxiety in many others.
- Long-term potentiation contributes to the development of specific phobia via the strengthening of synapses within neural circuits that communicate with the amygdala.
- Some studies suggest that up to 30 per cent of people with a phobic disorder may have a family history of someone closely related with a phobia of the same type.

Psychological contributing factors to the development of a simple phobia

- The behavioural model claims that phobic anxiety could be the result of learning.
- The cognitive model claims we may sometimes couple faulty reasoning and rationale with fearful stimuli from the environment and hence a new cognition is formed into a phobia.
- Memory biases may contribute to the development of a phobia when a person more readily recalls negative information about a specific object, situation or event.
- Catastrophic thinking occurs when an individual repeatedly overestimates the potential dangers and assumes the worst of an object or event.

Sociocultural contributing factors to the development of a specific phobia

- Specific environmental triggers in the environment can predispose an individual to the development of specific phobias, such as a traumatic event.
- According to social learning theory and parental modelling, children learn from their parents and often mirror what the parents do. Children learn how to respond to stress and difficulties by observing how parents respond to these.
- Stigma is a mark of disgrace that sets a person apart. When a person is labelled by their illness this can lead to negative attitudes and discrimination.

Biological interventions and their use for specific phobia

- Medications can relieve symptoms of anxiety; however, their use is not a long-term solution because they do not treat the underlying cause of the anxiety disorder.
- Biological treatments often target the enhancement of GABA neurotransmission, in order to inhibit the hyper and overexcited bodily responses seen in anxiety.
- A group of medications known as benzodiazepines can be used in the short-term treatment of phobic anxiety, because they enhance the GABA-induced inhibition of overexcited neurotransmitters.
- Relaxation techniques such as breathing retraining and exercise can help individuals cope effectively with the stresses related to their specific phobia.
- Exercise burns up these natural chemicals that accumulate during stress. This can reduce anxiety and improve mood.

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Psychological interventions and their use for specific phobia

- Cognitive behavioural therapy involves the application of learning principles to change thought processes and human behaviour, especially maladaptive behaviour.
- Systematic desensitisation is a technique that teaches sufferers to associate their feared stimulus with relaxation and feelings of being calm.

Social interventions and their use for specific phobia

- The education about a mental illness such as the nature of the illness, its treatment and management strategies is known as psychoeducation.
- Psychoeducation of family members and supporters of sufferers is an important factor in the treatment of a mental illness.
- Families and those supporting a person with a specific phobia can play an important role in assisting the sufferer in challenging their unrealistic or anxious thoughts towards the phobic stimulus.
- Irrational and pessimistic attitudes are known as cognitive distortions.
- Avoidance behaviours are behaviours that attempt to prevent exposure to the fear-provoking object, activity or situation.
- Avoidance behaviours assist in maintaining the mental disorder and can significantly restrict a sufferer's life.

Resilience as a positive adaptation to adversity

- An individual's ability to properly adapt to stress and cope with adversity is known as resilience.
- There are many influences that affect an individual's resilience and ability to bounce back from a negative experience.
- The influences that increase the likelihood that an individual will experience mental health problems are known as 'risk factors'. These could include relationship difficulties and negative family circumstances.
- The influences that decrease the likelihood that an individual will develop mental health problems are known as 'protective factors'. These include adequate diet and sleep, cognitive behavioural strategies and support from family, friends and community.
- Eating a nourishing diet can help improve mood, maintain healthy brain functioning and help people with anxiety disorders.
- Cognitive behavioural therapy involves a person working with a professional to evaluate and change unhelpful patterns of thinking that cause high levels of anxiety and lead to negative behaviours.
- Partnerships between professionals and consumers, and support and clinical services, will ensure that the experience and knowledge of people with anxiety disorders will be valued and heeded, and contribute to the development of appropriate and effective services.

Models of behaviour change

- The main focus of phobia treatments is to change maladaptive behaviours through the application of learning principles.
- Behavioural change models are attempts to explain the complexities of how and why behaviours change.
- The understanding of the different factors that influence behavioural change can be used to design more effective treatment strategies for sufferers of mental illnesses.
- The Transtheoretical Model proposes that individuals who are trying to change a behaviour move through stages of change: precontemplation, contemplation, preparation, action and maintenance/relapse.
- Decisional balance is the process of weighing the pros and cons of decision-making.
- Self-efficacy reflects an individual's confidence in maintaining their desired behaviour and their ability to cope with high-risk situations without relapsing to their unwanted behaviours.
- The Transtheoretical Model proposes that there are 10 processes that can help individuals successfully progress through the stages of change and attain the desired behaviour change.

APPLY YOUR KNOWLEDGE AND SKILLS

SECTION A: MULTIPLE-CHOICE QUESTIONS

Answer the following questions by writing the correct letter in your workbook. Only one answer is correct for each question.

1 The 2007 National Survey of Mental Health and Wellbeing found of the 16 million Australians aged 16–85 years, almost __________ experienced a mental disorder at some point in their life.

A 5 per cent
B 20 per cent
C 35 per cent
D 45 per cent

2 Which of the following characteristics are not accurate in describing the fear associated with a phobia?

A It is persistent.
B It is irrational.
C It is reasonable.
D It is intense.

3 A phobia is a type of __________ disorder.

A mood
B psychotic
C addictive
D anxiety

4 A chemical in the brain that is released between the synapses of two neurons is known as a:

A neuron.
B neurotransmitter.
C neurochemical.
D hormone.

5 The role of genetics and neurotransmitters is a __________ effect in the development and treatment of mental disorders.

A biological
B psychological
C cognitive
D sociocultural

6 The key role of gamma-amino butyric acid in the experience of anxiety is that it:

A should have an inhibiting response, calming an individual.
B should have an excitatory response, calming the individual.
C should have an inhibiting response, preparing the individual for action.
D All of the above

7 The experience of stress results in activation of the __________, which is known as the fight–flight response.

A central nervous system
B somatic nervous system
C sympathetic nervous system
D parasympathetic nervous system

8 Exposure to the fear stimulus will strengthen the memory circuit with which part of the brain?

A The amygdala
B The hypothalamus
C The hippocampus
D The penal gland

9 The consolidation theory proposes that:

A the strengthening of synapses occurs based on recent patterns of activity.
B structural changes to neural circuits occur with the formation of long-term memories.
C structural changes to neural circuits occur with the formation of short-term memories.
D that the loss of synapses occurs based on recent patterns of activity.

10 The __________ model proposes that phobic anxiety could be the result of learning.

A cognitive
B behavioural
C emotional
D social

11 Which model or theory proposes that behaviour is learnt from the environment through the process of observational learning?

A Classical conditioning
B Operant conditioning
C Trial-and-error learning
D Social learning theory

12 Social disapproval of an individual's personal characteristics or beliefs, or social disapproval of a type of behaviour is known as:

A prejudice.
B discrimination.
C stigma.
D a negative attitude.

13 __________ can relieve symptoms of anxiety; however, their use is not a long-term solution as they do not treat the underlying cause of the anxiety disorder.

A Medications
B Psychologists
C Psychiatrists
D Cognitive behavioural therapy

14 A person who suffers from anxiety should learn how to breathe from their __________, rather than their chest.

A shoulders
B stomach
C diaphragm
D nose

15 Reciprocal inhibition is:

A the concept that one emotional state is used to block another.
B a type of behavioural therapy whereby an individual with a phobia or fear is exposed to the fear-producing object very slowly.
C a type of behavioural therapy whereby an individual with a phobia or fear is exposed to the fear-producing object very quickly.
D the education about a mental illness such as the nature of the illness, its treatment and management strategies.

SECTION B: SHORT-ANSWER QUESTIONS

1 Distinguish between stress, phobia and anxiety.

2 How prevalent are anxiety disorders in Australia?

3 Identify four common symptoms associated with a specific phobia.

4 Outline the role gamma-amino butyric acid (GABA) may play in the development of a specific phobia.

5 Define long-term potentiation and outline how it contributes to the development of specific phobia.

6 Identify and describe one psychological contributing factor to the development of a specific phobia.

7 Identify and describe one social contributing factor to the development of a specific phobia.

8 Outline how breathing techniques may help individuals cope effectively with the stresses related to their specific phobia.

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9 What does cognitive behavioural therapy involve?

10 Identify the stages of change proposed by the Transtheoretical Model.

SECTION C: EXTENDED-RESPONSE QUESTION

Read the article below and then complete the task that follows.

IF YOU'RE AFRAID OF SPIDERS, THEY SEEM BIGGER: PHOBIA'S EFFECT ON PERCEPTION OF FEARED OBJECTS ALLOWS FEAR TO PERSIST

A better understanding of how a phobia affects the perception of feared objects can help clinicians design more effective treatments for people who seek to overcome their fears, according to the researchers from Ohio State University.

In the study, participants who feared spiders were asked to undergo five encounters with live spiders – tarantulas, in fact – and then provide size estimates of the spiders after those encounters ended. The researchers recruited 57 people who self-identified as having a spider phobia. Each participant then interacted at specific time points over a period of 8 weeks with five different varieties of tarantulas varying in size from about 1 to 6 inches long.

The spiders were contained in an uncovered glass tank. Participants began their encounters 12 feet from the tank and were asked to approach the spider. Once they were standing next to the tank, they were asked to guide the spider around the tank by touching it with an 8-inch probe, and later with a shorter probe.

Throughout these encounters, researchers asked participants to report how afraid they were feeling on a scale of 0–100 according to an index of subjective units of distress. After the encounters, participants completed additional self-report measures of their specific fear of spiders, any panic symptoms they experienced during the encounters with the spiders, and thoughts about fear reduction and future spider encounters.

Finally, the research participants estimated the size of the spiders – while no longer being able to see them – by drawing a single line on an index card indicating the length of the spider from the tips of its front legs to the tips of its back legs.

An analysis of the results showed that higher average peak ratings of distress during the spider encounters were associated with estimates that the spiders were larger than they really were.

Source: Ohio State University. (2012, February 22). If you're afraid of spiders, they seem bigger: Phobia's effect on perception of feared objects allows fear to persist. *ScienceDaily*.

Write a discussion section for a research report on this investigation. Your report must follow the usual convention for report writing and should:

- state the aim of the study
- include a description of the results
- explain whether or not the results support the hypothesis
- state whether a conclusion can be drawn from the results and explain why
- identify and explain an extraneous variable that may have affected the results and suggest how this variable could be controlled in future research
- identify and explain the ethical considerations relevant to this study.

This question is worth 10 marks.

SECTION D: ASSESSMENT TASK

A RESPONSE TO A SET OF STRUCTURED QUESTIONS

Choose one specific phobia. Answer the following set of structured questions about your chosen phobia.

1 Describe three characteristics that distinguish your selected specific phobia from an ordinary fear.

2 Identify and describe one biological factor that may contribute to the development of an anxiety disorder such as your chosen specific phobia.

3 Identify and describe one psychological factor that may contribute to the development of an anxiety disorder such as your chosen specific phobia.

4 Identify and describe one social factor that may contribute to the development of an anxiety disorder such as your chosen specific phobia.

5 Outline how the use of short-acting anti-anxiety benzodiazepine agents (gamma-amino butyric acid [GABA] antagonists) may be used in the management of an anxiety disorder such as your chosen specific phobia.

6 Outline how the use of systematic desensitisation may be used in the treatment of an anxiety disorder such as your chosen specific phobia. Provide an example of a fear hierarchy in your response.

7 Discuss how an adequate diet and enough sleep could influence a person's resilience to the development and maintenance of an anxiety disorder such as your chosen specific phobia.

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CHAPTER 11

SCIENTIFIC RESEARCH METHODS

KEY KNOWLEDGE INCLUDES:

- independent and dependent variables and operationalisation of variables
- the psychological concepts specific to a selected investigation and their significance, including definitions of key terms and psychological representations
- the characteristics of scientific research methodologies and techniques of primary qualitative and quantitative data collection relevant to the selected investigation: experiments, self-reports, questionnaires, interviews and/or use of rating scales; reliability and validity of data; and minimisation of experimental bias and confounding and extraneous variables
- ethics and issues of research including identification and application of relevant ethical, health and safety guidelines, and use of human subjects
- methods of organising, analysing and evaluating primary data to identify patterns and relationships including sources of error and limitations of data and methodologies
- models and theories, and their use in organising and understanding observed phenomena and psychological concepts including their limitations
- the nature of evidence that supports or refutes a hypothesis, model or theory
- generalisability of statistics from samples to the populations from which the sample was derived
- the key findings of the selected investigation and their relationship to psychological concepts and theories associated with neural function, consciousness, learning, memory and/or mental wellbeing
- conventions of psychological report writing and scientific poster presentation including psychological terminology and representations, standard abbreviations and acknowledgement of references.

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PSYCHOLOGY AND THE SCIENTIFIC METHOD

Most people agree that biology, chemistry and physics are all sciences. However, many people refer to psychology as 'just common sense'. This reference is unfounded, as psychologists employ the same scientific method used in biology, chemistry or any other scientific experiments – and this chapter looks in detail at the many methods and conventions psychologists use in research investigations. Without psychological research, we would probably understand little about the brain and how it functions – and about human behaviour, intelligence, personality, creativity and cognitive development.

The scientific method involves using experiments to test the truth of a proposition by means of careful measurement and controlled observation (see Figure 11.1). It consists of a series of orderly and systematic steps that are used to plan, conduct, interpret and report research with the aim of testing a hypothesis. In psychological research, seven steps are used; these are shown in Figure 11.2 and outlined below.

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FIGURE 11.1 Applying the scientific method to the study of behaviour requires careful observation. Here, a psychologist videotapes a session in which a child's problem-solving abilities are being tested.

STEP 1: IDENTIFY THE RESEARCH PROBLEM

The first step in psychological research is to identify the area in which to conduct a study. This involves deciding on the population of research interest. For example, a researcher may be interested in investigating the causes of eating disorders in adolescent females. To do this, the researcher first needs to conduct a literature search, which involves finding and reading relevant research and literature. Usually, past research is reported in periodicals and journals, which you can find in university libraries or on the Internet. In the case of eating disorders, a literature search might show that factors such as low self-esteem and previous use of weight-control measures (for example, laxatives and vomiting) may be related to future incidence of eating disorders in adolescent females. Next, a testable general research question (an aim) needs to be developed. In this case it might be: 'Do factors such as self-esteem and laxative use predict the likelihood of adolescent females developing eating disorders?'

STEP 2: FORMULATE A HYPOTHESIS

A hypothesis is a testable prediction of the relationship between two variables. A variable is any condition (event or characteristic) that can change. In other words, a hypothesis is an educated guess about what the researcher thinks the results of the experiment will be, based on information gathered in the literature search. That is, it is not just a guess made without prior knowledge or investigation.

The hypothesis is developed before the research is conducted and is written as a specific statement. An example of a hypothesis for the research into eating disorders might be: 'It is predicted that adolescent girls with low self-esteem are at higher risk of developing an eating disorder than adolescent girls with high self-esteem.'

STEP 3: DESIGN THE METHOD

The research method determines how the researcher will test the hypothesis. The type of research method chosen depends on the type of topic or problem being investigated. While designing the method, the researcher needs to determine:

- the population of research interest
- which participants will be studied
- how many participants will be studied
- how participants will be selected from the nominated population
- how participants will be allocated to various groups in the study
- the procedure that will be followed.

scientific method A data-gathering method that involves testing a hypothesis by means of careful measurement and controlled observation

hypothesis A testable prediction of the relationship between two variables

variable Any event, condition or characteristic that changes (varies) or can be made to change

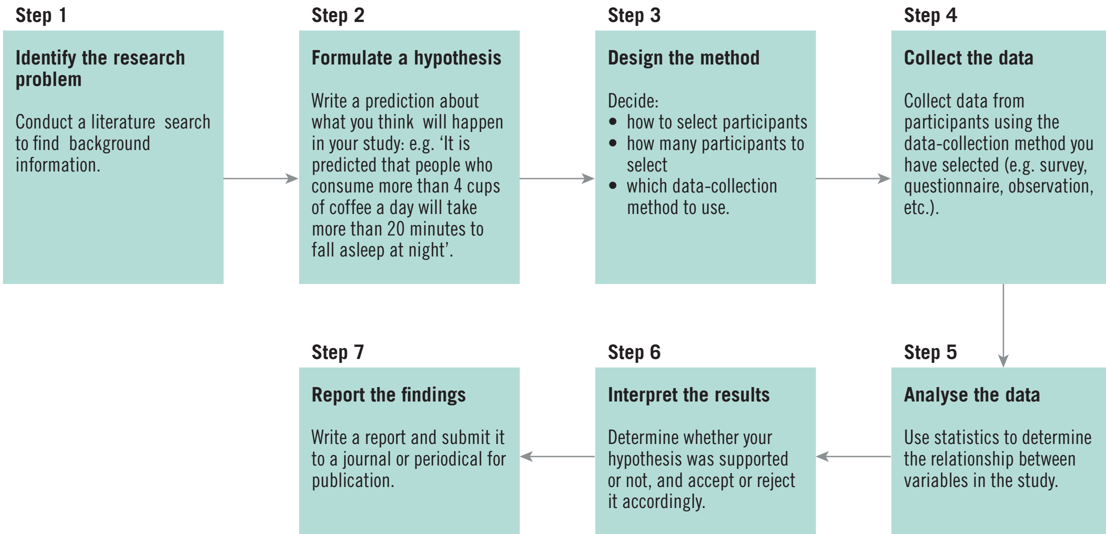

FIGURE 11.2 A summary of the steps involved in psychological research

Participants are the people or animals whose behaviour, characteristics or responses are investigated and measured as part of the experiment. Participants' responses generally form a study's data – the observed facts that constitute the results. (Note that 'data' is plural; 'datum' is singular.)

After choosing the participants, the researcher needs to decide on a particular research design and how the data will be collected. For example, will a controlled experiment be used, or an observational study or a case study? For the eating disorders research, if you chose to survey participants using a questionnaire (see page 353) to investigate the hypothesis, your design might be to give every female aged between 11 and 14 years who was attending any of three Melbourne secondary schools a survey about their eating behaviours – such as use of laxatives, frequency of vomiting and binge eating – and their feelings about their body image. You could plan to measure each participant's height and weight. Two years later, you could return to the same three schools and gather the data again from the same girls to see if their original feelings about their body image have affected current behaviour between the first survey and the current time.

Alternatively, you could design the study to use an experimental method (see page 339) to test the relationship between self-esteem and eating disorders. The participants from all three schools might be divided into two groups. All participants could be given questionnaires and interviews to initially gauge their eating habits and feelings about body image. One group might be given a series of training seminars on how to improve self-esteem. This could be followed up with more interviews and surveys, to gauge the effect of the seminars on their self-esteem and see if this has any effect on their eating behaviour.

STEP 4: COLLECT THE DATA

Researchers can use any of a variety of data-collection techniques, including questionnaires, direct observation, psychological tests or examination of files and documents. The data collected can be qualitative or quantitative. For the eating disorders research, a researcher might choose to gather data about the participants' levels of self-esteem using a questionnaire, and might gather data about their eating behaviours using an interview.

STEP 5: ANALYSE THE DATA

Data analysis involves objectively organising, summarising and representing raw data in a coherent and logical manner. Raw data are the actual data collected from a study. There are usually large amounts of raw data that are then 'broken down' into a smaller set or sets of numbers (for example, an average score in a set of scores). Descriptive statistics are used to summarise and organise data. Frequency tables, bar charts and line graphs are all examples of descriptive statistics.

STEP 6: INTERPRET THE RESULTS

Interpreting results involves forming conclusions about what the data show. A conclusion is a decision or judgement about the meaningfulness of a study's

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results. To draw a conclusion objectively, inferential statistics are used. If the statistical calculation is favourable, the results are considered to be significant and a conclusion is written that supports the hypothesis.

For example, if statistical analysis of the data from the eating disorder research clearly indicated that females who suffered from eating disorders had low self-esteem two years before the onset of the disorder, the data might be interpreted as supporting the hypothesis. The conclusion would be that female adolescents aged 11–14 years who have low self-esteem are more likely to suffer from an eating disorder in the future than adolescent girls who have high self-esteem.

STEP 7: REPORT THE FINDINGS

The report describes the background information used to formulate the hypothesis, gives information about the participants (such as age and gender), describes the procedures and materials used, and provides data analysis and interpretation (including graphs, tables and statistical tests). Reports also outline any problems or limitations encountered while conducting the study, and indicate how these may have affected the results. In addition, reports present conclusions based on the study's findings, as well as a list of references that were used to plan the study and prepare the report.

Once a research report is published in a journal, or is presented at a conference as a poster, other researchers can use it in their literature searches and further investigations. Publication also enables the general public to benefit from research findings.

REPORTING CONVENTIONS: REPORTS

Psychologists use a set format when reporting their research findings. It is important to note that this is a guideline only and often needs to be modified to suit a particular investigation.

Each formal report has two important characteristics. First, it needs to provide enough information about the study – for example, sampling method, materials used, procedure and data analysis – so that another researcher who reads the report is able to replicate the study. Second, the language used is very important: it needs to be clear, concise and written in the third-person and past tense.

Figure 11.3 shows the structure of a research report. Following are descriptions of each section in the formal report.

Title

The title briefly identifies what the investigation is about. Often it is easier to write a title after you have written the aim.

Abstract

An abstract is a brief summary (of approximately 100 words) of the entire report. It includes statements about the aim, participants, method, results and main conclusions.

Introduction

The introduction (200–600 words) provides background information obtained from literature searches on the topic. To provide a context for your investigation, you may want to include a brief description of the aim, method, results and conclusions of some previous studies in the research area. All specific terms mentioned should be defined and relevant theories and concepts should be introduced.

The introduction should lead to the current study's purpose. It includes the aim – a general, non-directional statement about what you want to investigate. The aim is followed by the research hypothesis, which also identifies the independent and dependent variable(s) (see pages 339–40).

Method

The method (150–200 words) must clearly describe how the investigation was conducted. It should include the following subsections:

- *Participants*
  - a description of the population of research interest
  - a description of the sample: how many participants were selected, plus any relevant features of the sample (for example, all girls)
  - how participants were allocated to groups

participants The people or animals whose behaviour, characteristics or responses are investigated and measured as part of an experiment

data The observed facts that constitute the results of an experiment

raw data The actual data collected from a study, before they are sorted or analysed; raw data appear in the appendix

conclusion A decision or judgement about the meaningfulness of the results of a study

inferential statistics Statistics that allow an experimenter to objectively make inferences and conclusions about data; they are often used to interpret results of a study

» *Materials*
  – a list of all materials used (for example, a questionnaire, word list A, word list B). A sample of written materials should be placed in the appendix

» *Procedure*
  – a detailed description of the steps in the experiment, written in past tense. Other information required includes how the independent variable was manipulated, the researcher's role(s), and the instructions given to participants. A sample consent form should be placed in the appendix.

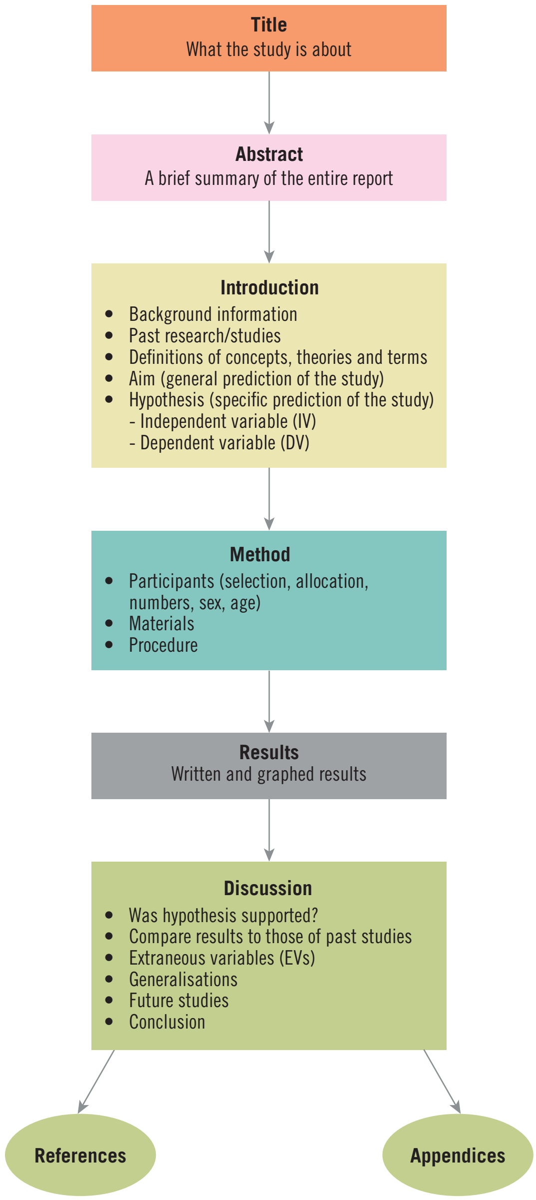

FIGURE 11.3 The structure of a research report

Results

The results section (150–200 words) should provide a summary of the main results. Results can be displayed in tables, charts or graphs, or as mathematical calculations. When using charts, graphs and tables, correct labels must be used and a descriptive title must be stated. A graph must have the axes labelled correctly. Results should also be described in a couple of short sentences.

If mathematical or statistical calculations are performed as part of the study, these also need to be reported in the results section. Lists of raw data are not included. Raw data are attached as appendices (see page 335).

Discussion

The discussion section (200–600 words) explains and interprets the results. A statement is given about whether the hypothesis was supported or rejected, based on the findings. If the hypothesis was rejected, you need to explain why you think the experiment did not support it. A conclusion is stated. Any extraneous variables that may have affected the results are identified and explained, and suggestions are given about how to control them in future research. Results of your study are compared with the results of the research mentioned in the introduction. Finally, the discussion should state whether the results of the sample can be generalised to the population from which the sample was drawn. This can only happen if the sample was representative of the population.

References

The reference list should include all references cited in your report. Psychologists use the referencing method specified by the American Psychological Association (APA) (2009). This means it will contain in-text reference citations, and a reference list that appears at the end of the paper.

CITING REFERENCES IN TEXT

All cited references must appear in the reference list and, conversely, every entry in the reference list must be cited somewhere in the text. Text citations are very simple to do. You need to use the author–date format when referencing material within text; that is, give the author's surname and the date of publication for the item you are citing, for example: 'Smith and Watson (2014) showed that …'

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If you are citing a publication with more than two authors, name all the authors the first time you cite them in the text, and in subsequent citations use the first author's name and the abbreviation 'et al.', followed by the date. For example, you would use 'Smith, Watson, Percy and Jones (2015)' the first time you referred to their publication, and then in subsequent mentions use 'Smith et al. (2015)'.

When quoting a source you must include a page reference after the year, for example: 'The author stated, "The effect disappeared within minutes" (Lopez, 2013, p. 311)'.

THE REFERENCE LIST

The following examples show how publication details for books, journals and Internet sites are presented in the reference list. While there is a description of different sources below, all sources are placed into one reference list. A reference list is ordered alphabetically according to the author's surname.

Books

Use the following format when referencing books.

- Author: The author's surname and initials are given (for example 'Green, A. H.'). If the book has more than one author, then all authors' names are cited in the order that they appear on the book's title page.
- Year of publication: This is enclosed in brackets, followed by a full stop (for example, 'Green, A. H. (1998).').
- Title of the book: This is italicised (or if this is not possible, underlined), and followed by a full stop (for example, 'Green, A. H. (1998). *The beginnings of perception.*').
- City of publication: This is followed by a colon (for example, 'Green, A. H. (1998). *The beginnings of perception*. Melbourne:').
- Name of publisher: This is followed by a full stop (for example, 'Green, A. H. (1998). *The beginnings of perception*. Melbourne: Barretts Press.).

An example of a full reference list entry for a book by a single author is: Garner, D. M. (1991). *Manual for the eating disorder inventory*. Odessa, Florida: Psychological Assessment Resources Inc.

An example of a full reference list entry for a book by multiple authors is: Booth, W. C., Colomb, G. G., & Williams, J. M. (1995). *The craft of research*. Chicago: University of Chicago Press.

Journals and periodicals

Use the following format when referencing material from journals and periodicals.

- Author: The author's surname and initials are given (for example, 'Brown, T. B.'). As already mentioned, a reference list is in alphabetical order according to surname. If there is more than one author, then all authors' names are cited in the order that they appear under the title on the first page of the article.
- Year of publication: This is enclosed in brackets, followed by a full stop (for example, 'Brown, T. B. (1999).').
- Title of the article: This is followed by a full stop (for example, 'Brown, T. B. (1999). From sensation to perception.').
- Title of the journal: This is italicised (or if this is not possible, underlined), and followed by a comma (for example, 'Brown, T. B. (1999). From sensation to perception. *Psychological Studies*,').
- Volume of the journal: The journal's volume number (italicised, or if this is not possible, underlined) and issue number (where relevant) are followed by a comma (for example, 'Brown, T. B. (1999). From sensation to perception. *Psychological Studies, 23*,')
- Page numbers: These are followed by a full stop (for example, 'Brown, T. B. (1999). From sensation to perception. *Psychological Studies*, *23*, 145–152.')

An example of a full reference list entry for a journal article by multiple authors is: Striegel-Moore, R. H., Solberstein, L. R., Frensch, P., & Rodin, J. (1989). A prospective study of disordered eating among college students. *International Journal of Eating Disorders*, *8*, 499–509.

Internet sites

Use the following format when referencing material from an Internet site: Author. (Year). Title of web page. Retrieved from URL. An example of a full reference list entry is: Dewey, R. A. (2002). Psych Web by Russ Dewey. Retrieved from http://www.psywww.com.

Appendix

An appendix (plural appendices) is the section where any extra materials that did not fit into the report are placed (for example, the raw data, or copies of materials or consent forms that have been used). Each appendix must be numbered, given a title and must be referred to in the body of the report.

11.1 CHECK YOUR UNDERSTANDING >>

1 Which of the following statement is true?
   A There are seven steps in the scientific method employed for psychological research.
   B In a formal written report of an experiment, the introduction comes before the abstract.
   C The method section of a formal written report identifies participants, materials and procedures.
   D Raw data appear in the results section of a formal written report.
2 A hypothesis is created:
   A after the research design is chosen.
   B after the research problem has been identified.
   C after the results are analysed.
   D after the conclusion(s) has been drawn.
3 Explain the difference between a conclusion and a generalisation.
4 In a written report, give three examples of the types of material that would be found in an appendix.
5 In a written report, what is the purpose of the abstract?
6 State the referencing method used in VCE Psychology. Use this method to cite your textbook in a reference list.
7 List the main headings in a scientific report.

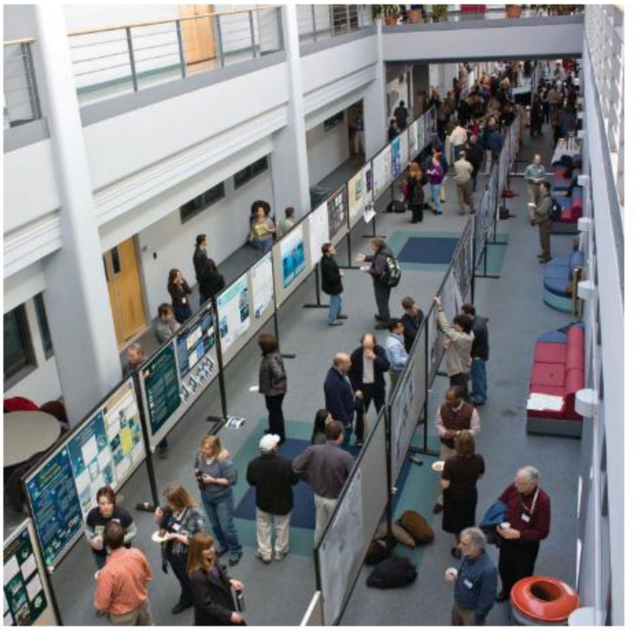
REPORTING CONVENTIONS: SCIENTIFIC POSTERS

Psychologists use posters to present their research at scientific conferences. Work and ideas can be shared and feedback from other researchers can be received in a way that can be less threatening than giving a talk. A poster session at a conference sees researchers display their posters and stand by them to answer questions that can clarify their research. As with other reporting conventions, posters have common headings, which are given below, and should appear in this order. Posters usually have two or three columns and would be read down the columns, from left to right. Columns make each line of text shorter and therefore easier to read.

Posters are not a scientific report placed on a poster; they are different from a written report in that they have much less text. There should not be more than 1000 words in total. You should see your poster as an illustrated abstract. Graphics and figures are the focus and should tell the story for you; the text is there to support the graphics. Formatting is important: carefully selected colours (choose two to three only) and a font theme can be used to create sections in the poster so that it is readable. All text must be legible from a distance and large blocks of text should be avoided. A font size of at least 20 points is recommended for text and section headings would be larger again. A dark type on a simple, light-coloured background is easier to read. Make sure your poster does not become cluttered and therefore difficult to read. This can be achieved by having 'white space' – sections of space separating your text and graphics.

REPRODUCED WITH PERMISSION OF R... KIRIAZIS

FIGURE 11.4 Researchers stand by their posters ready to talk about them. The poster needs to be clear and legible from a distance.



ALAMY STOCK PHOTO/NG IMAGES

FIGURE 11.5 A poster session at a psychology conference

ISBN 9780170365628

You can use any software program to create your poster: Microsoft PowerPoint, Adobe Illustrator, InDesign, Publish-It or Corel Draw.

Title

A title should be short and summarise the research question. It needs to attract the reader's attention, be informative and is written at the top of your poster. Immediately below the title, in a smaller font, is a list of authors. They are listed according to their contribution, with the highest contributor listed first. The presenting author's name is underlined. Your title can be in bold type, but should not be all capital letters or all italics.

Introduction

An introduction includes a hypothesis followed by the aims of the study. Any relevant background information, including psychological concepts, models, theories or similar studies, is then outlined using the minimum number of words. These need to be correctly referenced. A photograph in your introduction can be used to generate interest and to explain some information so that you use fewer words.

Methodology

This section summarises the way the experiment was conducted, how data was collected, and how ethical and safety guidelines were followed. This can be done using dot points that are written in past tense. It is not a recipe for someone else to follow; you are briefly telling people what you did. Diagrams, photographs (for example, you doing something) or flow charts can be used to describe a procedure with many steps. The summary that outlines the method that you use in your investigation needs to be able to be authenticated from your logbook entries.

Results

Results are presented in a way that will show trends or patterns. Results should not be interpreted in this section. A graph is preferable to a table of raw data. The type of graph you use must be appropriate: if you want to show a relationship between two variables, then use a scatter plot. Column and bar graphs are useful for comparing two data sets. Always make sure you label your axes and choose an appropriate scale so that the data takes up most of the plot area. Avoid using a coloured background for your graph. Also, grid lines will probably not be necessary: it is the pattern that matters, rather than exact values. You can use a legend next to your graph to draw attention to particular features of your results, to refer to the research question or to include relevant statistics, such as a mean.

Discussion

The discussion must analyse the results obtained and explain what your results mean. Identify the key findings of your experiment and compare them to existing knowledge, models or theories. State whether or not your results support your hypothesis. If not, suggest why. Identify unusual results, limitations in the data and methods, and suggest how these limitations could be overcome. Remember that this needs to be done concisely. To save space you may decide to combine this section with the results section rather than have it appear separately.

Conclusion

A conclusion is a clear statement that refers back to the research question and is based on the data you have gathered. A conclusion should only be a few sentences long.

Acknowledgements

Anyone that has helped you in your experiment should be thanked. This includes anyone who supplied equipment or laboratory assistance, helped develop ideas or assisted you in interpreting data.

References

All material that has been sourced and used must be referenced here. This is typically done by placing the author and year of publication (for example Jones, 2011). The reference list is a single list at the bottom of the poster, which is in alphabetical order according to author surnames. Refer to the reference section for a written report (see page 334).

Year 12 students are sleep deprived

Andrea Smith and Alex Lane

Introduction

Students who are completing Year 12 of VCE will have a sleep debt of 10 hours per week. This study aims to test the degree of sleep deprivation in Year 12 students.

Most high school students do not get enough sleep and can be considered sleep deprived (Duval, 2010).

Sleep deprivation is a state caused by inadequate sleep and can lead to learning and concentration difficulties (Better Health Channel, 2014).

It is believed that teenagers need between nine and ten hours of sleep per night (Better Health Channel, 2014).

Year 12 students do not achieve this number of hours and accumulate a sleep debt by the end of the week (Australian Centre for Education in Sleep, 2008).

Methodology

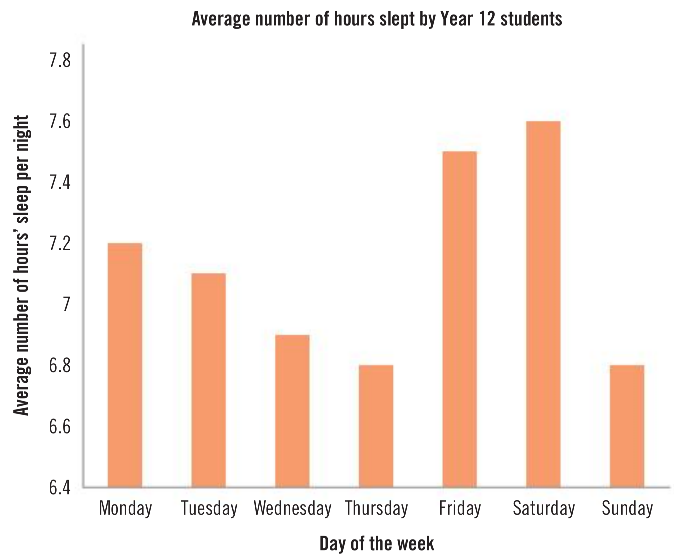
One hundred Year 12 students enrolled in VCE were asked to record the number of hours of sleep they had each night for 4 weeks. An average of the 4 weeks was calculated.

Participation was voluntary and anonymous.

The weekly sleep debt was calculated by comparing the average number of hours per night with the suggested amount of 10 hours.

Results

By the end of the week, the Year 12 students surveyed had accumulated a sleep debt of 20.1 hours.



Discussion

The results support the hypothesis that Year 12 students are sleep deprived. Even on the weekend, students were not able to achieve the required 10 hours. The reasons for this varied according to student commitments (for example, work or sport).

The degree of sleep debt was found to be double that of the estimated 10 hours.

Results support previous research findings from Duval (2010) and the Better Health Channel (2014).

Conclusion

Year 12 students are sleep deprived and are carrying a significant sleep debt.

References

Australian Centre for Education in Sleep. (2008). Sleep problems in adolescents. Retrieved from http://www.sleepeducation.net.au/adolescents.php.

Better Health Channel. (2014). Sleep deprivation. Retrieved from http://www.betterhealth.vic.gov.au/bhcv2/bhcarticles.nsf/pages/sleep_deprivation.

Duval, S. (2010). Most high school students are sleep deprived. Retrieved from http://www.cfah.org.hbns/2010/most-high-school-students -are-sleep-deprived.

Acknowledgements

Mrs Rose for assisting in accessing the sample.

Mr Humphrey for helping with the graph and maths calculations.

FIGURE 11.6 A poster on sleep deprivation

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EXPERIMENTAL RESEARCH: WHERE CAUSE MEETS EFFECT

The experimental method is the most widely used research method in psychology. The **experimental method** is a scientific research method that uses participants in a formal trial to confirm or reject a hypothesis. In an **experiment**, data is gathered under controlled conditions to test a hypothesis by exposing participants to a treatment and observing and measuring its effect to determine whether the treatment influences or causes a change in the aspect of their behaviour that is of interest.

Psychologists favour experiments because experiments allow them to control the conditions experienced by participants. Under controlled conditions, psychologists can better determine the effects of a treatment – in other words, identify cause-and-effect relationships between variables. For example, in a controlled experiment investigating the effects of caffeine on sleep, researchers can manipulate the strength and amount of coffee that participants consume. Researchers can then test sleep quality in a sleep laboratory that enables them to control variables such as noise and light, so that these do not affect the results. The data from such an experiment give us clear information about cause-and-effect relationships between caffeine and sleep. A researcher may then propose a model to explain how stimulants affect sleep patterns. Models are used to summarise or explain research and what the research may mean. While a model may be based on research, it is merely a theory about a relationship, which may need to be modified as new research is completed.

EXPERIMENTAL VARIABLES: IVs AND DVs

Scientific experiments predict the relationship between variables. A variable is any event or characteristic that changes (varies) or can be made to change and that might affect an experiment's outcome. Variables can be external factors that differ among different people, such as the amount of caffeine drunk in a day or amount of exercise engaged in over a week. Yet individual factors, such as gender, ethnic background, height and blood type, are also classified as variables for the purpose of psychological research.

When psychologists conduct research, they are often interested in observing and measuring abstract concepts that cannot be seen, such as aggression or intelligence. In order to do this scientifically, they must operationalise the concept, which means to make it physically measureable or testable. Therefore, when we identify an **operational variable**, we are defining or describing exactly what that variable is and exactly how it will be measured. For example, when investigating intelligence we might measure the variable of intelligence by the number of puzzles solved in an hour. We have therefore operationalised the variable by defining exactly how it will be measured.

Independent variables and dependent variables are types of variables that are important in research. An **independent variable (IV)** is a condition that an experimenter systematically *manipulates* (changes or varies) in order to gauge its effect on another variable. An IV is the suspected cause of differences in behaviour or results between an experimental and control group. The IV is said to cause a change in another chosen variable (the dependent variable).

A **dependent variable (DV)** is the condition in an experiment, or aspect of the participant's behaviour, that is affected by changes in the IV. It is the variable that the researcher *measures*. The DV is used as a measure of the IV's effect – it reveals the effects that exposure to the IV has had on behaviour. Such effects are often revealed by measures of performance, such as test scores. DVs 'depend' on the effects of another variable – the IV – as to how much they change and the way in which they change. For example, a researcher examining the effects of a new treatment therapy for schizophrenia might divide a sample into two groups. The experimental group would be given the new treatment (IV), while the control group would receive no treatment or the original treatment, then the effects of the new treatment would be measured (DV).

To demonstrate the difference between an IV and a DV, imagine you were a researcher involved in testing the effectiveness of a new memory drug. You ask participants to learn a list of nonsense syllables (such

experimental method A scientific research method that uses participants in a formal trial to confirm (or not confirm) a hypothesis

experiment A research method that involves gathering data under controlled conditions to test a hypothesis by exposing participants to a treatment and observing and measuring its effect

operational variable A variable defined or described in terms of the procedures used to observe and measure it

independent variable (IV) The variable that an experimenter systematically manipulates (changes or varies) to gauge its effect on another variable (the dependent variable)

dependent variable (DV) The variable that an experimenter measures (after exposure to the IV) as BIX, CFI and WOL) and then test their retention of the words by asking them to write down as many of them as they can recall. The two variables in the experiment would be the new drug and the retention of the nonsense syllables – but which is the IV and which is the DV? The IV is the variable manipulated by the experimenter, so, because the experimenter is manipulating the amount of drug given to the participants, the IV is the memory drug. The DV is the variable that is measured, so, if the results are the number of words remembered, then the DV must be the number of words remembered.

THE RESEARCH HYPOTHESIS

When researchers set up an experiment, they must state a prediction about the relationship between the variables. This prediction about the results is known as an experimental hypothesis. An experimental hypothesis is usually a broad and general prediction about the direction of the relationship between variables in an experiment. 'Direction' refers to whether the variables increase or decrease in relation to one another. For example, you might predict that consumption of alcohol will decrease driving ability. This is obviously a very general statement: it does not tell us what levels of alcohol or what type of alcohol are being referred to, or how 'driving ability' might be being measured.

A research hypothesis (also known as an operational hypothesis) must achieve more than an experimental hypothesis (see Figure 11.7). A research hypothesis clearly identifies the variables and states what operations (procedures or manipulations) will be used to observe and measure the variables.

Because the research hypothesis provides a testable prediction of the outcome, it must also predict the relationship between variables. Therefore, it must state the effect the IV is expected to have on the behaviour of the population from which the sample has been selected. A population is the larger group of research interest from which a sample has been drawn, and a sample is the group of participants selected from, and representative of, a population of research interest (see Figure 11.8). An example of a research hypothesis that operationalises the IV and DV would be: It is predicted that adults from Melbourne who sleep fewer than 6 hours a night will be more likely to score high (more than 8) on Koerner's irritability scale than will adults who sleep more than 6 hours a night.

SHUTTERSTOCK.COM/NATA-LIA

FIGURE 11.8 A sample (in this case, the orange juice in the glass on the left) is a representative subset of the population of research interest (in this case, the juice in the jug).

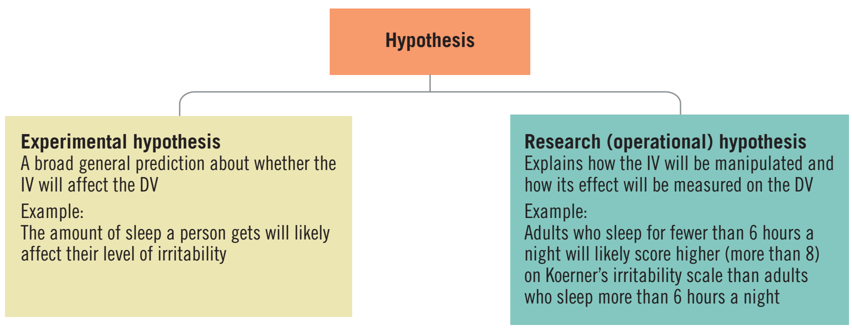

FIGURE 11.7 Basic differences between an experimental hypothesis and a research (operational) hypothesis

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In psychology, there is rarely a 100 per cent chance of something happening. There may be a 99 per cent chance that one variable is affecting another variable, but we do not know for sure. Therefore, when writing hypotheses, psychologists usually avoid using absolutes such as 'never', 'always' or 'will have'. Instead, they use terms such as 'more likely' or 'less likely'.

11.1 TRY IT YOURSELF >>

OPERATIONALISING VARIABLES

To operationalise a variable, follow these steps:

1. Identify the concept that you want to measure, for example intelligence or memory.
2. Determine one or more quantitative measures of this concept; for example, intelligence can be measured by the score on an IQ test, and memory can be measured by the ability to remember words in a list.
3. Determine the method for obtaining this measure; for example, the specific paper-and-pencil instrument used to produce an IQ score (such as the Stanford-Binet) and the methods for administering it properly and producing the numerical IQ score from the results, or the number of words a subject remembers after seeing a list of 20 words for 10 seconds.

QUESTION

1. Using the steps described above operationalise the following italicised variables and indicate whether each variable is an IV or a DV.
   a. Younger people have *better memories* than older people.
   b. Playing violent video games makes children *more aggressive*.
   c. Students who get *more sleep* are more engaged with their schoolwork than those who do not.
   d. Students who *read their textbook more often* achieve better marks on exams.

11.2 CHECK YOUR UNDERSTANDING >>

1. To test a possible cause-and-effect relationship, a simple psychological experiment creates two groups: the __________ group and the __________ group.
   A experimental; control
   B control; operational
   C independent; dependent
   D dependent; independent
2. Which of the following statements about psychological experiments is incorrect?
   A The control group is exposed to the IV.
   B The control group is used as a standard against which the performance of the experimental group is compared.
   C The experimental group is exposed to the IV.
   D The experimental group's performance is measured against the standard set by the control group.
3. The factor that is being manipulated in an experiment is called the:
   A hypothesis
   B control group
   C dependent variable
   D independent variable
4. In the following examples of research, identify the IV and the DV, and then write a research hypothesis.
   a. The effect of alcohol consumption on speed of reflexes
   b. The effect on male aggression caused by taking steroids
   c. Recording a car's mileage level when using premium grade petrol, then recording it again using standard grade petrol
5. Using an example, explain the difference between an experimental group and a control group.
6. List the main headings for a scientific poster.

EXTRANEOUS AND CONFOUNDING VARIABLES

An **extraneous variable** is a variable other than the IV that might cause unwanted changes in the DV. Extraneous variables compromise a study because, when analysing the results, they make it difficult to determine whether any change in the DV was caused solely by the IV and no other factor. Extraneous variables can be classified as neutral, controlled or confounding. If they are neutral, they have no effect on the experiment.

They are controlled if the experimenter has anticipated that they will be a problem and then ensured that they are eliminated before the experiment begins. When this elimination occurs, the extraneous variable is described as a **controlled variable**.

For example, if you conducted research on the effect of coffee consumption on performance of learning tasks, your IV would be the amount of coffee drunk and your DV would be the score or performance level on a learning task, such as recall of a list of numbers. In this experiment an extraneous variable might be

experimental hypothesis A broad and general prediction about the direction of the relationship between variables in an experiment; i.e. whether the variables increase or decrease in relation to one another

research (or operational) hypothesis A hypothesis that operationalises the variables by precisely defining and describing how each variable is measured, and predicts the exact effect the IV is expected to have on the DV

population The larger group of research interest from which a sample in a research study has been drawn

sample The group of participants in a research study selected from, and representative of, a population of research interest

extraneous variable In an experiment, a variable other than the IV that might cause unwanted changes in the DV

controlled variable An extraneous variable whose influence has been eliminated from an experiment so that it cannot affect results; it has been controlled

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alcohol consumed by the participants, since this too might affect performance on the learning task. If you wanted to control or eliminate this variable, you might only choose participants for your sample who did not drink alcohol at all, or monitor participants for an amount of time leading up to the experiment to make sure they did not consume alcohol in that time.

Extraneous variables may be present without the researcher knowing, and they may not be identified until after the experiment is complete (if they are identified at all). These uncontrolled variables are important because they can confuse the interpretation of results. This means that our assumption that the manipulation of the variable X (the IV) has or has not affected variable Y (the DV) may be inaccurate.

When an extraneous variable actually succeeds in confusing the results, it becomes a confounding variable. Confounding variables actually change the cause-and-effect relationship between the IV and the DV. When researchers plan their experiment, it is crucial that any potentially confounding variables that might be associated with the experiment are identified and controlled, so that they become controlled extraneous variables (which do not have a chance to affect results) rather than confounding variables (which do end up affecting results). Focus on research 11.1 demonstrates why.

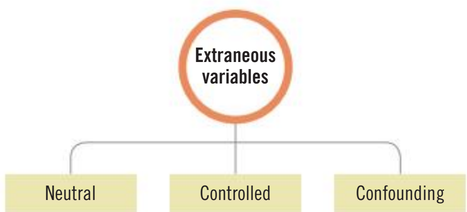

FIGURE 11.9 Extraneous variables can be either neutral, controlled or confounding.

FOCUS ON RESEARCH 11.1

EXPERIMENTAL COLA

There has always been intense rivalry between the brands Pepsi and Coca-Cola. Consequently, executives at Pepsi conducted a taste test to determine whether Coca-Cola drinkers preferred the taste of Coca-Cola or Pepsi. Regular Coca-Cola drinkers were asked to taste two samples of cola – one being Pepsi, the other Coca-Cola – and to identify which one they preferred (Sdorow, 1993).

In order to hide the identity of each of the colas, Pepsi was in a cup labelled 'M' and Coca-Cola was in a cup labelled 'Q'. The results indicated that the majority of participants preferred the cola labelled 'M': Pepsi. Pepsi was then advertised as the cola Coca-Cola drinkers prefer (Sdorow, 1993).

Coca-Cola executives decided to repeat the taste test to see if it yielded the same results. This time they filled both cups ('M' and 'Q') with Coca-Cola. Results indicated that most participants still preferred the cola in the cup labelled 'M', even though the same cola was in each cup! They concluded that the Pepsi experiment did not demonstrate that Coca-Cola drinkers prefer Pepsi to Coca-Cola, but instead that Coca-Cola drinkers prefer the letter 'M' to the letter 'Q'. The effect of the letters on the cups (being an extraneous variable) had been confounded with the type of cola (the IV). The IV did not cause the change in the DV, which was the participants' preference for Pepsi (Sdorow, 1993).

QUESTION

1 How might researchers test whether participants prefer Pepsi or Coca-Cola without the study results being affected by extraneous variables? Design an experiment to reduce or eliminate any extraneous variables.

POTENTIAL CONFOUNDING VARIABLES

We will now take a look at some reasons why confounding variables occur.

Non-standardised instructions and procedures

Test standardisation involves two things. First, it means that when a test is given to a number of participants, often at different times and in different places, standard procedures are used so that the testing will be consistent. The instructions, answer forms, amount of time in which participants must respond, the way tests are scored and so forth are the same for all participants in standardised tests. By standardising instructions and procedures, researchers have a greater chance of ensuring that the study's results are valid and reliable. Non-standardised tests may result in scores or responses that misrepresent participants' true characteristics.

Second, standardisation involves finding the norm, or average score, made by a large group of people such as those for whom the test was designed. Without standardisation, we couldn't fairly compare the scores of people taking the test at different times. And without norms, there would be no way to tell if a score is high, low or average. For example, without norms, a score on an intelligence test would be a meaningless number. Norms are established by giving the test to samples of hundreds or thousands of people who

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are representative of the people for whom the test is designed. If a test is to be used in Victoria, for example, samples might include representative proportions of gender groups, age groups, and city and country dwellers across the state. A standardised test is typically appropriate for specific groups and specific purposes. They have norms that can be described in terms of numbers that represent arithmetical averages (means) and distribution.

The use of non-standardised instructions and procedures would remove the systematic basis for making inferences about people. Unless a test is reliable and valid, it cannot measure behaviour accurately, and unless it has been standardised, there is no way to determine the meaning of an individual's score. Therefore, reliability and validity are important criteria for judging a test's value, and standardisation is essential in judging its utility.

Individual participant differences

Some extraneous variables that can influence the DV occur as a result of individual differences in the personal characteristics of participants. Collectively, these are known as participant variables. Participant variables include individual characteristics such as memory, motivation, mood, age, gender, prior experience, personality, expectations, ethnicity, religion and physical ability.

All participant variables have the potential to confound the results of an experiment; therefore, it is important that the researcher controls them. One way of achieving this is to ensure that all participants are as similar as possible in terms of the personal characteristics that are relevant to the experiment when they are selected for the sample and when they are allocated to either the experimental or control groups. Thus, the researcher must choose their research design carefully (see pages 345–6).

Order effect

Another possible extraneous variable can come in the form of the order effect (also known as the practice effect). Order effects may be experienced when the experimental group and the control group are made up of the same participants – that is, the one group experiences two (or more) different conditions or tests. The order effect occurs when prior knowledge of a task or situation influences a participant's performance and therefore influences the results of the experiment. That is, when a participant learns from one condition or test, this knowledge influences (positively or negatively) their performance on the next condition or test. Order effects can result in improved performance on a second test because of the extra practice; alternatively, a participant's performance might be impaired in the second condition because of boredom or fatigue due to previous experience with the same task.

Increasing the time period between completing the first and second conditions helps to overcome the effects of boredom, fatigue or practice when using the same participants for both conditions. For example, participants may be in the control condition one week, then in the experimental condition a week later. If this method of minimising order effect is inappropriate or impossible, the researcher can then counterbalance the conditions.

Counterbalancing alters the order that participants experience each condition. In the first test condition, half the participants are exposed to the control condition and the other half are exposed to the experimental condition. In the second test condition, this is reversed: those who experienced the experimental condition first now experience the control condition, and those who experienced the control condition first now experience the experimental condition. Counterbalancing helps to balance order effects over the experiment so that each effect occurs equally in both conditions.

Experimenter effect

Extraneous variables may also include differences in how the experimenter treats the participants. The experimenter effect refers to changes in participants'

uncontrolled variable An extraneous variable whose influence has not been eliminated from an experiment because the experimenter was not aware of it

confounding variable An uncontrolled variable that has had an unwanted effect on the DV and might be confused with the effect of the IV

standardisation Establishing standards for administering a test and interpreting scores

participant variables Individual differences in the personal characteristics of research participants that, if not controlled, can confound the results of the experiment

order effect Where prior knowledge of a task or situation influences a participant's performance, which in turn influences the results of the experiment; also known as the practice effect

counterbalancing A method used to control order effect, where half the participants in an experiment are exposed to the control condition first and the other half are exposed to the experimental condition first; this is then reversed in the second instance

experimenter effect Changes in participants' behaviour that are caused by the unintended influence of the experimenter rather than the IV

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behaviour that are caused by the unintentional influence of the experimenter rather than the IV itself. This is a common problem in psychological research: in essence, experimenters run the risk of finding what they expect to find.

The experimenter effect also applies outside the laboratory. Psychologist Robert Rosenthal (1973) reported an example of how expectations can influence people. He randomly assigned 100 Foundation (Prep) students of equal ability to five different maths classes. The children's teachers did not know about this random placement. Instead, each teacher was told that his or her students had unusually high or low ability. Students in the 'high ability' classes improved much more in their maths scores than those in the 'low ability' classes, even though all the classes had students of equal ability.

In this case the teachers apparently communicated their expectations subtly to students – the teachers expected the 'low ability' students to do poorly and the 'high ability' students to do well. Most likely they communicated these expectations through tone of voice and body language, or by giving different levels of encouragement or criticism. Their 'hints' created self-fulfilling prophecies that affected their students. **Self-fulfilling prophecy** refers to a prediction that prompts people to act in ways that make the prediction come true. In short, people sometimes become what we expect of them (Jussim & Eccles, 1992; Madon, Jussim, & Eccles, 1997).

A double-blind procedure can be used to counteract the experimenter effect. A **double-blind procedure** involves neither the experimenter nor the participants knowing which experimental condition the participants have been allocated to. In other words, they are not informed of, or are 'blind' to, which participants are experiencing which conditions and this prevents experimenters from unconsciously influencing participant behaviour. Typically in these experiments someone other than the experimenter controls the IV and interacts with the participants. In this way, it is possible for the experimenter not to know which participants were exposed to the IV until after testing, therefore eliminating experimenter influence on the results.

Placebo effect

Imagine that an experiment is conducted to see whether a particular stimulant affects learning. Before they are due to start studying, members of the experimental group take an amphetamine pill, while members of the control group take nothing. How much each participant learnt will be assessed later. Does this experiment seem valid? The study is actually seriously flawed, and as such it could not be said that any differences in the amount learnt will have been caused by the drug.

The amount of drug (that is, a quantity or no quantity) was not the only difference between the groups – the added difference was the fact that experimental group participants swallowed a pill, and control group participants did not. It might be that those who swallow the pill expect to do better, and this alone might affect their performance, even if the pill does not. So, without both groups having swallowed a pill in this experiment, it is impossible to tell whether the drug alone has affected learning.

But if we don't want to actually give the drug to both groups, how can we ensure conditions for both groups are the same? In this case we would use a placebo. A **placebo** is a fake treatment that has no active effect. Inert substances such as sugar in pill-form and salt water (saline) by injection are common placebos. So, in the example described above, both groups would swallow a pill but the control group would be given a placebo while the experimental group would be given the drug.

In turn, the **placebo effect** refers to changes in behaviour caused by the belief that one has been exposed to a treatment that will affect them in some way. This effect can be very powerful. For instance, it has been found that a saline injection is 70 per cent as effective as morphine in reducing pain. This is why doctors sometimes prescribe placebos – especially for complaints that seem to have no physical basis. Placebos have been shown to have an effect on pain, anxiety, depression, alertness, tension, sexual arousal, cravings for alcohol and many other processes (Kirsch & Lynn, 1999).

Placebos work by altering people's expectations about their own emotional and physical reactions (see Figure 11.10). These expectancies in turn influence bodily activities. For example, placebos that relieve pain do so by causing the pituitary gland to release endorphins. These powerful chemicals are similar to painkilling opiate drugs such as morphine (Ter Riet, de Craen, de Boer, & Kessels, 1998). Thus, if a placebo has any effect on participants' behaviour, the effect must be due to participant expectations rather than to the effect of an active chemical.

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"He was unhappy to learn that I had prescribed a placebo but when I told him it was an extra-strength placebo, he was pleased."

CARTOONSTOCK/RON MORGAN

FIGURE 11.10 Sugar pills are often used as placebos, and work by altering a person's expectations about their own emotional and physical reaction to the pill

To control the placebo effect, researchers often use a single-blind procedure, which is a procedure designed so that participants do not know if they are receiving a real drug or a placebo. In such experiments, all participants receive a treatment (for example, a pill or injection). People in the experimental group are given an active treatment that can affect them in some way, while those in the control group are given a placebo. Because participants are 'blind' as to whether they received the active treatment, expectations regarding the treatment do not differ across the groups. Any difference in behaviour between the groups is most likely caused by the active treatment. Note that while participants do not know which group they belong to, the experimenter does – this is how a single-blind procedure differs from a double-blind procedure.

11.3 CHECK YOUR UNDERSTANDING >>

1 Which of the following variables are not important in an experiment?
   A Extraneous and controlled variables
   B Confounding and controlled variables
   C Confounding and irrelevant variables
   D Irrelevant and neutral variables
2 Which of the following statements about variables is correct?
   A Extraneous variables are the variables manipulated by the researcher.
   B The independent variable can cause a difference in the dependent variable.
   C The dependent variable can cause a difference in the independent variable.
   D A confounding variable is always controlled by the researcher.
3 If participants make up both the experimental and control groups, they may perform better in the second condition because of their prior learning, or they may perform worse because of boredom or fatigue. This unwanted effect can be overcome by:
   A the order effect.
   B counterbalancing.
   C the confounding variable.
   D standardising instructions and procedures.
4 Using an example, explain how participant differences can affect an experiment.
5 State two possible extraneous variables that would need to be controlled before an experiment to test whether red lollies tasted sweeter than blue lollies.

EXPERIMENTAL RESEARCH DESIGNS: MINIMISING UNWANTED VARIABLES

The best way to control or eliminate unwanted variables is to ensure that groups of participants are as similar as possible in characteristics believed to be relevant to, or that might otherwise influence, the experiment. This is achieved by carefully selecting the experimental research design and by controlling the way participants are allocated to groups in the experiment. Each of these designs has advantages and limitations, and each is discussed below. Figure 11.11 shows the characteristics of each design.

Independent-groups design

The independent-groups design (also known as between-groups design) randomly allocates participants to either an experimental group or control group. The independent-groups design is the experimental design used most frequently in psychological research.

self-fulfilling prophecy A prediction that prompts people to act in a way that makes the prediction come true

double-blind procedure An experimental procedure where neither the experimenter nor the participants know which experimental condition the participants have been allocated to

placebo A fake treatment that has no active effect, such as a fake pill or injection

placebo effect Changes in behaviour caused by the participant's belief that they have been exposed to a treatment that will affect them in some way

single-blind procedure An experimental procedure where participants do not know which experimental condition they have been assigned to, but the experimenter does

independent-groups design An experimental design where participants are randomly allocated to either the experimental group or control group

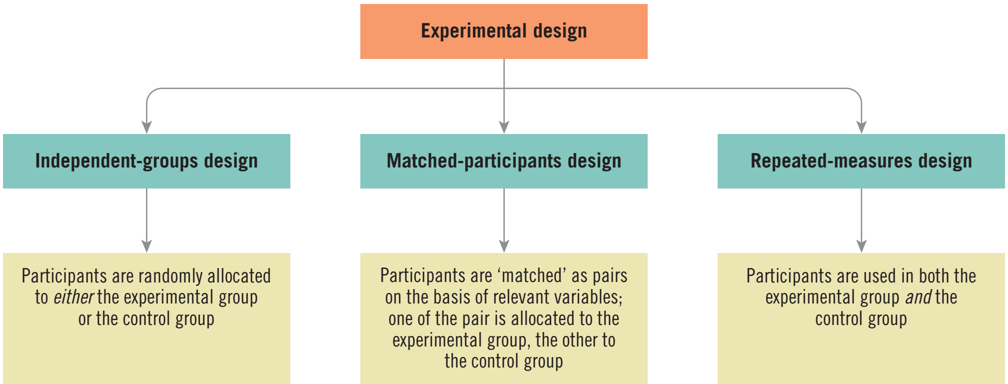

FIGURE 11.11 A summary of the characteristics of the three different experimental designs

The main goal of the independent-groups design is to ensure that each member of the sample has an equal chance of being selected for the control group as for the experimental group. This ensures that the two groups are well matched on important personality characteristics and are thus reasonably similar. A limitation of this design is that groups of equal size are difficult to achieve with a small sample. One way of overcoming this problem is to increase the number of participants in each condition. An advantage of the independent-groups design is that there are no order effects to control, and the independent-groups design is relatively quick and easy to complete, which makes it cost effective.

Matched-participants design

A **matched-participants design** matches (in pairs) participants on the basis of particular characteristics that can influence the DV, with one of the pair being randomly allocated to the experimental group and the other to the control group. Randomly allocating paired individuals ensures that groups are as similar as possible in terms of the individual characteristics (for example, age, intelligence, gender) that are of research interest. For example, a researcher may wish to study memory ability in primary-age children. The researcher could create two groups that have been pre-tested for intelligence because it has been determined that intelligence will influence memory ability. The experimental and control groups would then have equal numbers of children with high, medium and low intelligence.

While in a matched-participants design the experimental and control groups are usually very similar in terms of important personality characteristics, researchers are unable to perfectly match all participant characteristics. It is therefore likely that other, unconsidered personality characteristics may affect the DV in a matched-participants design. Another limitation of this design is that the process of selecting participants, matching them in pairs and then randomly assigning individuals from each pair to each group is quite time-consuming and therefore more expensive.

Repeated-measures design

A researcher may choose a **repeated-measures design** (also known as a within-groups design) where the same group of participants are exposed to both the experimental and control conditions. This removes differences in personal characteristics between the experimental and control groups. In addition, fewer participants are required for the study. For example, a researcher may wish to test a relaxation technique on stressed teachers. The first week, teachers were asked to rate their stress levels on the Friday. Then the researcher teaches the relaxation technique. Teachers are asked to use the technique during the second week, then rate their stress levels on the Friday. Each participating teacher is used for two weeks: one week in the control condition (no relaxation technique) and one week in the experimental condition (with a relaxation technique).

Because the same participants are used for both groups, does this mean a repeated-measures design is problem-free? Not necessarily. One limitation of the repeated-measures design that needs to be controlled is the order effect (see page 343). However, counterbalancing cancels out the order effect because participants are equally exposed to control and experimental conditions.

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11.4 CHECK YOUR UNDERSTANDING >>

1 Which of the following statements is correct?
   A In a matched-participants design, the same group of participants make up both the experimental and control groups.
   B In a repeated-measures design, participants are exposed to one condition first, after which they are exposed to a different condition.
   C An independent groups design is used to minimise the effect of differences in participants' personal characteristics.
   D A repeated measures design pairs participants on the basis of similar personal characteristics.
2 Which of the following statements is incorrect?
   A An independent-groups design does not result in the order effect.
   B A repeated-measures design can result in the order effect.
   C Counterbalancing offsets the order effect.
   D Random sampling offsets the order effect.
3 Which of the following research designs uses counterbalancing to control the effect of an unwanted variable?
   A A repeated-measures design
   B A matched-participants design
   C An independent-groups design
   D All of the above
4 When using an independent-groups research design, it is important to:
   A ensure that every member of the population has an equal chance of being selected for either the control or experimental group.
   B ensure that every member of the sample has an equal chance of being selected for either the control or experimental group.
   C control the unwanted effect of extraneous variables associated with the experimenter.
   D control the unwanted effect of extraneous variables associated with the participants.
5 List two advantages and two disadvantages of the independent groups research design.
6 Provide one example of an experiment where you would use a matched-participants design.
7 List two disadvantages of the matched-participants design.

SAMPLING PROCEDURES: CHOOSING PARTICIPANTS

The process of choosing participants is called participant selection, or sampling. As previously mentioned, research participants are collectively called 'a sample', which is a subset of the population from which it is drawn. Ultimately, psychologists are interested in entire populations, but it is often impossible to study an entire population because

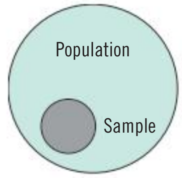

FIGURE 11.12 A sample is a subset of a population from which it is drawn.

they can be too large. By selecting a smaller sample, psychologists can draw conclusions relevant to the larger group without testing every person in it. However, samples should not be too small; the larger the sample taken from a population, the more representative of that population it is likely to be.

It is important that psychologists undertake proper sampling procedures so that results can be generalised to wider populations. If a sample is not representative, generalisations cannot be made.

Random sampling

Random sampling employs a carefully planned and systematic method of selecting participants for a study. Random sampling ensures that every member of a population has an equal chance of being selected for the sample. Further, the selection of one participant does not affect the chances of another participant being selected. Random sampling is used when the researcher needs the sample to be representative of the population. If researchers want to generalise the conclusions of their study to the wider population, the results must be representative and unbiased.

Two examples of random sampling techniques are:

- putting the names of each member of the population of interest into a container and then pulling out a set number of participants for the sample
- generating a list of numbers (for example, student identification numbers) that are in no specific order and then choosing every 5th, 10th or 100th number (and hence participant) to be part of the sample.

matched-participants design An experimental design where participants are paired (matched) on the basis of similar characteristics that can influence the DV, with one of the pair being allocated to the experimental group and the other to the control group

repeated-measures design An experimental design method where the same group of participants makes up both the experimental and control groups

random sampling A sampling technique ensuring that every member of the population of interest has an equal chance of being selected for the sample being used in a study

Random sampling is suited to research involving a population that is homogenous (where members of the population are similar). It ensures that every member of the population has a chance of being selected; therefore, it increases the likelihood of the sample being representative of the population. Random sampling also improves the chances of making accurate inferences about the population based on the results gained from the sample because it involves a statistically supported probability.

Random sampling does have limitations. Sometimes people are unwilling to participate in experiments, new therapies or research, so the sample becomes biased rather than representative. Furthermore, in some research a sample is sometimes difficult to obtain for a particular population because the members of the population are not available to participate in the research. Random sampling may not always be possible because researchers may not be able to acquire a name list of the population if the population is very large. For example, if a researcher was studying sleeping habits of Australians over 60 years of age, it would be difficult to acquire a list of all people in this age group. The researcher would not be able to generalise from the experiment to all Australians over 60 years.

Stratified sampling

Stratified sampling is used in research that requires the sample to contain the same proportions of participants that are found in the population. Stratified sampling involves dividing the population into distinct subsets (or strata) that share at least one common characteristic of research interest, then randomly selecting a separate sample from each group (or stratum) in the same proportion as occurs in the larger population.

Imagine that you want to investigate Australians' favourite foods in order to predict someone's favourite food based on characteristics such as age, ethnic background and religion. Say you predict that ethnic background is the characteristic likely to have the biggest impact on your research results. You establish that ethnic background in the target population is broken up as follows: 53 per cent Anglo-Saxon, 21 per cent Italian, 10 per cent Greek, 5 per cent Asian, 5 per cent Russian, 4 per cent Middle Eastern and 2 per cent African. You divide your population into these ethnic categories (strata). Your sample needs to contain 100 participants, so from the Anglo-Saxon ethnic group you randomly select 53 participants, then randomly select 21 participants from the Italian group, 10 from the Greek group, 5 from the Asian group and so on. Your sample now contains the same proportions of participants from different ethnic backgrounds as there are in the target population. You have created a stratified sample.

Stratified sampling is most commonly used when psychological characteristics or attitudes vary greatly among subgroups of the target population; therefore, it is most suited to populations that are dissimilar. Stratified sampling also reduces the possibility of sampling error and this, in turn, increases the precision of the results. The selection of a stratified sample does, however, require more time and effort than a random sample.

Imagine you were a researcher conducting a survey of attitudes of homeowners in suburbs surrounding a proposed new shopping centre. It would be reasonable to suppose that individual property values would affect the homeowners' responses. So the survey would use three strata from the population: those with houses in the bottom third of values, those with houses in the middle third of values and those with houses in the top third of values. Random samples would then be selected from each stratum.

Convenience sampling

Convenience sampling (also known as opportunity sampling) chooses participants because they are readily available to the researcher, so the sample may not actually be representative. For example, participants volunteer, or they are asked to participate because they are close by. In other words, they are convenient.

Convenience samples are used when researchers want an inexpensive approximation of the truth that will assist them to generate their hypothesis. They may also be working under time constraints or they may be unable to access the wider population. Before conducting the actual research experiment, researchers may conduct a pilot study using a convenience sample so they can identify any uncontrolled extraneous variables or weakness in method, and obtain a general estimate of the results.

If you answer a knock on your door and you agree to fill out a survey on the spot, you have become part of a convenience sample (see Figure 11.13). No random

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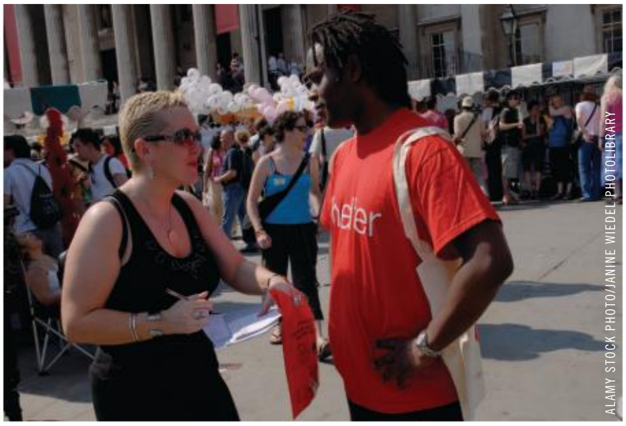

FIGURE 11.13 Convenience samples consist of participants who are available and no mechanism has been used to ensure that participants are representative of the population.

mechanism has been used to ensure that respondents are representative of the research population, because only people who were at home at that time of the day and who were willing to participate were used. The researcher still doesn't know the views of other residents in the area. Other examples of convenience sampling you may be familiar with include newspaper, magazine, radio and phone polls.

Results from research using a convenience sample can be legitimately used provided the limitations associated with the research are clearly understood and stated. Although this is a quick and inexpensive way for a researcher to select a sample, the sample may not be representative of the population; some groups may be overrepresented while others are underrepresented. If the sample includes volunteers, it may also be biased. For these reasons, results of a convenience sample cannot be generalised (we discuss generalisation of results on pages 358–9).

Try it yourself 11.2 contains a sampling activity.

11.2 TRY IT YOURSELF >>

SAMPLING

You will need:

- slips of paper
- a hat (or any container).

Each member of your class is a member of the population of research interest. Each person is to write their name on a slip of paper and to put it into the hat. The experimenter then pulls out 10 names from the hat. These names are the people in the sample.

QUESTIONS

1 What type of sampling is this?
2 Identify the advantages of this type of sampling.
3 Identify the disadvantages of this type of sampling.

ASSIGNING PARTICIPANTS TO GROUPS

Once participants have been selected, they need to be allocated to either the experimental group or the control group within the experiment. As with sampling, the allocation (or assignment) of participants must be done in a systematic and carefully planned manner. This is to ensure that possible extraneous variables associated with participants' individual characteristics are evenly distributed among the groups.

Experimental group and control group

A psychological experiment is usually constructed with two groups. The **experimental group** is the group (or groups) exposed to the independent variable (IV). The independent variable is the variable controlled by the researcher in order to gauge its effect on the dependent variable (DV). The dependent variable is the condition or the aspect of participant behaviour that is being measured. For example, psychologists interested in testing the effect of a new drug on sleeping habits would give the drug (IV – the variable being manipulated) to the experimental group to take. In turn, the DV would be the amount of hours of uninterrupted sleep obtained by participants; that is, the behaviour measured after manipulation of the IV.

The **control group** is the group that is exposed to the control condition; that is, where the IV under investigation is absent from the conditions experienced, but all other conditions are the same as those of the experimental group. The control group provides a standard that the performance of the experimental group can be compared with, in order to determine if the treatment (IV) has had an effect on behaviour (DV). For example, in the experiment into the effect of a new drug on sleep, the control group may be given a sugar pill, rather than the drug. All other conditions experienced by the control group and the experimental group would be the same. The amount of hours of uninterrupted sleep obtained by the control group would then be compared to those of the experimental group, to see if the drug taken by the experimental group has had any effect on sleep.

stratified sampling A sampling technique that ensures the sample contains the same proportions of participants that are found in the population

convenience sampling A sampling technique involving the selection of participants because they are readily available to the researcher

experimental group In a controlled experiment, the group of participants that are exposed to the independent variable

control group In a controlled experiment, the group of participants exposed to all conditions or variables except the independent variable

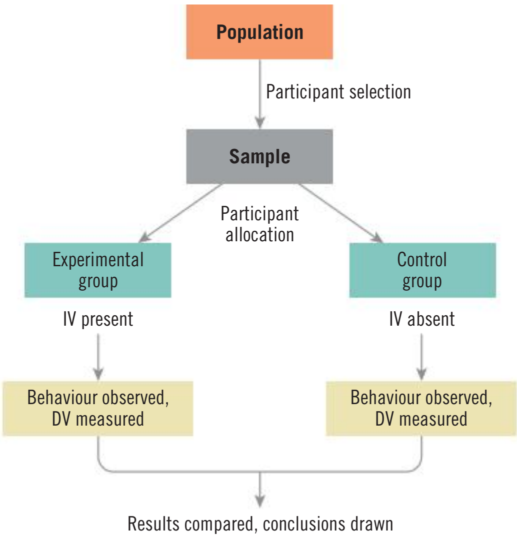

FIGURE 11.14 The control group is not exposed to the IV. The experimental group is exposed to the IV. Results from each group are then compared to determine the effect of the IV.

Suppose you notice that you seem to study better while you are listening to music. This might suggest the hypothesis that music improves learning. We might test this idea by forming an experimental group, where people study with music. Meanwhile, we would also form a control group, where people study without music. The sample from which we drew both groups might consist of Year 10 students of average intelligence and a B-average in their studies. We might then compare the two groups' scores on a test after they study under the different conditions. Without a control group it would be impossible to tell whether music had any effect on learning. The control group provides a point of reference against which to compare the experimental group's scores. Figure 11.14 shows that the difference between the control and experimental group is exposure to the independent variable.

Sometimes there is no control group in an experiment, but instead there are two or more experimental groups that are differentiated by two or more levels of the IV. For example, a study may investigate the sleep patterns of people with high and low anxiety. The two experimental groups in this case are people with high anxiety and people with low anxiety.

Additionally, sometimes the same group is exposed to the experimental condition and the control condition at different times. This means that only one group is used twice. In this experimental set-up we do not say there is a control group and an experimental group; instead, we say there is a control condition and experimental condition experienced by the same group of people at different times.

Random allocation

Random allocation is the most common method of assigning participants to experimental and control groups. Random allocation is an experimental procedure in which each participant in the sample has an equal chance of being assigned to the experimental group (and, therefore, exposure to the IV) or the control group (and, therefore, not exposed to the IV).

The main aim of random allocation is to ensure that participants in the experimental group are as similar as possible to participants in the control group, in terms of personal characteristics of interest. Thus, if the two groups think, behave or feel differently from each other at the end of the experiment, then the difference is more likely to have something to do with the treatment the experimental group has been exposed to – the IV – rather than any pre-existing difference.

Random allocation can be as simple as flipping a coin to determine which group each participant is allocated to. Other methods employed to ensure random allocation include (as for random sampling) pulling names out of a container or randomly selecting numbers (such as student-identification numbers) from a generated list.

11.5 CHECK YOUR UNDERSTANDING >>

1 Match each term with its definition.

a Convenience sample
b Random sample
c Stratified sample
d Random-stratified sample

i A form of stratified sampling involving random samples of each stratum being selected for the sample
ii Participants that are easily accessible to the researcher and usually volunteer
iii Gives everyone in the population the same chance of being selected for the sample
iv Contains the same proportion of participants as exists in the population

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2 Which of the following statements is correct?
  A Random sampling ensures that every member of the population has an equal chance of being selected for an experiment.
  B Stratified sampling chooses participants because they are readily available to the researcher.
  C Convenience sampling is time-consuming and expensive.
  D A random sample represents subgroups according to the proportions in which they exist in the population.
3 Random allocation:
  A occurs before random sampling.
  B occurs after random sampling.
  C involves selecting groups in the proportion they exist in the population.
  D provides the most representative sample.
4 Convenience sampling is the same as:
  A opportunity sampling.
  B random allocation.
  C random sampling.
  D stratified sampling.
5 Using an example, explain the difference between an experimental and a control group.
6 Using an example, explain the difference between a sample and a population.

DATA-COLLECTION TECHNIQUES

When a researcher conducts an investigation, they generate data – information gained from direct observation and measurement. Data are used as evidence to support research findings or to formulate predictions about future studies. The type of data collection selected for a study is determined by what is being investigated. For example, researchers may use a questionnaire when studying attitudes, they may use observation when gathering information about social behaviour, and they may use a brain recording or imaging technique for studying brain function.

TYPES OF DATA: QUALITATIVE AND QUANTITATIVE

Qualitative data are data that are descriptive and they can be written or verbal comments that often describe personal feelings and attitudes. As qualitative data are often based on personal accounts, they are open to personal, observer or researcher biases, making them difficult to statistically analyse. Examples of qualitative data include participants' descriptions of their childhood, or how they feel about using a particular brand of shampoo.

Quantitative data are data collected through systematic and controlled procedures. These data are in numerical form and can be statistically analysed. An example of quantitative data is the number of words recalled correctly from a list, or the score obtained on an intelligence test.

Aside from the experimental method (discussed in detail earlier in this chapter), there are several other techniques for collecting both qualitative and quantitative data. We will examine these now.

CASE STUDIES

A case study is an in-depth, detailed study of an aspect or several aspects of a single participant, group or event, usually undertaken to gain insight into a particular psychological phenomenon (for example, creative genius). Case studies are a non-experimental form of data collection that may arise when accidents or other natural events provide the opportunity for research. Case studies of individuals who have experienced gunshot wounds to the head, brain tumours, accidental poisonings and other adversities resulting in brain damage have provided much information about the structure and function of the human brain. Case studies can also take the form of clinical tests, interviews or observational studies – or a combination of these. When conducting a case study, the researcher records as much relevant information as possible about a variety of factors, such as the person's thoughts, feelings, life experiences, relationships and behaviours. (Much of this is therefore qualitative data.)

Many experiments that might be revealing are impractical, unethical or impossible to perform. Case studies, however, allow researchers to gather information about a variety of psychological phenomena that cannot be obtained by any other means (Edwards, 1998). For example, if a psychologist wanted to research the origins of language development in infants, it would be

random allocation A procedure for assigning participants to either the experimental group or control group in an experiment, ensuring that all participants have an equal chance of being allocated to either group

qualitative data Data that describe the changes in the quality of a behaviour; often accounts of personal attitudes or experiences, or descriptions of feelings

quantitative data Data collected through systematic and controlled procedures and presented in numerical form

case study An in-depth, detailed study of all aspects of a single participant, group or event, usually undertaken to gain insight into a particular psychological phenomenon

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unethical to deprive a group of infants of any exposure to language for 10 years in order to investigate the effect. However, case studies of individual children who have unfortunately been deprived of normal human contact for years after birth (because of mistreatment) do provide an insight into language development in children. Insights such as these allow psychologists to establish psychological principles of human behaviour.

One limitation of case studies is that they are uncontrolled studies. Case studies lack formal control groups, and this limits the conclusions that can be drawn from them. In psychological research, case studies usually involve atypical cases of behaviour, often as a result of brain damage. Individuals who suffer similar brain injuries may demonstrate very different reactions to the injury, so this is why psychologists prefer controlled experiments and often use laboratory animals for studies of the brain.

Case studies allow researchers to describe behaviour, but because behaviour is determined by a number of variables, a case study cannot determine what caused the behaviour. Therefore, case studies provide useful insights into human behaviour but their results cannot be generalised. Analysing and reporting on the amount of detailed information yielded by the case study method is also a very time-consuming – and subjective – process.

OBSERVATIONAL STUDIES

Observational studies involve one person watching and recording the behaviour of other persons or animals within a specific environment and drawing conclusions based on the recorded observations. When this non-experimental method of data collection is used, the behaviour of interest must be overt, or able to be observed by others. For example, we can observe someone building a sandcastle, but we cannot observe how they are feeling as they are building it. In psychology, observational studies can be applied to a range of settings such as watching chimpanzee societies in the jungle (see Figure 11.15), watching parent–child interactions in different cultures, or recording students' self-seating patterns in the cafeterias of multiracial schools.

Observational studies are an indirect means of gathering data and, similar to case studies, observational studies describe behaviour, but they do not explain behaviour.


ALAMY STOCK PHOTO/PAPILIO

FIGURE 11.15 Naturalistic observation allows psychologists to study natural behaviour such as a chimpanzee using a grass stem to obtain termites from inside a nest.

In observational studies, the accuracy of the data gathered may be influenced by whether or not the person(s) being observed know they are being observed. If observational studies are carried out in situations where participants are observed in their natural environment and do not know they are being observed, this is an effective way of reducing the extraneous variable of artificiality. (Artificiality is the unwanted effect on participant behaviour created by the unnatural environment – such as a laboratory setting – in which an experiment is conducted.) If, however, the observed person or animal is aware that their behaviour is being observed, they may alter their behaviour and thus bias the results. This is known as the observer effect. For example, if you were interested in the differences between aggressive and non-aggressive schoolchildren, you could not simply stroll onto a playground and start taking notes. As a stranger, your presence would probably change students' behaviour. So, when possible, observers must be as unobtrusive as possible.

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Observer bias is another limitation of observational studies. Observer bias occurs when the observer sees what they expect to see, or records only selected details; that is, the observer's expectations, past experience, motives or other personal factors interfere with the accuracy of their observations and recordings. This can be overcome by having more than one observer and combining their recordings.

SELF-REPORTS

In many situations, it is not possible to collect data about people's attitudes, beliefs and behaviours by observation only. For example, it would not be ethical to gather data about punishment methods employed by parents by observing them hitting their children. An alternative data collection method would be to ask people to report specific information about themselves.

In a self-report, individuals are simply asked to freely express their thoughts by answering questions (verbally or in writing) about a particular object, person, issue or experience. Self-reports are a form of subjective data because information given cannot be applied to other individuals.

Self-reports are a means of collecting both qualitative and quantitative data and questions involved may take a variety of formats: open-ended, fixed-response or indirect questions, or ratings on a multi-point scale such as a Likert scale.

Open-ended questions ask individuals to comment freely and without limitation on their attitude towards a particular issue such as: 'What are your thoughts about a mother breastfeeding her baby in a public place?' Open-ended questions often produce a large amount of descriptive data for analysis, which can give very specific, interesting and useful information about people's attitudes; but sifting through such a large amount of information can be time-consuming. Also, people are free to express themselves in any way they wish, and some people might find it difficult to explain their thoughts and feelings. It can be difficult to analyse and group this data and determine what people truly mean or which answers are the most significant.

Closed questions, however, do not involve large amounts of information, nor do they require the participant to search for appropriate words to express their thoughts. Closed questions restrict responses to a limited choice of answers. For example, if a person was asked, 'Do you believe teachers should be able to strike at any time for a pay rise?', participants may only have the response options of 'Yes', 'No' or 'Undecided'.

Although self-reports are a useful means of gathering data, they do have their limitations. Participants may misunderstand some questions or they may have a tendency to give socially acceptable answers rather than honest answers. Thus, it may be difficult to determine the accuracy of the data and the conclusions drawn from it.

Self-report questions can be asked and undertaken in the form of questionnaires or interviews.

Questionnaires

Self-report data can be gathered using a questionnaire (see Figure 11.16). A questionnaire is a written set of standardised questions that can be administered face to face, by mail, by telephone or via the Internet, and often takes the form of a survey. Questionnaire types can range from factual to opinion-based, or from tick-the-boxes to free-response answers.

Questionnaires allow participants to remain anonymous, so they are more likely to be honest in their responses. However, the validity of results relies on participants' honesty, and this cannot be controlled by the researcher. Another advantage is that responses are limited to a list of predetermined, standardised questions that cannot be varied from participant to participant. This may eliminate any extraneous variables that may be associated with non-standardised instructions or procedures. Also, because they can be administered by mail, telephone or the Internet, questionnaires are a relatively inexpensive way of gathering data when a large sample is required. They can also be administered to a large group simultaneously, which allows researchers to include a large geographical area in their study.

observational studies A method of data collection that involves watching and recording the behaviour of other persons or animals within a specific environment and drawing conclusions based on the recorded observations

observer effect Changes in the behaviour of a person being observed caused by their awareness of the presence of an observer

observer bias Bias in results of an observational study that occurs when an observer sees what they expect to see, or records only selected details of an observed behaviour

self-report A data-collection technique in which individuals are asked to freely express their attitudes (verbally or in writing) by answering questions

questionnaire A written set of standardised questions that can be administered face to face, by mail, by telephone or via the Internet

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FIGURE 11.16 Self-reports, in the form of a questionnaire, can provide both qualitative and quantitative data.

Questionnaires can provide both qualitative and quantitative data on attitudes, beliefs and behaviours; however, by their very nature, qualitative questions must often be more exact than quantitative questions. Qualitative questions assume that people will use words or understand language in the same way. This is not always the case, and there is the chance that some people may misunderstand some questions or that different people will interpret questions differently. Therefore, it is very important to avoid ambiguity in phrasing when constructing a questionnaire. Qualitative questions also require more thought and effort on the participant's behalf. They may become tired or bored, so responses may not be an accurate reflection of their attitudes.

Interviews

Interviews involve person-to-person questions and answers, in the form of face-to-face contact or voice-to-voice contact (phone interviews). In an unstructured interview, conversation between the interviewer and the person being interviewed is informal, and topics are taken up freely as they arise. In a structured interview, the interviewer obtains information by asking a planned series of questions and tries not to deviate from the plan. The data collected is qualitative.

In addition to providing information, interviews make it possible to observe a person's tone of voice, facial expression or body language – cues that can radically alter the interpretation of a message and cues that are absent from answers provided in written form. For example, a person may claim to be 'completely calm' while their body trembles. Interviews are also suited to gathering information from people who cannot write their responses because of a physical deficiency or poor literacy levels.

Interviews do have limitations as a data-collection method. Deviations from set questions can make it difficult to summarise, organise and analyse the results, and this puts the validity of the results in question. Also, interviewers can be swayed by their own preconceptions of the interviewee if they have stereotyped them. For example, if a person has been identified as 'a housewife', 'a heroin addict' or 'unemployed', they may be misjudged because of the interviewer's bias towards a particular lifestyle.

Additionally, participants cannot remain anonymous, and because responses are given in the presence of the interviewer (when in a face-to-face interview), interviewees may not answer honestly. Participants may try to deceive interviewers if they feel that their honest answer be regarded as socially unacceptable or incriminate them in some way. In addition, the interviewer's personality or behaviour may influence the interviewee's behaviour. When this occurs, it can accentuate or distort the person's apparent traits (Pollner, 1998).

Table 11.1 compares questionnaires and interviews as data-collection methods.

TABLE 11.1 Comparison of questionnaires and interviews as data-collection methods

	QUESTIONNAIRES	INTERVIEWS
Advantages	» Inexpensive in terms of time and money » Participants can remain anonymous and are likely to be honest in their responses » The format is standard for all participants and is not dependent on the mood of the interviewer » Information can be gathered from large samples, covering large geographic areas	» Participants do not need to be able to read or write » Data may be obtained on any subject as questions are not limited to predetermined questions » Questions can be clarified if participants are not sure of their meaning
Disadvantages	» Questions may be misunderstood	» Participants cannot remain anonymous so may give dishonest answers to make themselves appear more socially acceptable » Not practical for large samples

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11.6 CHECK YOUR UNDERSTANDING >>

1 Which of the following statements is incorrect?
   A A person studying elephant behaviour in the elephant's natural surroundings is an example of an observational study.
   B In observational studies, concealing the observer will limit the observer effect.
   C A tendency to give socially desirable answers can lower the accuracy of data gathered via interview.
   D Interviews produce only quantitative data.
2 Which of the following types of data is quantitative?
   A The average height of Year 11 students
   B Diary entries about the content of dreams
   C Fire victims' responses about the reaction times of CFA crews
   D Year 8 students' suggestions of foods that could be offered at their school cafeteria
3 An advantage of a questionnaire is that:
   A because participants remain anonymous, they are more likely to give honest answers.
   B the pre-determined questions don't vary between participants, so they eliminate extraneous variables associated with non-standardised procedures.
   C they don't have to be administered face to face, so they can be used simultaneously with large groups.
   D All of the above
4 Match each term with its definition.

a Qualitative data	i Information usually presented in numerical (statistical) form
b Quantitative data	ii A list of standardised questions about a participant's thoughts
c Questionnaire	iii Information obtained from direct observation and measurement
d Interview	iv When another person asks an individual to comment on their attitude to an issue
e Data	v Describes the changes in the quality of a behaviour; usually written in words

5 State one limitation of case studies.
6 State two limitations of an observational study.
7 State two advantages and two disadvantages of self-reports.

STATISTICS: ANALYSING AND INTERPRETING DATA

Researchers use two forms of statistics to help them analyse and interpret data: descriptive and inferential statistics.

Descriptive statistics are used to describe, summarise, organise and analyse data so that it can be more easily interpreted and explained to others. Examples of descriptive statistics include graphs, tables, measures of central tendency and frequency distributions. Descriptive statistics do not determine the meaningfulness of the results; that is, they do not determine whether or not the results support the research hypothesis.

Inferential statistics are used to interpret results so researchers can decide what the results mean. They allow researchers to determine the significance of the results. Researchers use inferential statistics to make inferences (draw conclusions) about whether the results support or do not support the research hypothesis and decide whether the conclusions can be generalised to the population of research interest.

MEASURES OF CENTRAL TENDENCY: MEAN, MEDIAN AND MODE

One form of descriptive statistics is the measure of central tendency – a number describing a 'typical score' around which other scores fall; that is, the tendency for a majority of scores to fall in the mid-range of possible values.

A familiar measure of central tendency is the mean, or 'average', but other measures of central tendency include the median and the mode. To illustrate each measure, we will use an example: Table 11.2 shows the raw data for an imaginary experiment into the effects of a potentially memory-enhancing drug (let's call the drug Rememberine). Group 1 was given the drug. Group 2 received a placebo. Both groups then undertook a test of memory and their scores were recorded.

In order to tell whether there is a difference in memory scores between the two groups, we need to calculate an average (mean) score for each group. As one type of 'average', the mean is calculated by adding all the scores for a given group, then dividing the total by the number of scores in the group.

interview A form of qualitative data collection where individuals are asked to comment on their attitude towards particular issues

descriptive statistics Statistics used to describe, summarise, organise and analyse data

measure of central tendency A measure of the tendency for a majority of scores to fall in the mid-range of possible values

mean A measure of central tendency found by adding up all the values and dividing the total by the number of values

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TABLE 11.2 Raw scores on a memory test for participants taking Rememberine or a placebo

PARTICIPANT NUMBER	GROUP 1 (REMEMBERINE)	GROUP 2 (PLACEBO)
1	65	54
2	67	60
3	73	63
4	65	33
5	58	56
6	55	60
7	70	60
8	69	31
9	60	62
10	68	61
Sum of participants	650	540
Mean	65	54
Median	66	60
Mode	65	60

So, the mean for Group 1 in our experiment = 65 + 67 + 73 + 65 + 58 + 55 + 70 + 69 + 60 + 68 = 650.

There are 10 participants in the group, so we divide the total (650) by 10, which gives a mean of 65.

The same is done for Group 2. As you can see in Table 11.2, the group means reveal a difference between the two groups.

The mean is sensitive to very high or very low scores in a distribution. For this reason it is not always the best measure of central tendency. (Imagine how distorted your results would be if you were to calculate average yearly income using a small sample of people that happened to include a multimillionaire!) In such cases, the middle score in a group of scores is used; this is known as the median.

The median is found by arranging scores from the highest to the lowest and selecting the score that falls in the middle. In other words, half the values in a group of scores fall below the median and half fall above.

When we arrange the scores for Group 1 in Table 11.2 in order, we have: 55, 58, 60, 65, 65, 67, 68, 69, 70, 73. Because there are 10 scores, an even number, there is no actual 'middle score'. This problem is overcome by taking the mean of the two middle scores – in this case 65 and 67 – yielding a single number to serve as the median for that data set. The median for Group 1 is, therefore, 66.

The final measure of central tendency is the mode, which is the most frequently occurring score in a group of scores. If you were to count the scores in Table 11.2, you would find that Group 1's mode is 65, and Group 2's mode is 60. The mode is usually easy to obtain; however, it can be an unreliable measure, especially in a small group of scores. The mode's advantage is that it reveals the score actually obtained by the greatest number of people.

See Figure 11.17 for an overview of the measures of central tendency.

MEASURES OF VARIABILITY

Say that a researcher had discovered two drugs that lower anxiety in agitated patients. However, let us also assume that one drug consistently lowers anxiety by moderate amounts, whereas the second sometimes lowers anxiety by large amounts, sometimes has no effect, or sometimes even increases anxiety in certain

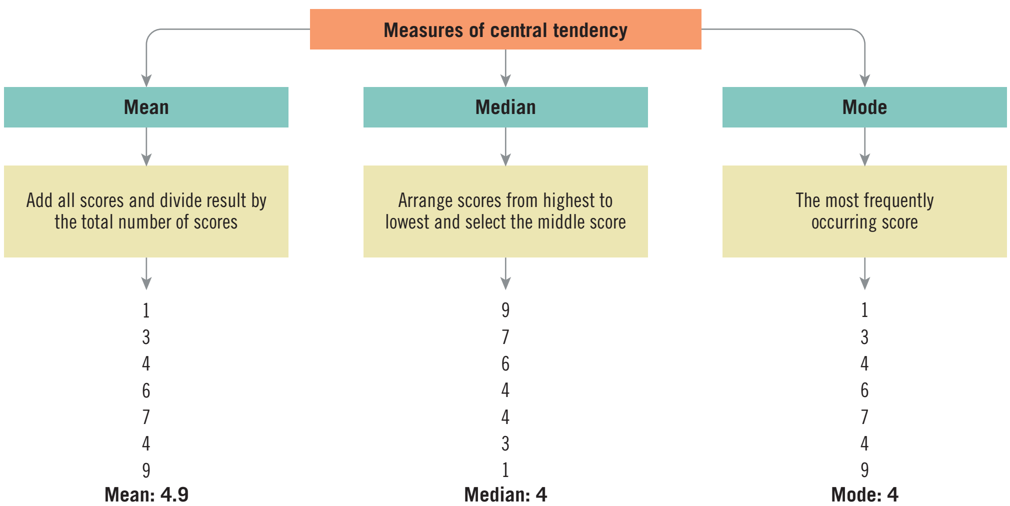

FIGURE 11.17 A measure of central tendency provides a number that describes a 'typical' score around which other scores fall.

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patients. Overall, there is no difference in the average (mean) amount of anxiety reduction; even so, it is clear that an important difference exists between the two drugs. So as this example shows, it is not enough to simply know the average score in a distribution: we also need to know whether scores are grouped closely together or scattered widely.

Measures of variability provide a single number that tells us the degree to which scores in a distribution are spread out or clustered together. When scores are widely spread, the measure of variability gets larger; when they are close together, it gets smaller. If you look at Table 11.2, you will notice that the scores within each group vary widely. But how can we show this?

The simplest way to show the variability of score distribution is to calculate the range of scores, which is the difference between the highest score and the lowest score in a distribution. In Group 1 of the experiment shown in Table 11.2, the highest score is 73 and the lowest is 55. Thus, we can say the range is 18 (73 – 55 = 18). In Group 2, the highest score is 63, and the lowest is 31, which makes the range 32. Scores in Group 2 are therefore more spread out than are those in Group 1.

PROBABILITY IN PSYCHOLOGY: *P*-VALUES AND CONCLUSIONS

Probability refers to the likelihood of an event occurring. In the imaginary drug experiment used as an example in Table 11.2, we found that the average memory score was higher for the group given the drug than it was for the group given the placebo. Certainly, this result is interesting, but might it not have occurred by chance? We can assume that if two groups were tested repeatedly, with neither receiving any drug, then their average memory scores would sometimes differ. But how much would the two means have to differ before we could consider the difference significant, or not wholly due to chance?

Tests of statistical significance are inferential statistics that provide an estimate of how often experimental results might have occurred by chance alone. The results of a significance test are stated as a probability, or *p*-value. This probability gives the odds that an observed difference is due to chance alone. In psychology, an experimental result that could have occurred by chance five times (or fewer) out of 100 (in other words, a less than 5 per cent probability, or $p < 0.05$) is considered statistically significant (see Figure 11.18).

Some researchers use a more conservative estimate of statistical significance, depending on the research they are conducting. In a conservative experiment (a drug trial, for instance) where it is important that only results due to the IV are reported, the significance levels are set very high (for example, at 0.01 or 0.001). In such cases, a statistically significant result is considered to be one that could have occurred by chance alone one time (or fewer) out of 100 (in other words, an equal or less than 1 per cent probability, or $p < 0.01$). In other exploratory studies where researchers are examining general trends, much lower significance levels can be set (for example, at 0.1). In our imaginary memory experiment, the probability is less than 0.05 ($p < 0.05$) that the group means would differ by chance alone. This allows us to conclude with reasonable certainty that the drug actually did improve memory scores.

If you conduct a study with a significance level set at $p < 0.05$, then the following will be true:

- If p is calculated to be less than or equal to 0.05 (for example, 0.04), then the difference between the experimental group's results and the control group's results is said to be statistically significant (that is, not due to chance alone), and likely due to the effect of the IV. The experimental hypothesis is therefore supported and the researcher can make an objective conclusion.
- If p is greater than 0.05 (for example, 0.08), then the difference between the experimental group's results and the control group's results is said to be not statistically significant (that is, it is likely due to chance alone). The experimental hypothesis is rejected.

Table 11.3 summarises *p*-values.

median A measure of central tendency found by arranging scores from the highest to the lowest, and selecting the score that falls in the middle

mode A measure of central tendency found by selecting the most frequently occurring score in a group of scores

variability A single number that tells us the degree to which scores in a distribution are spread out or clustered together

range The difference between the highest score and the lowest score in a distribution

statistical significance A number obtained from inferential statistics that provides an estimate of how often experimental results could have occurred by chance alone; expressed as '*p*-value'

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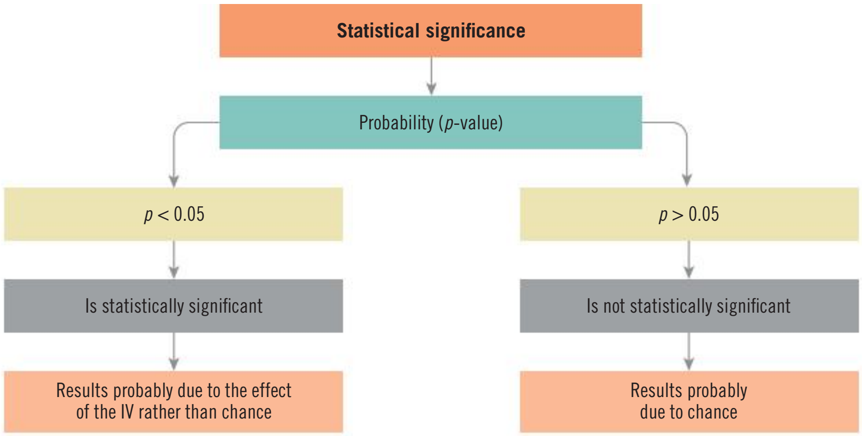

FIGURE 11.18 Tests of statistical significance provide an estimate of how often experimental results might have occurred by chance alone.

TABLE 11.3 Summary of p-values

IF p IS LESS THAN 0.05 ($p < 0.05$)	IF p IS GREATER THAN 0.05 ($p > 0.05$)
The difference between control and experimental groups is statistically significant	The difference between control and experimental groups is not statistically significant
The difference is unlikely to be due to chance alone	The difference between the groups is likely to be due to chance alone
The difference between the groups is likely to be due to the IV	The difference is unlikely to be due to the IV
The experimental hypothesis is supported	The experimental hypothesis is rejected

11.7 CHECK YOUR UNDERSTANDING >>

1 Match each term with its definition.

a Statistical significance
b Median
c Descriptive statistics
d Inferential statistics

i The score that falls in the middle of a score set when scores are arranged from highest to lowest
ii Statistics that are used to describe, summarise, organise and analyse data
iii Statistics that are used to interpret results
iv A statistic that provides an estimate of how often experimental results could have occurred by chance alone

2 Which of the following statements is correct?
A If scores are placed in order from smallest to largest, the median is defined as the middle score.
B The mode calculates the average score in a set of scores.
C The mean in a set of scores is the score that occurs most often.
D Descriptive statistics describe, summarise and interpret data.

3 Which of the following statements is incorrect?
A Tests of statistical significance describe, organise, summarise and analyse data.
B Tests of statistical significance involve probability.
C Tests of statistical significance give an estimate of how often research results could have occurred by chance alone.
D Tests of statistical significance suggest a result is significant if $p < 0.05$.

4 Which of the following p-values would be considered the most statistically significant?
A $p < 0.01$
B $p < 0.05$
C $p < 0.28$
D $p < 0.80$

5 Explain the difference between descriptive statistics and inferential statistics.

6 Calculate the mode, median and mean for the following sets of data:
a 11, 12, 16, 18, 19, 19, 34, 36, 37, 102
b 13, 13, 13, 16, 16, 19, 19, 20, 21, 22
c 22, 25, 26, 27, 27, 28, 29, 39, 40, 40, 40

GENERALISATION OF FINDINGS

A researcher studies the effects of a new therapy on a small group of depressed people. Is the researcher interested only in these particular people? Usually not. Except in rare instances, psychologists seek to discover general laws of behaviour that they can apply widely to humans and animals. Undoubtedly, the researcher in this case would like to know if the therapy holds any promise for all depressed people.

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A generalisation is a decision or judgement about whether findings obtained from a sample are representative of the relevant population. The extent to which research findings can be generalised depends on the topic being researched. For example, phenomena where there is little individual variation – such as sensation, attention and memory – can be easily generalised to the population. On the other hand, characteristics where there are large individual differences – such as those of personality, temperament and intelligence – often make it far more difficult for researchers to generalise sample results to the population of research interest.

A researcher can only make generalisations about a population if the sample used was representative of that population. For this reason, sampling techniques are very important.

If research findings can indeed be generalised to the population of research interest, then we would expect that the results would be similar if the study was replicated using a different sample from the same population.

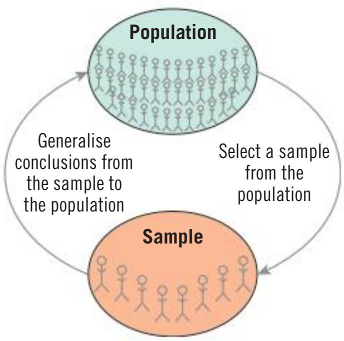

FIGURE 11.19 Generalisations can only be made about a population if the sample used was representative of that population.

11.8 CHECK YOUR UNDERSTANDING >>

1 Which of the following must be present if a generalisation is to be made?
   A A representative sample of the relevant population
   B A detailed conclusion
   C A measure of consistency
   D A *p*-value
2 When the findings of a study based on the results of the sample are applied to the population from which the sample was taken, __________ has occurred.
   A random allocation
   B stratified allocation
   C generalisation
   D artificiality
3 Write definitions for the terms 'conclusion' and 'generalisation'.

ETHICAL PRINCIPLES AND PROFESSIONAL CONDUCT

Ethical principles apply to all types of psychologists who treat clients or conduct research. The term ethics refers to moral principles and codes of behaviour that must be followed. The Australian Psychological Society (APS) has developed a *Code of Ethics* (2007) – as well as complementary *Ethical Guidelines* (first published in 2007 and regularly updated) – that all psychologists must follow when conducting research and treating clients. The code covers rules, regulations and ethics that psychologists are bound to observe, and the principles apply to all psychologists, whether they are conducting research using humans or animals. All relevant ethical guidelines must be adhered to, including not only the APS guidelines but also the Australian National Health and Medical Research Council (NHMRC) guidelines. All of these guidelines are designed to ensure that participants suffer no physical or psychological harm during or as a result of the experiment.

EXPERIMENTER'S ROLE

It is the experimenter's responsibility to protect participants' physical and psychological welfare. Participants' welfare is the most important aspect of a study – even more important than the research findings. At no time must an experiment be conducted that causes severe distress to participants. If a participant does encounter unexpected distress, the experiment must immediately stop and the experimenter must provide the participant with access to follow-up counselling or therapy. If a psychologist is conducting a study with another professional who is not a psychologist – and who is therefore not bound by the APS's *Code of Ethics* – the researcher must ensure that the other professional(s) agree to follow the code and any other relevant guidelines before starting the research.

The NHMRC Act of 1992, created by the Australian Government, covers research involving humans or animals. The Act outlines a number of ethical values that must be adhered to:

» *research merit* – A researcher can explain that there are potential benefits from the research, such as expanding our understanding of a subject.

generalisation A decision or judgement about whether results obtained from a sample are representative of the relevant population

ethics Moral principles and codes of behaviour

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- *integrity* – At all times during research or counselling, psychologists must behave in a professional manner. They must not bring disrepute to the profession of psychology or to scientific research and must be willing to communicate results.
- *respect* – The researcher is aware of the welfare, rights and customs of the participants.
- *beneficence* – The benefits to society are shown to outweigh any risk of harm to participants.
- *justice* – A researcher must be fair in how each participant is recruited and used so that no participant is exploited.

PARTICIPANTS' RIGHTS

According to the APS, all research in psychology must respect the participants' rights, to ensure that participants suffer no physical or psychological harm during or as a result of the experiment. If you are a research participant, you should expect that all guidelines will be adhered to and all your rights upheld. Types of participants' rights are discussed next.

Focus on research 11.2 demonstrates why participants' rights should be protected at all times.

11.2 FOCUS ON RESEARCH

THE MONSTER STUDY

In 1939, psychologist Wendell Johnson, of the University of Iowa, was interested in how children acquired language. Specifically, Wendell wanted to know whether reinforcement could be used to teach children to stutter.

He used a group of orphaned children of normal ability as his participants. He separated the children into two groups. Group 1 received positive reinforcement, in the form of praise and encouragement, for their speech. Group 2 received negative consequences for their speech as every mistake they made was criticised and they were labelled as stutterers. Children who received negative consequences showed negative psychological effects, such as a deflated sense of self, and many were so damaged that they retained speech problems throughout their lives.

The use of orphaned children in this way was thought so shocking that Johnson's results were originally hidden, for fear of this experiment damaging his reputation. They were, however, eventually released and, in 2001, 62 years after the experiment, the University of Iowa publicly apologised for the study.

QUESTIONS

1 Write a research hypothesis for this experiment.
2 Identify the IV and the DV.
3 Identify the experimental group and the control group.
4 Identify three modern ethical principles that were breached by this experiment.

Confidentiality

Confidentiality refers to the participant's right to privacy in terms of access, storage and disposal of information related to the research. Participants cannot be identifiable once an experiment has commenced. Researchers will often assign a number to each participant and refer to them by this number, rather than using their name. A participant's involvement in and results from an experiment cannot be disclosed to anyone else unless written consent has been obtained. If a participant is under the age of 18 years, their parent or guardian must provide this written consent.

Withdrawal rights

The participant's right to withdraw should be disclosed during the process of obtaining informed consent. A participant is entitled to withdraw from a study at any time, or have their results withdrawn, without experiencing any pressure or negative consequences. A researcher cannot withhold a participant's withdrawal rights, even if their withdrawal is detrimental to the research.

Access to results

All participants have the right to a copy of any document that is published by the researcher. This opportunity must be offered to participants before the experiment commences, as part of the informed consent procedure.

Voluntary participation

A participant must decide to participate in an experiment of their own free will; they must demonstrate voluntary participation. Participants must not experience any pressure to participate (for example, coercion or bribery) or any negative consequences (for example, threats) if they decide not to participate in the experiment. For example, a researcher using first-year university students cannot require all students to participate in research in order to pass their first year.

Informed consent

A researcher must follow certain procedures when recruiting participants – they must obtain informed consent. Where appropriate, before an experiment commences, the researcher must fully inform the

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Consent form

Dear participant,

You are invited to participate in a project being conducted by the University of Springfield entitled 'Effects of alcohol consumption on driving ability'. The study will be conducted on Friday 13 October.

The purpose of this study is to determine whether the consumption of alcohol affects the number of errors made while driving, with the view to developing educational programs that will dissuade young people from drink-driving. In this important phase of research, we are examining how alcohol consumption affects the ability to control a motor vehicle.

On the day of information collection, you will be asked to consume a series of drinks that may or may not contain alcohol or caffeine. Your driving ability will then be tested on a driving simulator. If you do not want to consume alcohol or caffeinated drinks, please inform the researcher at the start of the test.

The experiment will take approximately two hours. During this time, your vision, ability to detect colour, auditory processes and reflexes will also be tested.

All results will remain completely confidential. You will be assigned a code so that your name will not be identified with or appear on any records. The results will be presented as group results only, and you will not be identified in any reports resulting from this work.

You are free to withdraw your participation at any time. If you would like to discuss any issues of concern after the experiment, you may contact one of the chief investigators. All questions will be treated confidentially.

We thank you for your assistance.

Project title: Effects of alcohol consumption on driving ability

Participant consent:

I, ______________________ (participant's name), have read and understood the information above, and any questions I have asked have been answered to my satisfaction. I agree to participate in this research, aware that I may withdraw my consent at any time. I agree that research data collected for the study may be published or provided to other researchers on the condition that my name is not used.

Name of participant: ______________________

Signature of participant: ______________________

Date: ______________________

FIGURE 11.20 An example of a consent form

participants of the true nature and purpose of the experiment, what they will be asked to do and then obtain their written consent to participate. If a participant is under the age of 18 years or is legally unable to give consent, their parent, guardian or power of attorney should complete the informed consent form.

Researchers must also outline any reasonable foreseeable risks to the participant and inform participants of their rights, including their right to withdraw. The consent form must identify any possible physical or psychological stress that may be encountered during the experiment (see Figure 11.20). The researcher must ensure that any psychologically or physiologically vulnerable person does not participate in the study. Where possible, participants must also be informed about the research procedures employed in the study. In situations where it is considered inappropriate to gain informed consent from participants, the researcher must gain the permission of an ethics committee to withhold information.

participants' rights The individual rights of all participants that must be respected by the researcher, as outlined in ethical guidelines relating to psychological research

confidentiality A participant's right to privacy in terms of access, storage and disposal of information related to a research study in which they participated

withdrawal rights A participant's right to withdraw from a study or research at any time without experiencing any negative consequences

voluntary participation Participation whereby participants agree to take part in an experiment free from pressure or fear of negative consequences

informed consent Where a participant gives their written consent to participate in a study after being fully informed of the true nature and purpose of the experiment (where appropriate), any foreseeable risks and their rights; this occurs before an experiment begins

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Deception

Deception refers to withholding information from the participant about a study's true purpose, before the experiment begins. Deception is used in cases where giving participant's information about an experiment beforehand might influence their behaviour during the study and thus affect the accuracy of results. Approval for the use of deception must be given by an ethics committee before starting a study.

An example of deception is where a researcher studying guilt led subjects to believe they had broken an expensive piece of machinery. During the experiment, a machine suddenly popped loudly, released a plume of smoke and sputtered to a stop. As the embarrassed participants were about to leave, the experimenter asked them to sign a petition he was circulating. The petition called for doubling tuition fees at the school. Almost all control participants had previously refused to sign the petition; however, because of their guilt after 'breaking' the machine, more than 50 per cent of the experimental participants signed (Rubin, 1970). In this case, if the experimenter had informed participants of the true nature of the study, they would have known the machine was not really broken, and their responses may have differed.

Perhaps guilt could have been studied in some other way; nevertheless, some questions simply cannot be answered without using deception. When this is the case, researchers must deceive participants as little as possible, and offer debriefing after the study.

Debriefing

When deception is used, the researcher must ensure that participants do not suffer any psychological or physical stress as a result of the deception. Therefore, participants must be debriefed. Debriefing is where participants are informed of the study's true purpose once the experiment has ended. During debriefing, a researcher must correct any mistaken attitudes or beliefs that have been caused by or that relate to the experiment. They must provide an opportunity for the participants to gain access to information about the study, including procedures, results and conclusions. Participants must also be given information on available services they may want to use if they experience any distress as a result of their participation.

11.9 CHECK YOUR UNDERSTANDING >>

1 Match each term with its definition.

a Voluntary participation
b Debriefing
c Deception
d Informed consent

i Telling participants of the true aim and nature of the experiment and informing them of their rights before they agree in writing to participate
ii Withholding the true purpose of the experiment from participants
iii At the end of the experiment, informing participants of the true purpose of the experiment if deception was used, correcting any mistaken beliefs about the experiment, and advising participants of counselling services available if they are distressed
iv Individuals agree to take part in the experiment of their own free will

2 Which of the following must occur after an experiment is completed?
A No harm
B Deception
C Debriefing
D Beneficence

3 Which of the following statements is incorrect?
A When researchers say they will reimburse participants for any costs incurred as a result of participation in the study, this is not a violation of voluntary participation.
B When researchers say they will reimburse participants for any costs incurred as a result of participation in the study, this is a violation of voluntary participation.

4 To ensure that the ethical principle of voluntary participation is upheld, researchers must:
A inform participants of the nature of the research before starting the research.
B inform participants of all their rights (including confidentiality rights and withdrawal rights) before starting the research.
C not offer participants a bribe or threaten or pressure them to participate in any way.
D All of the above

5 Explain the difference between deception and debriefing.

deception When information about the true purpose of a study is not given to participants before a study begins

debriefing Informing participants of the true purpose of an experiment once it has ended; correcting mistaken attitudes or beliefs; providing the opportunity to gain information about the study; providing information about services to help with distress that is a result of participation

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CHAPTER SUMMARY

Experimental research

- The steps in experimental research: a research problem is identified, a hypothesis is formulated, a method is designed, data is collected and analysed, results are interpreted and findings are reported.
- A research hypothesis identifies the IV and the DV, states how these will be measured and predicts the relationship between them.
- Researchers must ensure that all extraneous variables and possible confounding variables are identified and eliminated, or at least controlled, otherwise they will not be able to determine whether the DV was caused by the IV or whether the DV was the result of some unwanted variable.
- Extraneous and confounding variables can be linked to individual participant differences, placebo effect, the experimenter effect, order effects or non-standardised instructions and procedures.
- A number of methods exist for controlling or eliminating unwanted variables, such as type of experiment, counterbalancing, single- and double-blind procedures, placebos, type of sampling procedures, standardised instructions and procedures, and the type of experimental research design chosen.

Sampling procedures and allocation to groups

- Participants from the population of research interest can be selected for the sample using a variety of methods, including random sampling, stratified sampling, random-stratified sampling and convenience sampling.
- Once selected for the sample, participants are usually randomly allocated to either the experimental group (exposed to the IV) or the control group (not exposed to the IV).

Types of qualitative and quantitative data

- Data can be collected in a variety of ways including case studies, observational studies, self-reports, questionnaires and interviews.
- Each type of data has advantages and limitations. For example, qualitative data (data in words) is more detailed, but is sometimes difficult to analyse and interpret, whereas quantitative data (data in numbers) is easy to analyse and interpret, but often does not include a lot of detail.
- Qualitative data involves statistics such as measures of central tendency (mean, median and mode), probability values and their interpretation.
- Conclusions are based on the statistical significance of the results.

Ethical principles and guidelines for professional conduct

- Psychologists must follow a code of conduct and ethics when conducting research and treating clients and patients. This ensures that the participants' rights are upheld and protected at all times.
- The ethical principles that psychologists are bound to follow relate to confidentiality, voluntary participation, withdrawal rights, informed consent procedures, use of deception and debriefing.

APPLY YOUR KNOWLEDGE AND SKILLS

SECTION A: MULTIPLE-CHOICE QUESTIONS

Answer the following questions by writing the correct letter in your workbook. Only one answer is correct for each question.

1 In an experimental study, an experimenter effect is said to have occurred if:

A the researcher's characteristics or expectations influence the results.
B statistical analysis shows that the researcher's hypothesis is supported.
C there are no extraneous variables.
D statistical analysis shows that the researcher's hypothesis is not supported.

2 An operational hypothesis is a statement that describes:

A the size of the study sample.
B the methods used to address the research questions.
C how the participants in the study will be recruited.
D how the study will be statistically analysed.

3 The primary reason for using random sampling is to ensure that:

A the participants are less likely to provide biased responses.
B there is no experimenter effect.
C the participants are representative of the population of research interest.
D there are no confounding variables.

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4 One purpose of using inferential statistics is to:
- **A** identify extraneous variables.
- **B** generalise the results of a study to a sample.
- **C** identify whether an experimenter effect has occurred.
- **D** generalise the results of a study to a population.

5 A researcher is conducting a study that requires participants to name the colour of written words as quickly as possible. In the first condition, the colour of the words matches the word that is written; for example, 'red' is written in red. In the second condition, the colour does not match the word written; for example, 'red' is written in blue. The researcher records the number of errors made and the time taken to say the colour of the word. The IV in this study is:
- **A** the font used to write the words.
- **B** the number of errors made.
- **C** the time taken to say the colour of the word.
- **D** whether or not the colour matches the word.

6 A researcher wanted to test the effects of air pollution on problem-solving ability. Participants were placed in an unpolluted room and given a set of problems to solve. The time this took was recorded. Participants were then given a different list of problems of equal difficulty and asked to solve them in a polluted room. The time it took to do so was recorded. To what experimental condition were participants exposed in the unpolluted room?
- **A** The experimental condition
- **B** The control condition
- **C** The independent condition
- **D** The dependent condition

7 A sample is selected to match the distribution of age and religion that occurs in the population. This type of sample is called a:
- **A** matched sample.
- **B** stratified sample.
- **C** random sample.
- **D** convenience sample.

8 If a researcher wants to give all members of a research population an equal chance of being part of a sample, then they would use a:
- **A** random sample.
- **B** stratified sample.
- **C** operationalised sample.
- **D** convenience sample.

9 In an experimental study, a placebo effect is said to have occurred if:
- **A** the participant's expectations influence the study results.
- **B** the results for the experimental and control groups are very similar.
- **C** the researcher is not aware of which subjects are in the experimental group and which subjects are in the control group.
- **D** the researcher's expectations influence the study results.

10 In generalising from a sample to the population, it is important that the sample:
- **A** is representative.
- **B** has been standardised.
- **C** is not too large.
- **D** is selected so that all members of the population participate.

11 What is the mode of the following distribution of scores: 2, 2, 4, 4, 4, 14?

A 2 **B** 5 **C** 6 **D** 4

12 Which of the following would be the measure of central tendency that would most likely be affected by a few extreme scores?
- **A** Mean
- **B** Median
- **C** Mode
- **D** None of the above

13 If a difference between two samples is not statistically significant, which of the following can be concluded?
- **A** The difference is probably due to the effect of the IV.
- **B** The difference is probably due to the effect of the DV.
- **C** The difference could be due to chance.
- **D** The difference could not be due to chance.

14 If a researcher uses deception in their study, they must:
- **A** inform participants of this before participants agree to participate.
- **B** allow participants to withdraw at any stage.
- **C** debrief participants at the end of the study.
- **D** debrief participants at the beginning of the study.

15 Which of the following is a feature of confidentiality?
- **A** Participant awareness of the study's purpose
- **B** No lasting harm resulting from participating in a study
- **C** No identifying information is revealed about a participant
- **D** The right to withdraw from the study at any time is provided

SECTION B: SHORT-ANSWER QUESTIONS

1 A researcher believes that banning smoking at work will result in a reduction in the number of cigarettes smoked each day. She identifies companies planning to ban smoking at work, and surveys the smokers at work before and after the ban. On both occasions, smokers are asked how many cigarettes they smoke each day. Write an appropriate research hypothesis for this study.

2 You are going to conduct a study on the amount of sleep obtained by Year 12 students one week before end-of-year exams. Explain how you might obtain a random sample for your study.

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3 Identify one advantage and one limitation of the case study method of data collection.

4 Identify one similarity and one difference between an extraneous variable and a confounding variable.

5 Explain why a random sample is considered to be representative of the population of research interest.

6 Explain why reliability and validity are important to any research study.

7 Identify the main characteristic and purpose of a control group in an experiment.

8 Under what circumstances can the results of a study using a convenience sample be considered legitimate?

9 Explain the difference between the ethical principles of informed consent and voluntary participation.

10 Correctly cite this book or ebook as if you were writing it in a reference list.

SECTION C: EXTENDED-RESPONSE QUESTION

In reference to experimental research, explain how the independent-groups design, the matched-participants design and the repeated-measures design can be used to minimise the effect of extraneous variables associated with individual participant differences. Comment on whether all differences can be controlled for each design.

In your response, ensure that you show an understanding of:

- what an extraneous variable is
- what individual participant differences are
- each of the types of experimental design mentioned.

This question is worth 10 marks.

SECTION D: ASSESSMENT TASK

SCIENTIFIC INVESTIGATION: INVESTIGATING PEOPLE'S VIEWS ON ANIMAL EXPERIMENTATION

You (and your psychology class) are to create a scientific poster on the issue of animals being used in experiments. You will need to collect data about people's views on using animals in experiments.

DIRECTIONS

Do the following as a class:

1 Formulate an experimental hypothesis for this study.

2 Formulate an operationalised research hypothesis for this study.

3 Create an informed consent form for the participants to read and sign.

4 Each class member must ask five people about their views on animal experimentation using photocopies of the questionnaire on page 366.

5 All class members are to bring the raw data to class. (The investigation will be based on the class data, not on your five participants.)

6 Collate and analyse the class data.

7 Create your poster following the reporting conventions outlined on pages 336–7 of this chapter.

HOW TO SCORE THE QUESTIONNAIRE

- Add up answers from questions 1, 2, 5, 6 and 10.
- For questions 3, 4, 7, 8 and 9 you need to reverse the scoring. That is, if the participant scored 1 on these questions, change it to 5 points; if the participant scored 2 on these questions, change it to 4, and so on. (If you have trouble keeping track of this, mark these 'reverse' questions with an asterisk (*) or some other symbol before you begin scoring.)
- Add up the changed scores from questions 3, 4, 7, 8 and 9 and total them with the score you added up for questions 1, 2, 5, 6 and 10 to obtain one final overall score for the questionnaire.

WHAT THE SCORES MEAN

A score of 10–26:
Category 1 – Animals should never be used in experiments.
The respondent is against using animals in experiments at any time or in any place. If researchers want to know about drugs for humans, they should test them on humans – not animals.

A score of 27–39:
Category 2 – Animals should sometimes be used in experiments.
The respondent believes that there is a time and a place for using animals in experiments – when it is necessary. However, the respondent also feels that unnecessary or very painful experiments should not be conducted.

A score of 40–50:
Category 3 – Animals should always be used in experiments.
The respondent believes that animal species are inferior to humans and should be used for all experiments – even painful, unnecessary ones.

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Questionnaire

Age: ______________

Gender: ________________

1	2	3	4	5
Strongly disagree	Disagree	Neutral	Agree	Strongly agree

Circle your response to each of the following questions, based on the strength of response shown above.

1	Animals should be used in all experiments.	1	2	3	4	5
2	Animals should only be used in medical research.	1	2	3	4	5
3	Animals should not be used to test cosmetics.	1	2	3	4	5
4	It is inhumane to use animals in experiments.	1	2	3	4	5
5	Many drugs and vaccines could not have been developed without experiments on animals.	1	2	3	4	5
6	Only rats and mice should be used in experiments.	1	2	3	4	5
7	Monkeys should not be used in experiments.	1	2	3	4	5
8	It is cruel to use animals in experiments.	1	2	3	4	5
9	Experiments should be done on humans instead of animals.	1	2	3	4	5
10	It is OK to inflict pain or harm on animals but not humans.	1	2	3	4	5

For researcher's use only

Score: __________

Category: __________

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GLOSSARY

acculturation A process that involves a person changing their behaviour to adopt the cultural traits or social patterns of the dominant culture they have moved to

acculturative stress Stress caused by attempting to psychologically and socially adapt to the demands and values of a foreign culture

acetylcholine A neurotransmitter that can act in both an excitatory and inhibitory manner; also plays a role in cognitive processes such as memory and learning

acquisition The learning itself; the gaining (acquiring) of knowledge or a skill

acquisition phase The period of time between presentation of a stimulus and receiving reinforcement

acquisition process The process of learning the conditioned response

action potential (neural impulse) An electrical charge that sweeps down the axon of a neuron, prompting the release of neurotransmitters

acute partial sleep deprivation A lack of adequate sleep time required for optimal daytime functioning; usually lasting 1–2 days

acute stress A state of brief but intense physiological arousal in response to an immediate perceived stressor that normally has no negative effects on health and wellbeing

addiction The inability to resist a recurring urge to behave in a certain way despite knowing the potentially harmful consequences

adequate diet Food and water intake that includes sufficient energy for a person's needs

adequate sleep The necessary amount for individuals to function effectively during the daytime and cope with normal daily stress

adrenaline A chemical produced in the body that activates systems for the fight–flight response

affective functioning Emotional control or responsiveness

agonist A substance that increases the release of a neurotransmitter or imitates its activity by causing the post-synaptic neuron to fire

alarm-reaction stage The first stage of the GAS, where resistance to stress first drops below normal, then increases above normal

all-or-nothing event An event that happens completely or not at all

alpha waves Brainwaves experienced during a deeply relaxed state, with a low–medium amplitude and medium–high frequency

altered state of consciousness (ASC) A state of consciousness that is characteristically different from normal waking consciousness in terms of awareness, sensation and perception

Alzheimer's disease An irreversible and progressive neurodegenerative disease that gradually kills brain cells, causing severe cognitive and behavioural decline that eventually results in death; associated with low levels of acetylcholine

amnesia A temporary or permanent, partial or total loss of memory

AMPA (α-amino-3-hydroxyl-5-methyl-4-isoxazole-propionate) receptors Specific receptors found on the dendrites of post-synaptic neurons that bind glutamate

amplitude (of brainwaves) The strength of a brainwave as measured by the size of the peaks and troughs from a baseline of zero activity

amygdala A cluster of neurons in the brain's limbic system associated with memory, learning and initiating fear responses

amyloid plaques Sticky, abnormal clusters of beta-amyloid fragments that collect on the outside of nerve cells, destroying the synapses and the conduction of nerve impulses

antagonist A substance that inhibits the release of a neurotransmitter or blocks receptor sites, making the post-synaptic neuron less likely to fire

antecedent An event that comes before a response

anterograde amnesia A form of memory loss for events that happen after an amnesia-causing event

anxiety A feeling of apprehension, dread or uneasiness in response to an unclear or ambiguous threat

anxiety disorder A mental disorder that involves feelings of extreme anxiety, accompanied by physical and psychological symptoms, which prevents a sufferer from normal functioning

approach strategies Practical stress management strategies that consist of behavioural or psychological responses designed to change (remove or diminish) the nature of the stressor or how one thinks about it

ascending tracts Axon columns in the spinal cord that sensory information is sent through from the PNS up the spinal cord to the brain for processing

attachment A relationship between two people who feel strongly about each other so that they exhibit behaviours to continue the relationship

attention A voluntary or involuntary tendency to orient towards or focus on a particular stimulus and ignore other stimuli

automatic processes Actions that require little conscious awareness or mental effort, and do not interfere with performance on other activities

autonomic nervous system (ANS) The division of the PNS that transmits motor messages from the brain to the body's internal organs and glands, which results in involuntary activity of internal organs and glands, and transmits messages back to the brain about the activity level of these organs and glands

avoidance behaviours Behaviours that attempt to prevent exposure to the fear-provoking object, activity or situation

avoidance strategies Stress management strategies that involve choosing your response to a stressor based on trying to either cognitively or behaviourally avoid or escape painful or threatening thoughts, feelings, memories or sensations associated with the stressor

axon The fibre that carries information away from the cell body of the neuron

axon terminals Fibres that branch out from the end of the presynaptic neurons axon and link with the dendrites of the postsynaptic neuron; responsible for releasing neurotransmitters into the synapse

basal ganglia Clusters of nerves cells that regulate motor control

behaviour The actions and mannerisms in which an organism behaves in response to a particular situation or stimulus

behavioural model Proposes that phobic anxiety could be the result of learning

benzodiazepines A group of medications used in the short-term treatment of phobic anxiety; they enhance the GABA-induced inhibition of overexcited neurotransmitters, resulting in calming nervous activity

beta blockers Medication used to treat high blood pressure, congestive heart failure, abnormal heart rhythms and anxiety by reducing heart rate and blood pressure

beta waves Brainwaves characteristic of normal waking consciousness, with a low amplitude and high frequency

biofeedback A process by which a person receives information about their autonomic physiological activity (measured using precise instruments) in order to learn how to control these

biological rhythms The cyclical natural rhythms our body follows to perform a variety of functions

biopsychosocial model An approach that proposes that health and illness outcomes are determined by the interaction and contribution of biological, psychological and social factors

blood alcohol concentration (BAC) The amount of alcohol present in the bloodstream

blood–brain barrier A mechanism that prevents or slows the passage of potentially harmful molecules in the blood from entering the brain but allows other molecules to enter

bradykinesia Slowness of movement and gradual loss of spontaneous and voluntary movement

brain The master organ of the nervous system responsible for receiving and processing information from the rest of the body and generating responses to it

brain trauma Brain trauma involves physical damage to the brain that results in emotional, physical or behavioural dysfunction

breathing retraining The process of identifying incorrect breathing habits and replacing them with correct ones

bright light therapy A treatment for circadian phase disorder that exposes people to intense but safe amounts of artificial light for a specific and regular length of time to help synchronise their sleep–wake cycle with a normal external day–night cycle

case study An in-depth, detailed study of all aspects of a single participant, group or event, usually undertaken to gain insight into a particular psychological phenomenon

cataplexy A sudden temporary muscle paralysis that leads to falling down; where someone is totally paralysed but fully conscious

catastrophe A sudden, unpredictable, uncontrollable, intense event that causes large-scale damage and suffering for a group

catastrophic thinking Occurs when an individual repeatedly overestimates the potential dangers and assumes the worst of an object or event

central nervous system (CNS) A major division of the nervous system consisting of all the nerves in the brain and spinal cord

central sleep apnoea (CSA) A sleep disorder characterised by multiple non-breathing periods during sleep because the brain stops sending signals to the diaphragm muscles that control breathing to maintain normal breathing

cerebellum A structure attached to the rear of the brainstem responsible for implicit memory of learnt skills and actions

channels Gates or pathways that allow ions to enter and leave the neuron

chronic changes Changes that are long-lasting

chronic partial sleep deprivation Routinely sleeping less than the normal time needed for optimal daytime functioning

chronic stress A state of prolonged physiological arousal in response to a persistent stressor that negatively affects health and wellbeing

chunking Grouping separate items of information to form a larger single information unit (chunk) so our short-term memory can hold more than the usual seven single items of information at any given moment

circadian phase disorder A sleep disorder that disturbs a person's ability to sleep and wake for the periods of time necessary to maintain good health and wellbeing, caused by the sleep–wake cycle being out of sync with the natural night–day cycle of the external environment

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circadian rhythms Regular automatic physiological changes controlled by the suprachiasmatic nucleus that occur during a 24-hour cycle to regulate bodily processes (e.g. body temperature)

classical conditioning A form of learning where two normally unrelated stimuli are repeatedly linked so that existing reflex responses are elicited by new stimuli; also known as Pavlovian or respondent conditioning

cognitive behaviour strategies Structured psychological treatments that recognise that a person's way of thinking (cognition) and acting (behaviour) affects the way they feel

cognitive behavioural therapy (CBT) The application of learning principles to change thought processes and human behaviour, especially maladaptive behaviour

cognitive bias A type of error in thinking that occurs when people are interpreting information

cognitive model A psychological perspective that is interested in investigating internal mental processes, thoughts and memories, and their influence on behaviour

conclusion A decision or judgement about the meaningfulness of the results of a study

conditioned response (CR) A reflex response to a previously neutral stimulus that occurs after learning has taken place

conditioned stimulus (CS) A stimulus that evokes a specific response due to learning

confidentiality A participant's right to privacy in terms of access, storage and disposal of information related to a research study in which they participated

confounding variable An uncontrolled variable that has had an unwanted effect on the DV and might be confused with the effect of the IV

consciousness Our awareness of internal and external environments at any given moment in time

consequence An event that comes after a response; the effect of the response

consolidation The process by which information is transferred from STM to LTM for relatively permanent storage

consolidation theory Proposes that structural changes to neural circuits occur with the formation of long-term memories

context-dependent cues Environmental cues in the specific context or environment where the memory was formed, which enhance the retrieval of memories formed in that context

contextual factors The set of circumstances or facts that surround a particular event and influence whether or not we perceive a stimulus as a stressor and the intensity of the stress experienced

control group In a controlled experiment, the group of participants exposed to all conditions or variables except the independent variable

controlled processes Actions that require a high level of conscious awareness, attention and mental effort

controlled variable An extraneous variable whose influence has been eliminated from an experiment so that it cannot affect results; it has been controlled

convenience sampling A sampling technique involving the selection of participants because they are readily available to the researcher

coping A process involving constantly changing thoughts and behaviours so we can manage the demands (internal or external) of stressors we appraise as taxing or exceeding our resources

coping effectiveness The degree to which a coping strategy or combination of strategies is successful in alleviating stress

coping flexibility The ability to stop an ineffective coping strategy (or evaluate the coping process) and implement an alternative effective coping strategy (or adapt the coping process)

coping skills Learnt behaviours or techniques that help us solve problems or meet the demands of a stressor

coping strategy The behavioural and psychological responses a person makes to a stressor that are intended to manage the stressor and reduce the physical and psychological stress related to it

corpus striatum A midbrain structure composed of white and grey matter that contributes to the production of smooth, purposeful muscle movements

counterbalancing A method used to control order effect, where half the participants in an experiment are exposed to the control condition first and the other half are exposed to the experimental condition first; this is then reversed in the second instance

countershock The second stage of alarm-reaction in the GAS, where resistance to stress rises above normal levels because of the activation of the sympathetic nervous system

cranial nerves Linked directly to the brain, allow sensory and motor messages to travel directly to and from the organs located in the head

craniotomy The surgical removal of part of the skull to expose the brain

cued recall Recalling information from memory with some cues or hints for assistance

cumulative risk The accumulation of and exposure to multiple risk factors that increase susceptibility to developing a mental disorder or perpetuates an existing mental disorder

daily pressures Frequently experienced stressors consisting of relatively minor events that require adjustments in behaviour

data The observed facts that constitute the results of an experiment

debriefing Informing participants of the true purpose of an experiment once it has ended; correcting mistaken attitudes or beliefs; providing the opportunity to gain information about the study; providing information about services to help with distress that is a result of participation

deception When information about the true purpose of a study is not given to participants before a study begins

decisional balance The process of weighing the pros and cons of decision-making

declarative memory A type of explicit LTM for specific factual information that can be expressed in words; subgroups are semantic memory and episodic memory

delayed sleep phase disorder A disorder of sleep timing in which a person's sleep–wake cycle is routinely delayed by 2 hours or more from a normal sleep pattern, causing a person to go to sleep later and wake later

delta waves Brainwaves experienced during the deepest stages of sleep, with high amplitude and low frequency

delusion A belief or thought that is not supported by or connected to reality

dementia A general term that describes the symptoms of a variety of brain illnesses that progressively kill brain cells and result in irreversible structural and chemical changes in the brain that lead to permanent and severe cognitive loss

dendrite A neuron fibre that Is connected to the soma and receives incoming messages

dependent variable (DV) The variable that an experimenter measures (after exposure to the IV)

depolarisation When an action potential travels down the axon and its interior briefly becomes positive compared to the outside

depolarise To change the resting potential of a neuron so that the internal environment becomes more positively charged

depressants A group of drugs that calm neural activity and slow down bodily functions; include alcohol, benzodiazepines, barbiturates, opioids and cannabis

descending tracts Axon columns in the spinal cord that motor messages are sent through from the brain down the spinal cord to the PNS and the rest of the body

descriptive statistics Statistics used to describe, summarise, organise and analyse data

disorganised attachment Instability in a caregiving relationship that interferes with the child's sense of trust and security

distracter A false item, similar to the correct item, that is included with items to be recognised and can lead to unreliable identification

distress A negative psychological response to a stressor, characterised by negative psychological states, that impedes optimal performance

divided attention When an individual simultaneously focuses on two or more stimuli, or simultaneously undertakes two or more tasks

dopamine A neurotransmitter found in the brain; involved in smooth and coordinated voluntary movements, learning, arousal and emotional experience

dopamine agonists Drugs that mimic the effect of dopamine by activating dopamine receptors in the brain that would normally be stimulated by dopamine

double-blind procedure An experimental procedure where neither the experimenter nor the participants know which experimental condition the participants have been allocated to

dreams A series of images, thoughts and emotions that passes through the mind during sleep

dyskinesia A condition characterised by abnormal involuntary muscle movements

dysomnias A group of sleep disorders characterised by disturbance of normal sleep pattern, including quality, amount and timing of sleep

echoic memory The subsystem of sensory memory that receives and stores an unlimited amount of auditory information in the form of an echo for up to 3–4 seconds

elaborative rehearsal The rehearsal technique involving linking new information in some meaningful way with information already stored in LTM, or with other pieces of new information, to hold it in short-term memory for longer than the usual 18–20 seconds

electrocardiograph (ECG) A machine used to detect, amplify and record the electrical activity of heart muscles

electroencephalograph (EEG) A machine used to detect, amplify and record the brain's electrical activity, measured in the form of brainwaves

electromyograph (EMG) A machine used to detect, amplify and record the electrical activity of voluntary muscles

electrooculograph (EOG) A machine used to detect, amplify and record the electrical activity of muscles that control eye movement

emotion-focused strategies Approach strategies aimed at managing the emotional distress caused by a stressor by changing the unpleasant emotions associated with it

encoding The process that converts information into a usable form (code) that can be stored and represented in the memory system

endocrine system The collection of glands in the body that produce hormones that regulate bodily function

endorphins A group of neurotransmitters that help to combat the negative effects of stress by producing a positive mood state and promoting feelings of euphoria

epinephrine A chemical secreted by the medulla in the brain that helps to increase levels of arousal that occur when the sympathetic nervous system is activated

episodic memory A type of declarative memory for personally significant events associated with specific times and places

ethics Moral principles and codes of behaviour

eustress A positive psychological response to a stressor, characterised by positive psychological states, that helps the body perform at an optimal level

evidence-based interventions Treatments that have been proven effective based on the integration of clinical research and expertise aimed at changing target behaviour

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evolutionary theory A theory that suggests that we have periods of inactivity, or sleep, when we do not need to engage in activities important to our survival

excessive (compulsive) exercising Repeatedly exercising beyond the requirements of what is considered safe

excitatory messages Messages transmitted by neurotransmitters that stimulate the next neuron to fire

experiment A research method that involves gathering data under controlled conditions to test a hypothesis by exposing participants to a treatment and observing and measuring its effect

experimental group In a controlled experiment, the group of participants that are exposed to the independent variable

experimental hypothesis A broad and general prediction about the direction of the relationship between variables in an experiment; i.e. whether the variables increase or decrease in relation to one another

experimental method A scientific research method that uses participants in a formal trial to confirm (or not confirm) a hypothesis

experimenter effect Changes in participants' behaviour that are caused by the unintended influence of the experimenter rather than the IV

explicit memory A long-term memory of events and factual information that can be intentionally and consciously recalled

extinction The gradual decrease in strength or frequency of a conditioned response when the unconditioned stimulus is no longer available

extraneous variable In an experiment, a variable other than the IV that might cause unwanted changes in the DV

eyewitness testimony A statement (usually given in court) from an individual who has viewed an event that consists of their personal recollection of that event

fight–flight response The automatic reaction of the sympathetic nervous system to stress that causes physiological change that prepares it to either confront (fight) a threat or escape to safety (flight)

fight–flight–freeze response The body's response options to a threat consisting of either confronting it (fight), escaping from it (flight) or becoming immobilised (freeze) in its presence

forebrain A region of the brain that consists of the thalamus, hypothalamus and cerebrum; located above the midbrain, it is the largest and most highly developed part of the brain responsible for our most complex processes

free recall Recalling information from memory in any order with no cues for assistance

freeze response A response to a threat whereby we feel so helpless to deal with it that we become immobilised in its presence due to activation of the parasympathetic nervous system overriding the sympathetic nervous system

frequency (of brainwaves) The number of brainwaves per second

gamma-amino butyric acid (GABA) The primary inhibitory neurotransmitter; its overall effects are to calm or slow neural transmission and therefore the body's response

general adaptation syndrome (GAS) According to Hans Selye, the body's typical response pattern in terms of resistance to stress over time, comprising three stages: alarm-reaction, resistance and exhaustion

generalisation A decision or judgement about whether results obtained from a sample are representative of the relevant population

genetic factors Biological factors that commonly enhance (or reduce) an individual's risk of, or vulnerability to, developing a particular condition

genetic vulnerability An increased likelihood of developing a particular disease based on a person's genetic make-up

glial cells Nervous system cells that are specialised to provide structural and nutritional support to neurons and maintain a healthy environment for neurons

glutamate The primary excitatory neurotransmitter in the brain responsible for the fast transmission of neural messages and involved in cognitive functions

glutamatergic synapses Synaptic connections involving the transmission of the neurotransmitter glutamate

grey matter The centre area of the spinal cord that contains cell bodies, their axons and their dendrites

hallucination A sensory experience (e.g. seeing or hearing something) that does not actually exist

hindbrain A region of the brain located at the base of the brain that includes the cerebellum, pons and medulla and is responsible for controlling our basic survival functions

hippocampus A brain structure buried deep within the brain and extending into the temporal lobes; associated with memory formation and storage

homeostasis The body's balanced and healthy state

hormones Chemicals produced in the glands and secreted directly into the bloodstream to act on distant sites

Huntington's disease A genetic disorder characterised by jerky movements and associated with the degeneration of neurons in the brain that contain the neurotransmitter GABA

hypnic jerk A reflex muscle contraction that occurs during Stage 1 NREM sleep as the body is relaxing

hypnogogic state A state when alpha waves begin to present on the EEG and a person is drifting from wakefulness to sleep

hypochondria A preoccupation with minor bodily problems and the presence of illnesses that appear to be imaginary

hypothalamus A brain structure that activates, controls and integrates the peripheral autonomic nervous system, endocrine processes and many somatic functions, such as body temperature, sleep and appetite

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hypothesis A testable prediction of the relationship between two variables

iconic memory The subsystem of sensory memory that receives and stores an unlimited amount of visual information in the form of a visual image for approximately $\frac{1}{3}$ to $\frac{1}{2}$ of a second

implicit memory A long-term memory of learnt actions and skills that we store in LTM and retrieve unconsciously (often referred to as procedural memory)

independent variable (IV) The variable that an experimenter systematically manipulates (changes or varies) to gauge its effect on another variable (the dependent variable)

independent-groups design An experimental design where participants are randomly allocated to either the experimental group or control group

induced ASC An ASC that is intentionally produced (e.g. being under the influence of drugs or alcohol)

inferential statistics Statistics that allow an experimenter to objectively make inferences and conclusions about data; they are often used to interpret results of a study

informed consent Where a participant gives their written consent to participate in a study after being fully informed of the true nature and purpose of the experiment (where appropriate), any foreseeable risks and their rights; this occurs before an experiment begins

inhibitory messages Messages transmitted by neurotransmitters that make the next neuron less likely to fire

insomnia A sleep disorder characterised by the inability to fall sleep, frequent night-time waking, waking too early, or a combination of these, which results in sleep deprivation

interneuron A specialised neuron that links sensory and motor neurons in the spinal cord

interview A form of qualitative data collection where individuals are asked to comment on their attitude towards particular issues

ion An electrically charged atom

ion channels Molecular tunnels in the axon membrane

ionotropic glutamate receptors Located on post-synaptic neurons, these receptors allow direct passage of ions in or out of the neuron after binding glutamate

jet lag A temporary circadian phase disorder characterised by fatigue and sleep disturbance that results from a disruption of the body's normal circadian rhythm following long periods of air travel through several time zones

K-complex A short burst of high-amplitude brainwaves, experienced in Stage 2 NREM sleep

kinase An enzyme found in the post-synaptic neuron that catalyses the transfer of phosphates to the AMPA channel

labelling When a certain characteristic of an individual is used as a name or brand to describe them

leading question A question posed to a witness that is phrased in such a way that it prompts or suggests the desired answer to a question

learning A relatively permanent change in behaviour (or behaviour potential) due to experience

levodopa (L-dopa) A drug that the brain converts to dopamine; used to treat Parkinson's disease

levodopa-carbidopa intestinal gel (LCIG) An alternative to the standard treatment of levodopa, it is injected into the small intestines via a portable pump

life events Stressors that consist of significant but relatively rare events that require substantial adjustments in behaviour within a relatively short time

long-term depression (LTD) The reduced efficacy of synaptic transmission

long-term memory (LTM) The third memory system in the multi-store model of memory; used for relatively permanent storage of an unlimited amount of information

long-term potentiation (LTP) A form of neural plasticity that leads to an increase in the efficacy of synaptic transmission

magic number 7 (+ or – 2) The number of single items of information that the average short-term memory can hold at any one time

maintenance rehearsal The rehearsal technique involving the repetition of information a number of times so it can be held in short-term memory for longer than the usual 18–20 seconds

maladaptive Not adjusting adequately or appropriately to the environment or situation

matched-participants design An experimental design where participants are paired (matched) on the basis of similar characteristics that can influence the DV, with one of the pair being allocated to the experimental group and the other to the control group

mean A measure of central tendency found by adding up all the values and dividing the total by the number of values

measure of central tendency A measure of the tendency for a majority of scores to fall in the mid-range of possible values

median A measure of central tendency found by arranging scores from the highest to the lowest, and selecting the score that falls in the middle

melatonin A hormone secreted by the pineal gland that causes drowsiness and helps to regulate the sleep–wake cycle

memory An active information-processing system that receives, stores, organises and recovers information

memory bias A type of error in thinking that may either enhance or impair the recall of memory, or it may alter the content of what we report remembering

memory reconstruction Remembering past events and features of these events and putting them together during memory recall

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mental disorder The psychological state of someone who has emotional or behavioural problems serious enough to require psychiatric intervention; also known as mental illness

mental health problems A disruption to an individual's usual level of social and emotional wellbeing, including when their abilities are negatively affected

mental health The psychological state of someone who is functioning at a satisfactory level of emotional and behavioural adjustment

metabotropic glutamate receptors These receptors indirectly activate secondary messengers that influence the passage of ions in and out of the neuron

microsleep A short period of sleep where the individual appears to be awake, but brain activity indicates that they are asleep; occurs because of sleep deprivation

midbrain A region of the brain located between the hindbrain and forebrain; consists of many nerve fibre systems connecting these, including the reticular formation

mode A measure of central tendency found by selecting the most frequently occurring score in a group of scores

model Someone who serves as an example in observational learning

modelling The process of learning by observing another person's behaviour and the consequences of the behaviour

monosynaptic reflex A reflex response that involves one synapse and the interaction between a sensory neuron and a motor neuron

motor neuron disease A disease of the nervous system associated with the wasting away of motor neurons and linked to a lack in the regulation of the neurotransmitter glutamate

motor neurons Specialised neurons (efferent) that carry motor commands from the CNS to muscles, glands and organs

multi-store model of memory The memory model that visualises memory as a system consisting of multiple memory stores through which a stream of data flows for processing

myelin sheath A fatty layer coating some axons that protects the axon and assists with the speedy delivery of the nerve impulse

narcolepsy A sleep disorder in which an individual suffers sudden uncontrollable daytime sleep attacks accompanied by muscle paralysis lasting from a few minutes to half an hour

naturally occurring ASC An ASC that is produced spontaneously without any conscious effort or decision-making (e.g. daydreaming)

negative reinforcement When a response removes, reduces or prevents an unpleasant stimulus and creates a positive consequence; it increases or strengthens the likelihood of that response occurring again

nervous system A communication system that consists of networks of neurons that connects the brain, spinal cord and different parts of the body to each other via electrochemical signals.

neurodegenerative disease A disease that gradually and progressively kills nerve cells and results in nervous system dysfunction and permanent loss of ability

neurofibrillary tangles Twisted strands of tau protein found in the centre of dead and dying nerve cells

neurogenesis The production of new brain cells

neurohormone A chemical synthesised in the neuron that is secreted directly into the bloodstream to act on distant sites

neuromodulator Chemical substance that modifies the response of a neuron to a specific neurotransmitter

neuron An individual nerve cell that receives, transmits and processes information

neurotransmitter A chemical messenger synthesised within a pre-synaptic neuron and transmitted across the synapse

neutral stimulus (NS) A stimulus that does not naturally elicit any specific response

NMDA (*N*-methyl-D-aspartate) receptors Specific receptors found on the dendrites of post-synaptic neurons that bind glutamate

nodes of Ranvier Small gaps that occur at regular intervals in the myelin sheath that speed the transmission of the nerve impulse

norepinephrine Important in controlling arousal, wakefulness, hunger, learning and memory; it is also involved in a range of emotional experiences

normal waking consciousness (NWC) A state of consciousness characterised by clear and organised alertness to internal and external stimuli

NREM sleep A type of sleep that is broken into four stages, where the sleeper falls into a deeper and deeper sleep as the stages progress; characterised by relaxation of the muscles, a slowing down of physiological functions and brainwaves that decrease in frequency and increase in amplitude

nucleus The control centre of the neuron; also contains DNA

objective data Measurements of behaviour collected under controlled conditions, which allow data to be directly observed or measured

observational learning When learning occurs by watching (observing) others and noting the consequences of their actions, then imitating or not imitating their behaviour

observational studies A method of data collection that involves watching and recording the behaviour of other persons or animals within a specific environment and drawing conclusions based on the recorded observations

observer bias Bias in results of an observational study that occurs when an observer sees what they expect to see, or records only selected details of an observed behaviour

observer effect Changes in the behaviour of a person being observed caused by their awareness of the presence of an observer

obstructive sleep apnoea (OSA) A sleep disorder characterised by multiple non-breathing periods during sleep because of an obstruction or blockage in the upper airways

operant conditioning A learning process in which the likelihood of a behaviour being repeated is determined by the consequences of that behaviour

operant extinction When the learned response gradually decreases in strength or rate of response after reinforcement stops

operant spontaneous recovery The reappearance of a previously reinforced response after a period of apparent extinction

operant stimulus discrimination The ability to differentiate between stimuli similar to the stimuli that signal reinforcement and non-reinforcement

operant stimulus generalisation The tendency to respond to stimuli similar to stimuli that precede operant reinforcement

operational variable A variable defined or described in terms of the procedures used to observe and measure it

order effect Where prior knowledge of a task or situation influences a participant's performance, which in turn influences the results of the experiment; also known as the practice effect

paradoxical sleep Occurs during REM sleep where physiologically a lack of muscle tone is experienced and the body is still and relaxed, but cortically the brain is active and alert

paraplegia Damage to the middle and lower parts of the spinal cord, resulting in paralysis to both legs and part of the torso

parasomnias A group of sleep disorders characterised by abnormal or unusual behaviour or physiological occurrences during sleep

parasympathetic nervous system The branch of the ANS that maintains an energy level appropriate for normal bodily functioning and physically calms us after high arousal by reversing the changes in bodily functioning caused by the domination of the sympathetic nervous system

partial sleep deprivation Getting some sleep in a 24-hour period but less than normally required for optimal daytime functioning

participant variables Individual differences in the personal characteristics of research participants that, if not controlled, can confound the results of the experiment

participants The people or animals whose behaviour, characteristics or responses are investigated and measured as part of an experiment

participants' rights The individual rights of all participants that must be respected by the researcher, as outlined in ethical guidelines relating to psychological research

peripheral nervous system (PNS) A major division of the nervous system consisting of all the nerves outside of the CNS; transmits sensory information inwards to the CNS and transmits motor messages from the brain outwards to the rest of the body

perpetuating risk factors Factors that prolong the course of the mental health problem and inhibit recovery

phobia A persistent, irrational and intense fear of a specific object, activity or situation

physical exercise Any planned, structured or repetitive bodily movement produced by skeletal muscles that requires energy expenditure and aims to improve or maintain physical fitness

pineal gland A gland in the centre of the brain that secretes melatonin and helps regulate body rhythms and sleep–wake cycles

placebo A fake treatment that has no active effect, such as a fake pill or injection

placebo effect Changes in behaviour caused by the participant's belief that they have been exposed to a treatment that will affect them in some way

plasticity The brain's ability to reorganise its neural pathways when damaged or to adapt to changing conditions

polarisation When an axon is at rest there is an increase in negative ions inside the axon compared with positive ions outside

polysynaptic reflex A reflex response that involves the activation of more than one synapse; it includes an interneuron making a connection between a sensory and a motor neuron

population The larger group of research interest from which a sample in a research study has been drawn

positive reinforcement When a pleasant or desirable event follows a response and generally increases or strengthens the likelihood of that response occurring again

post-synaptic neuron The neuron that receives the impulse

post-traumatic stress disorder (PTSD) A pattern of symptoms following exposure to a stressful life event that sets off clinically significant distress or impairment of human functioning

pre-synaptic neuron The neuron that sends the impulse

precipitating risk factors Factors that trigger the onset or exacerbation of a mental health problem

predisposing risk factors Factors that increase vulnerability to develop a mental health problem

primacy effect The serial position effect where recall is best for the first items on the list, then for items at the end of the list, then for items in the middle of the list

primary appraisal In the transactional model of stress and coping, when we decide if a situation is threatening or positive, relevant or irrelevant to our situation

problem-focused strategies Approach strategies that directly target the stressor and aim to reduce it

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procedural memory A type of implicit LTM for learnt actions and skills that can usually only be expressed as actions

protective factors Factors that enhance or have a positive effect on the health of an individual

psychoactive drugs Any class of drug that alters the brain's chemistry, which subsequently changes a person's perceptions, thoughts and behaviours

psychoeducation The education about a mental illness such as the nature of the illness, its treatment and management strategies

psychological construct A concept used to describe something that is believed to exist, because we can measure its effects, but we cannot directly observe or measure it

psychometric vigilance test (PVT) A test used to measure behavioural alertness, where participants respond to a visual stimulus and their speed and accuracy of the task are measured

psychopathology The scientific and systematic study of abnormal experience, cognition and behaviour; also a term used to refer to psychologically unhealthy behaviour

psychosomatic illness Physiological symptoms that arise as a result of psychological stressors or factors

psychotherapy A psychological technique in the treatment of mental disorders, used to facilitate positive changes in personality, behaviour or adjustment

punisher Any unpleasant stimulus that reduces the likelihood of an unwanted behaviour occurring again

punishment Any event following a response that decreases the likelihood of the response occurring again because it introduces an unpleasant stimulus

quadriplegia Damage to nerves in the lower neck resulting in paralysis of the body below the neck

qualitative data Data that describe the changes in the quality of a behaviour; often accounts of personal attitudes or experiences, or descriptions of feelings

quantitative data Data collected through systematic and controlled procedures and presented in numerical form

questionnaire A written set of standardised questions that can be administered face to face, by mail, by telephone or via the Internet

random allocation A procedure for assigning participants to either the experimental group or control group in an experiment, ensuring that all participants have an equal chance of being allocated to either group

random sampling A sampling technique ensuring that every member of the population of interest has an equal chance of being selected for the sample being used in a study

range The difference between the highest score and the lowest score in a distribution

raw data The actual data collected from a study, before they are sorted or analysed; raw data appear in the appendix

recall A measure of retention that involves retrieving stored information using few or no cues for assistance

recency effect The serial position effect where recall is best for items at the end of a list, then for items at the beginning, then for items in the middle of the list

receptor cells Cells located in the sense organs that are specialised to detect (receive) specific types of sensory information

receptor sites Tiny areas on the cell membrane that are sensitive to certain neurotransmitters, located mainly on dendrites but also on the soma of neurons and in muscles and glands

reciprocal inhibition The concept that one emotional state is used to block another, as is the case in systematic desensitisation

recognition A measure of retention that involves identifying previously learnt information from a list or group of alternatives

reflex A simple response to a stimulus that is innate or involuntary

reflex action A simple automatic response that is hardwired into our nervous system

rehearsal The active manipulation of information in short-term memory in order to hold it for longer than the usual 18–20 seconds

reinforcement Any event that increases the likelihood that a response or behaviour will occur again

relaxation response The counterpart of the fight–flight response, which calms your body by reversing the effects of the sympathetic nervous system, returning it to its normal level of functioning

relearning A measure of retention that involves learning information that has been previously learnt and stored in LTM as a means of assessing whether any information was retained from the original learning

REM behaviour disorder A disorder whereby there is a failure of the muscle paralysis that occurs during REM sleep

REM rebound The process whereby an individual experiences extra amounts of REM sleep after being deprived of it

REM sleep A type of sleep characterised by brainwaves with high frequency and low amplitude; the muscles of the body are in a state of paralysis and dreams may be experienced

repeated-measures design An experimental design method where the same group of participants makes up both the experimental and control groups

repolarisation When the resting potential of the neuron is restored

research (or operational) hypothesis A hypothesis that operationalises the variables by precisely defining and describing how each variable is measured, and predicts the exact effect the IV is expected to have on the DV

resilience An individual's ability to properly adapt to stress and cope with adversity

response Any identifiable behaviour, external or internal, that is elicited by a stimulus

response cost When a reinforcer or positive state of affairs is removed following a response, and this decreases the likelihood that this response will occur again

resting potential The typical internal environment (negatively charged) of a neuron in comparison to external environment (positively charged)

restoration theory A theory that states that sleep is vital for replenishing and revitalising the mind and body to keep them functioning at optimal levels

retrieval The process of locating information stored in memory and bringing it into consciousness when needed, to complete a cognitive task

retrieval cues Any stimuli that assists in retrieval of information

retrograde amnesia A form of memory loss for events occurring before an amnesia-causing event

risk factors Factors that impede or have a negative effect on the health of an individual

rumination The compulsively focused attention on the symptoms of one's distress, and on its possible causes and consequences, as opposed to its solutions

sample The group of participants in a research study selected from, and representative of, a population of research interest

savings score A formula that calculates the percentage of information retained from original learning after relearning has occurred

schemas Preconceived ideas that represent aspects of the world or the things in it, influenced by culture and experience

scientific method A data-gathering method that involves testing a hypothesis by means of careful measurement and controlled observation

secondary appraisal In the transactional model of stress and coping, when we assess what resources are available to us to help combat or cope with the stressor

selective attention Attending to a particular stimulus while ignoring others; it requires a high level of awareness

self-efficacy An individual's belief in their capacity to execute behaviours necessary to produce specific performance attainments

self-fulfilling prophecy A prediction that prompts people to act in a way that makes the prediction come true

self-referencing An elaborative rehearsal technique involving linking new information to the self or to personal experience to hold it in short-term memory for longer than the usual 18–20 seconds and to increase its chances of transfer to and retrieval from LTM

self-report A data-collection technique in which individuals are asked to freely express their attitudes (verbally or in writing) by answering questions; involves an individual keeping a record of their own subjective experiences (thoughts, feelings and behaviours)

semantic memory A type of declarative memory for impersonal factual knowledge about the world

semantic network theory The theory of how information in LTM is stored and organised in a hierarchical network of linked meaning

sensory memory The first stage of the multi-store model of memory; it receives and stores an unlimited amount of sensory information for up to a few seconds

sensory neurons Specialised neurons (afferent) that carry sensory information from internal and external environments inwards towards the CNS

sensory register A subsystem of sensory memory that receives and stores specific sensory information received from a sense organ

serial position effect A pattern of recall for list items, where recall is better for items at the beginning or end of a list than for items in the middle

serial recall Recalling information from memory in the order or sequence in which it was learnt, with no cues for assistance

serotonin A neurotransmitter found in the CNS; involved in the regulation of pain, mood and sleep

shift work disorder A circadian phase disorder caused by a person's work hours being scheduled during the normal sleep period (at night), causing their circadian rhythms to be out of step with their work patterns

shift work Hours of paid employment that are outside the period of a normal working day and may follow a different pattern in consecutive periods of weeks

shock The first stage of alarm-reaction in the GAS, where resistance to stress drops below normal and the body acts as though it is injured; blood pressure and body temperature decrease

short-term memory (STM) The second and most active memory system in the multi-store model of memory; stores a limited amount of information entering from sensory memory or retrieved from LTM for a short period of time unless the information is rehearsed

single-blind procedure An experimental procedure where participants do not know which experimental condition they have been assigned to, but the experimenter does

sleep An altered state of consciousness that features the suspension of awareness of the external environment and is accompanied by a number of physiological changes to the body

sleep apnoea A sleep disorder characterised by multiple non-breathing periods during sleep, where breathing stops between 20 seconds and up to 2 minutes

sleep debt The amount of sleep loss accumulated from an inadequate amount of sleep, regardless of the cause

sleep deprivation Going without sleep or not getting sufficient amounts of sleep to support optimal daytime functioning

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sleep diary A log of subjective behavioural and psychological experiences surrounding a person's sleep

sleep disorder A condition that consistently disrupts the normal NREM–REM sleep cycle

sleep laboratory A controlled environment that enables the electronic recording and measurement of sleep patterns

sleep latency The period of time it takes a person to fall asleep

sleep phase delay A shift in the sleep–wake pattern towards the evening that causes a delay in sleep onset

sleep spindles A type of brain activity characterised by a short burst of high-frequency brainwaves, experienced during Stage 2 NREM sleep

sleep-deprivation psychosis A disruption of mental and emotional functioning as a result of lack of sleep

sleep-onset insomnia A sleep disorder characterised by an inability to fall asleep at the beginning of the night, or at the point of normal 'sleep onset'

sleep–wake cycle The rhythmic biological pattern of alternating sleep with wakefulness over a 24-hour period

sleep–wake cycle shift Changes in how sleep is initiated and maintained as well as the percentage of time spent in each stage of sleep, caused by the circadian rhythms that regulate the sleep–wake cycle shifts to a different sleep and wake time

sleepwalking A sleep disorder characterised by a sleeping person walking and sometimes completing routine tasks or activities, often when in deep sleep (Stages 3–4 NREM)

slow-wave sleep (SWS) A sleep state characterised by the emergence of delta waves; SWS is experienced during Stages 3 and 4 NREM sleep

social factors Factors related to culture and environment that impact on behaviour

social learning theory Proposes that behaviour is learnt from the environment through the process of observational learning

soma The main cell body of a neuron that contains the nucleus

somatic nervous system The division of the PNS that transmits sensory information received from sensory receptor cells inwards towards the CNS, and motor messages from the CNS to the body's voluntary skeletal muscles; also known as the skeletal nervous system

specific phobia An intense, irrational fear and avoidance of a particular object, activity or situation

spinal cord A part of the CNS that consists of a cable of nerve fibres stretching from the base of the brain to the lower back, that transmits sensory information from the PNS to the brain and motor messages from the brain to the PNS

spinal nerves Part of the PNS; form a direct connection between spinal cord and muscles, organs and glands throughout the body, allowing sensory and motor messages to travel to and from the brain

spinal reflex The simplest stimulus response that occurs in the spinal cord

spontaneous recovery The reappearance of a conditioned response to the conditioned stimulus after a period of apparent extinction

stage of exhaustion The final stage of the GAS, where the body's resources are depleted and its resistance to stress falls below normal

stage of resistance The second stage of the GAS, where the resistance to stress remains above normal levels; cortisol is released to help repair the damage caused by stress on the body

standardisation Establishing standards for administering a test and interpreting scores

state of consciousness An individual's level of awareness of internal and external stimuli at any given moment

state-dependent cues Retrieval cues associated with your internal physiological or psychological state at the time the memory was formed, which enhance the retrieval of memories formed in that state

statistical significance A number obtained from inferential statistics that provides an estimate of how often experimental results could have occurred by chance alone; expressed as '*p*-value'

stigma Social disapproval of an individual's personal characteristics or beliefs, or social disapproval of a type of behaviour

stimulants A group of drugs that elevate mood, increase alertness and reduce fatigue by exciting neural activity in the brain, which increases bodily functions; they include caffeine, nicotine, amphetamine, methamphetamine and cocaine

stimulus Any object or event that elicits a response

stimulus discrimination The ability to discriminate between stimuli so that only a specific stimulus produces the conditioned response

stimulus generalisation When stimuli similar to the conditioned stimulus produce the conditioned response

storage The retention of information in the memory system over time

stratified sampling A sampling technique that ensures the sample contains the same proportions of participants that are found in the population

stress A state of mental or physical tension that occurs when an individual must adjust or adapt to their environment but they do not feel they have the capacity to do so

stress responses A set of physical and psychological responses that are automatically triggered as a result of sympathetic nervous system activation following the perception of a threat

stressor The object or the event that causes a feeling of stress

subjective data Data collected through personal observations, interpretations, emotions and judgement

substance abuse The harmful or hazardous use of psychoactive substances, including alcohol and illicit drugs

substantia nigra A midbrain structure composed of nerve cells that produce dopamine, associated with movement control

suprachiasmatic nucleus (SCN) A cluster of neurons in the hypothalamus situated directly above the optic chiasm that receives information about the intensity and duration of light from the retina via the optic nerve, which it uses to regulate the body's circadian rhythms associated with the sleep–wake cycle

sympathetic nervous system The branch of the ANS that alters the activity level of internal muscles, organs and glands to physically prepare our body for increased activity during times of high emotional or physical arousal

synapse The microscopic gap between neurons, over which messages pass

synaptic plasticity The term used to describe the changes that occur to the synaptic connection between two or more neurons

synaptic pruning A process of removing extra, weak or unused synaptic connections so that neural transmission is as efficient as possible

synaptic vesicles Sacs that store neurotransmitters, these vesicles move to the surface and release a neurotransmitter when a neural impulse arrives at an axon terminal

synaptogenesis The process by which synapses are formed between neurons

systematic desensitisation A type of behavioural therapy whereby an individual with a phobia or fear is exposed to the fear-producing object, activity or situation very slowly, by degrees, under relaxed conditions until the fear response is extinguished

theta waves Brainwaves experienced during the early stages of sleep, with a mix of medium–high amplitude and a low–medium frequency

threshold The point at which a nerve impulse is triggered

tonic immobility Physical relaxation to the point of immobility

total sleep deprivation Getting no sleep at all in a 24-hour period

transactional model of stress and coping A model that proposes that stressful experiences are a transaction between a person and their environment; if demands exceed resources, stress is the likely result

transcription factor A protein involved in the expression of genes (which are turned 'on' or 'off')

ultradian rhythm A biological rhythm that follows a cycle of less than 24 hours; such as eye-blinks, heartbeats and sleep patterns

unconditioned response (UCR) The natural, automatic response to a specific unconditioned stimulus

unconditioned stimulus (UCS) A specific stimulus that is innately capable of eliciting a reflex response

uncontrolled variable An extraneous variable whose influence has not been eliminated from an experiment because the experimenter was not aware of it

variability A single number that tells us the degree to which scores in a distribution are spread out or clustered together

variable Any event, condition or characteristic that changes (varies) or can be made to change

vertebrae Rings of bone surrounding the spinal cord that form the spinal column (backbone)

vesicles Small sacs within the pre-synaptic neuron that contain neurotransmitters

video monitoring Videotaping a person while they are sleeping to record and then analyse any observable disturbances in their sleep

visual imagery Forming a mental representation, or mental picture, of an item or scene

voluntary participation Participation whereby participants agree to take part in an experiment free from pressure or fear of negative consequences

white matter The outer layer of the spinal cord that contains only myelin-coated axons

withdrawal rights A participant's right to withdraw from a study or research at any time without experiencing any negative consequences

working memory Part of our memory system that temporarily stores and manipulates a limited amount of information needed to perform cognitive tasks

Yerkes-Dodson curve A graph that demonstrates the relationship between arousal and performance, showing the optimal level of performance; insufficient or excessive arousal results in insufficient performance

zeitgeber An external cue such as light, temperature, noise and food that can influence biological cyclical changes

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SELECTED ANSWERS

CHAPTER 1

CHECK YOUR UNDERSTANDING 1.1

1 First: receive sensory information from our external or internal environment.

Second: process sensory information so that we understand it.

Third: organise a coordinated response to this information by our muscles, organs and glands.

Example: We feel a cat rub up against our leg. We process the sensory information and then we make a coordinated response to look down and pick up the cat. Examples will vary.

2 B

3 The brain can be referred to as the engine room because it receives and processes information from the rest of the body and generates responses to it. It is responsible for everything we think, feel and do, and therefore controls the overall functioning of the nervous system.

4 A

5 B

6 Grey matter is located in the centre of the spinal cord and is made of cell bodies, their axons and their dendrites. White matter is located in the outer layers of the spinal cord, forming columns that run the length of the spinal cord and made up entirely of myelin-coated axons.

7 Ascending tracts transmit sensory information up the spinal cord to the brain. Descending tracts transmit motor information down the spinal cord to nerves of the peripheral nervous system.

CHECK YOUR UNDERSTANDING 1.2

1 C

2 B

3 The purpose of the 12 cranial nerves is to allow sensory and motor messages to travel directly to and from organs in the head, such as our eyes, ears and mouth, directly to the brain to be processed.

4 Students are encouraged to think of their own example, so answers will vary. A possible example: When we are running a shower and adjusting the water temperature, sensory receptors in your skin register the temperature and that information is transmitted by sensory neurons in the somatic nervous system up the spinal cord and on to the brain. The brain then identifies whether we need to adjust the water temperature by adding more hot or cold water. The brain then sends messages via motor neurons down the spinal cord to muscles in your arm and hand to enable you to turn the taps.

5 a Autonomic
 b Somatic
 c Autonomic
 d Autonomic
 e Somatic
 f Autonomic

6 The ANS controls involuntary responses by connecting to muscles that control the activity level of our internal organs and glands where as our somatic nervous system controls voluntary responses by transferring sensory information from sensory receptors to the brain and receiving motor information from the brain to enable voluntary muscle movements.

7 D

CHECK YOUR UNDERSTANDING 1.3

1 D

2 D

3 a Parasympathetic
 b Sympathetic
 c Parasympathetic
 d Sympathetic
 e Sympathetic
 f Parasympathetic

4 Examples of some changes:
- Isaac's heart rate will increase to pump blood at a faster rate around his body so he has the energy to run around the oval.
- An expansion of his lungs will deliver more oxygen to Isaac's muscles.
- An increased release of sugars from Isaac's liver will provide him with energy to play.
- Increased perspiration will help cool the body and regulate Isaac's body temperature while he is playing.
- Isaac's pupils will dilate to allow more light into his eyes so he can see more effectively.

5 The parasympathetic nervous system is responsible for returning Isaac's body to its normal level of functioning so he can maintain homeostasis. This response is slower than that of the sympathetic nervous system because levels of adrenalin and other hormones that are released during vigorous activity (and influence our internal organs) take time to disappear.

6 We would experience stress (a state of intense arousal that causes our internal systems to operate at abnormally high levels), which could lead to a range of physiological and psychological disorders.

7 The sympathetic nervous system is activated quickly so that increased levels of adrenalin and other hormones can instantly enter our bloodstream. However, these hormones take some time to disappear, which is why the effects of the parasympathetic nervous system last longer than those of the sympathetic nervous system.

CHECK YOUR UNDERSTANDING 1.4

1 C

2 B

3 Spinal reflexes aid our survival because they allow us to react quickly, by making rapid responses to stimuli that may be potentially dangerous.

4 Monosynaptic reflexes involve the interaction between a sensory neuron and a motor neuron and therefore only a single synapse between the two is activated. A polysynaptic reflex involves the activation of more than one synapse as a sensory neuron sends the message via an interneuron to a motor neuron to enable the response. Therefore more than one synapse is activated.

5 When Ivan touches the hot oven door he immediately removes his hand because sensory receptors in the skin detect the pain and send the message along sensory neurons directly to the spinal cord via at least one interneuron and onto a motor neuron that causes the muscle in Ivan's arm to contract so he can withdraw his arm. This occurs quickly and independently of the brain.

6 The activities of our autonomic nervous system are mostly self-regulating because they control involuntary (or smooth) muscles that regulate the activity level of our internal organs and glands such as heart rate and body temperature. An independent and constantly functioning ANS means that the vital organs and body systems we depend on for physical survival are kept functioning more or less automatically – and without any conscious effort.

7 During periods of stress or when our arousal levels remain heightened, we may use techniques such as meditation and yoga to reduce our stress or arousal levels. They work because they involve relaxation techniques (e.g. breathing exercises), which help us gain control over our autonomic nervous system.

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CHECK YOUR UNDERSTANDING 1.5

1 C
2 B
3 A
4 C
5 Dendrites receive incoming chemical messages from neighbouring neurons and send the message inwards to the soma. The axon transmits the message in the form of an electrical impulse to the axon terminals where it crosses the synapse to the next neuron in a chemical form.
6 The axon terminal of the pre-synaptic neuron release a neurotransmitter into the synapse and then this neurotransmitter is absorbed by the receptor sites in the dendrites of the post-synaptic neuron.
7 Synaptogenesis is important because it allows us to form many new synaptic connections between neurons and to establish the neural pathways that allow different brain areas and structures to communicate. Those pathways that are most often stimulated and strengthened (due to being used most often) become a permanent part of the brain. New synapses are constantly created and strengthened as a result of learning, exposure to new experiences and even in the formation of memories.

CHECK YOUR UNDERSTANDING 1.6

1 B
2 C
3 b, d, a, c
4 D
5 'Afferent' means carrying towards or inwards, therefore sensory neurons are also referred to as afferent neurons because they send information inwards to the spinal cord.

   'Efferent' means moving away from or outwards, therefore motor neurons are also referred to as efferent neurons because they send motor messages out to the rest of the body.
6 • Sensory neurons detect and respond to specific types of external energy or internal stimulation, whereas motor neuron enable movements to be made.
   • Sensory neurons carry information inwards to the brain, whereas motor neurons carry information outwards to the muscles organs and glands.
   • Sensory neurons are located in the ascending tracts of the spinal cord, whereas motor neurons are located in descending tracts.
7 Interneurons are important because they enable you to respond instantly in a manner that enhances your survival. These specialised nerves, located primarily in the spinal cord of the CNS, form a direct connection between motor neurons and sensory neurons. Interneurons are activated when sensory neurons receive an intense sensation and enable the activation of motor neurons and a quick response (independent of the brain).

CHECK YOUR UNDERSTANDING 1.7

1 D
2 C
3 C
4 A
5 Synaptic vesicles store the neurotransmitters, and when the action potential reaches the axon terminal these synaptic vesicles move to the surface of the membrane and release the neurotransmitter.
6 Just as a key has its own patterns and shape that fit into a specific hole in a lock, each neurotransmitter has a distinct molecular shape that fits into a specific receptor site. Likewise, just as a correct key opens the right lock, a neurotransmitter attaches to a specific receptor site.
7 Agonists drugs increase the release of neurotransmitters or imitate certain neurotransmitters causing the post-synaptic neuron to fire an action potential, whereas antagonists drugs inhibit the release of neurotransmitters or block the receptors sites for these neurotransmitters.

CHECK YOUR UNDERSTANDING 1.8

1 D
2 C
3 D
4 GABA is an inhibitory neurotransmitter and stops or slows down neural transmission, whereas glutamate is an excitatory neurotransmitter and allows action potentials to fire and therefore speeds up neural transmission. Neural transmission requires a balance between these neurotransmitters so that they can work together to regulate the flow of messages around the brain.
5 Excessive amounts of glutamate can be toxic because it can affect the development of neural circuits, leading to inappropriate connections being formed.
6 Anxiety disorders. These types of drugs are agonists because they increase the activity of GABA, thereby inhibiting post-synaptic action potentials and as a result calming down the body's responses.
7 It has been found that low levels of GABA are associated with less inhibition of neurons firing, thus an excess of action potentials are fired throughout the brain causing a seizure. Glutamate with its opposing effect continues to produce excitatory responses in neural transmission. This lack of GABA and continued release of glutamate can also cause an imbalance of brain activity, leading to overstimulation and epileptic seizures.

CHECK YOUR UNDERSTANDING 1.9

1 C
2 D
3 D
4 The primary motor symptoms of PD include:
   • unpredictable tremor, or shaking
   • rigidity, or stiffness of the muscles
   • bradykinesia, or slowness of movement and gradual loss of spontaneous movement
   • reduced coordination and balance.
5 Dopamine is a neurotransmitter that is involved in the transmission of impulses that direct smooth, coordinated voluntary movements. When neurons in the structure of the brain associated with Parkinson's disease are damaged, their ability to produce dopamine is impaired. Damaged dopamine-producing neurons generate less dopamine so when this happens, the symptoms of Parkinson's disease appear.
6 Accumulation of the alpha-synuclein protein occurs, causing Lewy bodies (abnormal parts of a neuron) to form, and it can also impair structural components such as axons and axon terminals.
7 Excessive accumulation of alpha-synuclein can occur in dopamine-producing neurons and therefore affect the transmission of dopamine.

CHECK YOUR UNDERSTANDING 1.10

1 A
2 A
3 A
4 Carlsson findings suggested that a decrease in dopamine leads to impaired movement and motor control, and that injection of the drug levodopa results in restored movement.
5 Difference: Levodopa is absorbed by brain cells and converted to dopamine, whereas dopamine agonists stimulate the dopamine receptors of the brain, thereby mimicking the effect of dopamine.

   Similarity: They can both have side effects that are sometimes worse than the initial symptoms of the condition. One of these side effects is dyskinesia (abnormal involuntary movements).
6 Benefits of LCIG: It results in constant plasma concentrations of levodopa, therefore there is a reduction in the time it takes for the medication to wear off, with improvements in side effects associated with dyskinesia also evident.

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7 a dopamine
b dopamine and glutamate
c glutamate
d serotonin
e glutamate and GABA
f acetylcholine
g GABA
h GABA and serotonin

APPLY YOUR KNOWLEDGE AND SKILLS

SECTION A: MULTIPLE-CHOICE ANSWERS

1 D	6 D	11 B
2 C	7 D	12 B
3 A	8 D	13 D
4 C	9 B	14 C
5 A	10 B	15 D

CHAPTER 2

CHECK YOUR UNDERSTANDING 2.1

1 B
2 D
3 D
4 D
5 B
6 *Eustress* is considered to be positive because it results in a positive psychological state that is enjoyable and increases our alertness and energises us. Examples: excitement, enthusiasm and optimism. *Distress* is considered to be negative because it results in a negative psychological state that is not enjoyable and impedes our ability to perform and cope at an optimal level. Examples: anger, anxiety, fear, or feelings of helplessness and hopelessness.
7 Possible answers: *Acute stress* is the body's immediate response to a perceived stressor; it results in high, intense arousal; it is usually short term; it usually doesn't cause psychological or physical damage; it can motivate and energise us. *Chronic stress* is the body's response to a persistent or long-term stressor; it often does not appear to be intense; it produces a long-term and higher than normal physiological arousal; it can cause psychological and physiological damage because it depletes our body's natural resources.

CHECK YOUR UNDERSTANDING 2.2

1 B
2 A
3 B
4 C
5 B
6 *Daily pressures* are frequently experienced stressors consisting of relatively minor events that require adjustments in behaviour. *Life events* are stressors that consist of significant but relatively rare events that require substantial adjustments in behaviour within a relatively short time.
7 The greater the degree of assimilation, the lower the level of acculturative stress.

CHECK YOUR UNDERSTANDING 2.3

1 D
2 D
3 C
4 A *major life event* is a significant but relatively rare event (positive or negative) that requires a change in behaviour within a relatively short time. A catastrophe is a sudden, unpredictable, intense event that causes large-scale damage and long-term suffering for a group.
5 People find it easier to recover from the stress caused by a natural disaster than a man-made disaster because natural disasters can be seen as inevitable or fate, so there is no-one to blame. Man-made disasters could have been prevented, so someone can be blamed.
6 Any three of the following: The person should persistently re-experience the traumatic event through flashbacks or vivid nightmares; the person actively avoids any reminders of the traumatic event; the person experiences negative changes in thought and emotions; the person experiences behavioural changes, such as constantly feeling highly aroused and on alert; the symptoms must be present for at least 1 month; the person experiences significant distress or impairment in functioning.

CHECK YOUR UNDERSTANDING 2.4

1 C
2 C
3 B
4 C
5 When confronted by a threat, we would freeze if we felt helpless and unable to fight the stressor or run away to safety.
6 A *stressor* is any person, object or event that is perceived as threatening. *Stress* is the mental and/or physical tension experienced when a person perceives a stressor and has to change their behaviour to meet its demands, but they feel they do not have the capacity to do so. The *stress response* is the involuntary physical and/or psychological changes caused by the perception of a stressor, which automatically activates the sympathetic nervous system.
7 The fight–flight–freeze response is the body's automatic response option to a threat. If we think we can defeat the threat or escape it, the sympathetic nervous system is activated and, in turn, it activates the fight–flight response that causes the physiological changes that energise us and physically prepare our body to deal with the stressor by either confronting it (fight) or running away to safety (flight). If we feel helpless and overwhelmed by the stressor, the parasympathetic nervous system is activated. It overrides the sympathetic nervous system and immobilises us.

CHECK YOUR UNDERSTANDING 2.5

1 D
2 A
3 A
4 B
5 C
6 Possible answers include:
- extreme loss of skeletal muscle tension and relaxation of bladder and bowels to conserve energy that can be redirected to core organs needed for basic survival until the danger has passed
- a release of endorphins that activate the body's opiate receptors, causing a numbing effect so the person doesn't feel intense pain
- a rapid drop in blood pressure, which helps reduce blood loss from wounds.

7 The general adaptation syndrome suggests that prolonged stress depletes our body's natural resources and weakens our immune system, causing us to be more susceptible to long-term illness or disease.

CHECK YOUR UNDERSTANDING 2.6

1 A
2 C
3 A
4 The relaxation response is the counterpart of the fight–flight response. It calms your body by reversing the effects of the sympathetic nervous system and returning it to its normal level of functioning.
5 Cortisol is a steroid hormone produced by the adrenal glands involved in a range of biological functions essential to the maintenance of homeostasis (e.g. proper glucose metabolism, regulation of blood pressure, insulin release for blood sugar maintenance, immune function and anti-inflammatory reactions, and central nervous system activation).
6 Too much cortisol in your bloodstream can cause a biochemical and hormonal imbalance that can have a number of negative effects (e.g. suppressed thyroid function, blood sugar imbalances, decreased bone density and muscle tissue, higher blood pressure, lowered immunity and inflammatory responses, and increased weight gain due to accumulation of abdominal fat).

CHECK YOUR UNDERSTANDING 2.7

1 C
2 D
3 B
4 C
5 The *transactional model of stress and coping* suggests that stress response is determined by psychological factors unique to the individual because it results from our cognitive appraisal of the stressor (challenge or threat) followed by our assessment of the personal and social resources we have to cope with the stressor. The *general adaptation syndrome model* suggest that the stress response is a typical three-stage non-specific physiological response caused by any demands placed on the body by either unpleasant or pleasant conditions.
6 Cognitive appraisal determines an individual's unique stress response because it involves the person identifying the degree of threat a stressor poses to them and an evaluation of their coping resources.
7 Possible answers include: distinguishes between eustress; considers the role a range of psychological factors such as personality, motivation and confidence play in the stress response and acknowledges that stress is a subjective experience; highlights that people can change their appraisal of a stressor and their response to it, therefore the individual plays an active role in their stress response.

CHECK YOUR UNDERSTANDING 2.8

1 D
2 C
3 A
4 Coping is a process that involves a person constantly changing their thoughts and behaviours so they can manage the demands (internal or external) of stressors they appraise as taxing or exceeding their resources.
5 Because the demands placed on a person by a stressor vary according to the nature of the stressor, one coping strategy may be effective in dealing with one stressor but not effective in dealing with a different stressor.
6 Some coping strategies could be considered maladaptive because they do not help the person deal with the stressor and often intensify its effects.

CHECK YOUR UNDERSTANDING 2.9

1 B
2 A
3 B
4 Physical exercise is any planned, structured or repetitive bodily movement produced by skeletal muscles that requires energy expenditure and aims to improve or maintain physical fitness.
5 Physical exercise promotes the release of endorphins, which are a group of mood-lifting neurotransmitters that help us cope with the psychological and social pressures associated with stress more effectively.
6 Physical exercise is an effective way of coping with stress because, although it does not remove or reduce a stressor, it prepares the body and mind to cope more effectively with stress.

CHECK YOUR UNDERSTANDING 2.10

1 B
2 A
3 C
4 *Approach* coping strategies consist of behavioural or psychological responses designed to change (remove or diminish) the nature of the stressor or how one thinks or feels about it. *Avoidance* coping strategies involve choosing your response to a stressor based on trying to either cognitively or behaviourally avoid or escape painful or threatening thoughts, feelings, memories or sensations associated with the stressor.
5 Avoidance strategies are considered to be less effective strategies for coping with stress than approach strategies because, unlike approach strategies, they do not target the source of the stress or help the person manage it. They may also lead to the development of maladaptive behaviours (e.g. substance abuse).

APPLY YOUR KNOWLEDGE AND SKILLS

SECTION A: MULTIPLE-CHOICE ANSWERS

1	C	6	A	11	C
2	D	7	D	12	B
3	D	8	D	13	B
4	D	9	D	14	C
5	B	10	B	15	A

CHAPTER 3

CHECK YOUR UNDERSTANDING 3.1

1 A
2 B
3 C
4 B
5 The CNS consists of the brain and spinal cord; it sends motor messages to the PNS and receives and processes sensory information. The PNS transmits the messages to or from the brain and spinal cord to or from the rest of the body.
6 Kandel used aplysia because they are simple-celled organisms with large neurons that can be easily observed.
7 Neural pathways are strengthened as an organism learns, including changes to the number of neurotransmitters.

CHECK YOUR UNDERSTANDING 3.2

1 A
2 B
3 B
4 Increased branching of dendrites in some areas of brain, thicker cortices, greater synapse formation
5 Synaptogenesis: the formation of new neural connections between neurons as the axons and dendrites extend and link to form a synapse
6 It occurs typically early in development, but also as an organism learns or is exposed to stimuli.
7 In an *enriched environment*: 'bushier' dendrites, more synaptic connections in the brain, more efficient transmission of messages through neural networks. In a *deprived environment*: fewer synaptic connections, less bushy dendrites

CHECK YOUR UNDERSTANDING 3.3

1 D
2 D
3 A
4 Neuroplasticity is the umbrella term to describe the malleability of the brain and nervous system, allowing the brain to be reorganised or 're-wired' in response to experiences over a lifetime
5 a by modifying the strength or efficacy (effectiveness) of synaptic transmission of existing synaptic connections
  b by producing growth of new synaptic connections or the pruning away of existing ones, or
  c by modulating the excitability properties of individual neurons.
6 To enable an organism to adapt to changing conditions (to learn)
7 Synaptic connections allow the transmission of information whereas may allow neural networks to become more efficient

CHECK YOUR UNDERSTANDING 3.4

1 A
2 B
3 D
4 D
5 A pre-synaptic neuron sends a message via neurotransmitters across the synaptic gap to the receiving neuron, the post-synaptic neuron.
6 Within a neuron: electrical stimulation
Between neurons: chemical (neurotransmitters)

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7 Neurotransmitters will either activate (increase likelihood of action potential) or inhibit the post-synaptic neuron.

CHECK YOUR UNDERSTANDING 3.5

1 D
2 A
3 A
4 D
5 Long-term potentiation (LTP) is a form of neural plasticity that leads to a long-lasting increase in neural excitability at the synapse along specific neural pathways as a result of changes in the efficacy (effectiveness) of synaptic transmission.
6 Hebb proposed that neurons that form a synaptic connection and 'fire together' will become strengthened and 'wire together'.
7 Removal of the hippocampus may result in an inability to consolidate some forms of long-term memory.

CHECK YOUR UNDERSTANDING 3.6

1 C
2 A
3 D
4 A
5 The pre-synaptic neuron needs to be electrically stimulated and the ions entering through gated channels are positively charged. This causes a release of neurotransmitters via the vesicles to cross the synaptic gap to the post-synaptic neuron.
6 The glutamate binds to AMPA receptors opening the cell up for sodium ions to enter and also binds to the NMDA receptors. This causes the cell to become positively charged (depolarised) and for the magnesium ion to be removed from the NMDA receptor, allowing more sodium as well as calcium ions to enter the cell. There are also internal changes to the cell, and more AMPA receptors may emerge if there is sufficient calcium entering the cell. The cell will then become further depolarised and transmit a message.
7 Long-term potentiation: When a particular stimulus is repeatedly presented, so is a particular circuit of neurons stimulated and therefore the circuitry becomes more efficient at transmitting messages, and the effects are long-lasting, which is part of the learning and memory-formation process.

CHECK YOUR UNDERSTANDING 3.7

1 A
2 A
3 C
4 LTD may enable pruning and removal of synapses that are not needed, improving the efficiency of the network.
5 LTD is the reduced excitability of a post-synaptic neuron.
6 LTP results in a more efficient transmission of neural information, whereas LTD will result in a decrease in neural transmission.
7 Kinase and phosphatase are enzymes found in cells. Kinase can work to release phosphate, allowing it to bind to other parts of the cell, whereas phosphatase prevents the phosphate from binding.

CHECK YOUR UNDERSTANDING 3.8

1 D
2 A
3 D
4 A
5 *Hormones* are released from glands into bloodstream to act on specific target cells. *Neurotransmitters* are released from the pre-synaptic neuron vesicles to act on adjacent post-synaptic neurons. *Neurohormones* are released from the pre-synaptic neuron into the bloodstream to act on specific target cells.
6 Neurotransmitters are produced in the neuron, are stored and transmitted in vesicles, transmit from pre-synaptic to post-synaptic neuron, and bind to specific receptor sites on the post-synaptic neuron.
7 Chemically, hormones and neurotransmitters can be similar; it is the function of the chemicals that defines them. For example, hormones act on more distant sites and neurotransmitters act locally at the synapse.

CHECK YOUR UNDERSTANDING 3.9

1 D
2 D
3 D
4 D
5 Ionotropic receptors are involved in allowing ions to travel into and out of cells.
6 Glutamate binds to glutamatergic receptors on the post-synaptic neuron, causing changes to the ion environment within the cell. This depolarises the neuron, causing an action potential to occur.
7 Ionotropic receptors are activated by neurotransmitters such as glutamate, causing the channels or gates to open and allowing the cell to depolarise as positively charged ions enter the cell.

CHECK YOUR UNDERSTANDING 3.10

1 C
2 A
3 D
4 B
5 Adrenaline acts on cells to increase heart rate and blood pressure so blood can be carried around the body faster, expands the lungs' air passages so we can take in more oxygen, and enlarges the eyes' pupils so we can take in more light to see better. Adrenaline's main role is to provide energy so that the major muscles of the body can either 'fight' the threat or 'flee' from the threat.
6 When an emotional arousing event occurs, and drugs that block adrenaline in the body are administered, the event is not well remembered compared to when adrenaline is activated.
7 The amygdala, hippocampus and cortex

APPLY YOUR KNOWLEDGE AND SKILLS

SECTION A: MULTIPLE-CHOICE ANSWERS

1	C	6	D	11	D
2	D	7	B	12	D
3	A	8	C	13	B
4	C	9	B	14	C
5	A	10	D	15	D

CHAPTER 4

CHECK YOUR UNDERSTANDING 4.1

1 B
2 A
3 D
4 A *stimulus* is any object, event or thing that comes before a response. A *response* is any behaviour that occurs elicited by a stimulus. Example: stimulus = wind blowing dirt in face; response = blinking to avoid dirt going into eyes.
5 All classically conditioned behaviours are the result of pairing a neutral stimulus with a stimulus that reflexively produces a response.

CHECK YOUR UNDERSTANDING 4.2

1 C
2 D
3 B
4 Before conditioning: a stimulus that does not elicit any relevant response (NS)

During conditioning: A NS is paired (multiple times) with a UCS, which reflexively elicits an UCR.

After conditioning: Learning is complete when the NS becomes the CS, which occurs when the CS can elicit the CR without the presence of the UCS.
5 Conditioning has occurred if the CS (what was once the NS) can elicit the CR without the presence of the UCS.

CHECK YOUR UNDERSTANDING 4.3

1 D
2 B
3 B
4 NS – cockatoo; UCR – fear or crying due to mother's screaming; UCS – mother's screaming and running inside; CR – fear of cockatoo; CS – seeing a cockatoo
5 *Extinction*: If the cockatoo is presented a number of times without the mother screaming and running away, the fear (CR) will eventually extinguish or stop.

   Spontaneous recovery: If after a period of extinction the cockatoo is presented again, the CR may reappear (usually a weaker response that extinguishes quickly).

   Stimulus discrimination: There is only the fear response (CR) to cockatoos (CS), not other species of birds.

   Stimulus generalisation: There is a fear response (CR) to other birds that may look similar to a cockatoo, such as a white seagull.

CHECK YOUR UNDERSTANDING 4.4

1 D
2 B
3 A
4 (1) The alarm sounding is the stimulus that signals (2) the behaviour to get out of bed, with (3) the consequence that David gets to school on time.
5 Answers will vary.

CHECK YOUR UNDERSTANDING 4.5

1 A
2 B
3 A
4 Similarities: Both increase the likelihood of a behaviour occurring in the future.

   Differences: Positive reinforcement applies a pleasant stimulus after a desired behaviour, whereas negative reinforcement is the removal of an unpleasant stimulus when a desired behaviour is completed.

   Positive reinforcement example: My teacher gives me praise and smiles at me when I answer the question correctly.

   Negative reinforcement example: My teacher stands behind my desk when I am talking too much, so I stop talking and my teacher moves away.
5 A reinforcer will increase the likelihood of a behaviour occurring in the future. A reward may not reinforce behaviour; it only acts as a reinforcer if it is desirable for the individual.

CHECK YOUR UNDERSTANDING 4.6

1 C
2 C
3 A
4 Punishment and response cost can be more effective if they occur shortly after the undesirable behaviour, if they are appropriate (not too severe) for the age and the reason they are being used for, when reinforcement cannot or is difficult to administer.
5 Punishment:

   Antecedent – Tom's friend calls him a nasty name.

   Behaviour – Tom pushes his friend.

   Consequence – Teacher makes Tom clean up the yard for pushing.

   Response cost:

   Antecedent – Amanda's mum asks her to do her homework.

   Behaviour – Amanda does not do her homework.

   Consequence – Amanda cannot go to the movies with her friends.

CHECK YOUR UNDERSTANDING 4.7

1 A
2 D
3 B
4 Stimulus generalisation: If a dog is conditioned to sit at the command 'sit', the dog may also sit when a different antecedent is used such as 'bit' because it is similar to the antecedent used during conditioning.

   Stimulus discrimination: If the dog only sat when the command 'sit' was used, then it is showing stimulus discrimination and has learnt only to respond to that antecedent.
5 The psychologist may use positive reinforcement (which should increase the likelihood of a behaviour occurring in the future). She could offer him 5 minutes free time for every 10 minutes he can sit without interrupting. Eventually Morgan may be able to sit for the entire session. Or she may punish him every time he interrupts, perhaps using response cost by keeping him in class for lunch if he interrupts.

CHECK YOUR UNDERSTANDING 4.8

1 C
2 D
3 C
4 Operant conditioning: Learning can take place without anyone else present. There is no modelling required, unlike observational learning, which requires a model or someone to watch.

   They both include elements of reinforcement, which predicts the likelihood of the behaviour occurring again in the future.
5 Attention: Peter will need to watch other surfers and pay attention to what they do.

   Retention: He will need to make a mental representation of the surfers' moves so that he can remember these when he starts surfing.

   Reproduction: Peter will need to have the physical and psychological capacity to learn to surf and to replicate the correct moves.

   Motivation: He will need to want to learn to surf.

   Reinforcement: He may have the personal satisfaction of being able to surf or he may have others praise his surfing.

CHECK YOUR UNDERSTANDING 4.9

1 C
2 D
3 D
4 Attention: The children watched adult models behaving aggressively towards a Bobo doll.

   Retention: The children made a mental representation of the behaviour they observed.

   Reproduction: The children had the physical and psychological capacity to learn and to perform the aggressive behaviour.

   Motivation: Some children may have wanted to learn the behaviour because it was modelled by an adult (modelling of appropriate behaviour) and they may have wanted to impress the adult.

   Reinforcement: Some children saw the model being rewarded for aggression; some received tangible rewards.
5 Possible extraneous variables: Children's backgrounds – perhaps some children were previously exposed to high or low levels of violence. The sample may not represent the population (socioeconomic and cultural factors). Ensure that the sample is large and use stratified sampling to make it as representative as possible.
6 Attention: Claire needs to pay attention to her mother's actions while driving.

   Retention: She needs to make a mental representation of the actions she observes.

   Reproduction: Claire will need to have the psychological and physiological capacity to learn to drive.

   Motivation: Claire will need to want to learn to drive; for example, so that she can drive herself around.

   Reinforcement: Claire will avoid crashing or fines if she learns properly, and can become more independent.

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CHECK YOUR UNDERSTANDING 4.10

1 B
2 D
3 C
4 a Informed consent
  b Do no harm
  c Debriefing
  d Confidentiality
5 The experiment was not ethical. There would be no point attempting to replicate the experiment because there are sufficient individuals in the population with conditioned fear responses (phobias), and the experiment caused harm to the participant (that was the nature of the experiment).

APPLY YOUR KNOWLEDGE AND SKILLS

SECTION A: MULTIPLE-CHOICE ANSWERS

1	B	6	C	11	B
2	A	7	D	12	D
3	C	8	C	13	B
4	B	9	C	14	B
5	D	10	D	15	A

CHAPTER 5

CHECK YOUR UNDERSTANDING 5.1

1 A
2 C
3 D
4 C
5 We cannot consciously control sensory memory because we need to be exposed to all external stimuli we come in contact with so we don't miss important survival-related stimuli. By controlling STM via selective attention, we are able to focus on important stimuli and ignore unimportant stimuli.
6 STM has a limited duration because there is a constant stream of information entering it. If information was held for too long, we might miss some new important information.
7 Sensory memory's unlimited capacity ensures that we receive all important and potentially dangerous information from our environment. Sensory memory's limited duration allows us to select the most important information for further processing and ignore less important information. These qualities help us adapt our behaviour to suit a constantly changing environment, therefore our survival chances are enhanced.

CHECK YOUR UNDERSTANDING 5.2

1 A
2 B
3 A
4 B
5 A
6 Answers will vary. Example: Knowing that you received a blue bicycle for your 10th birthday is an explicit memory. The memory of how to ride the bicycle is an implicit memory.

CHECK YOUR UNDERSTANDING 5.3

1 B
2 D
3 B
4 C
5 The amygdala evaluates environmental stimuli for danger or threat. It determines the emotional significance of the stimuli before the cerebral cortex receives the information and regulates our emotional response to it.
6 If the hippocampus is damaged, the person will have short-term memory problems (explicit) because the hippocampus is unable to receive information sent from cortical areas that initially receive and process the various features that comprise a memory. Therefore, it cannot form a complete integrated memory of a single, multi-faceted event.

CHECK YOUR UNDERSTANDING 5.4

1 B
2 C
3 B
4 B
5 Recognition is a more sensitive measure of retention than recall because it provides retrieval cues that serve as prompts or reminders of information that could not otherwise be recalled. Recall provides no, or minimal, retrieval cues.
6 Recognition is a measure of retention that involves identifying previously learnt information from a list or group of alternatives. For example, a multiple choice test on a topic you have studied. Cued recall involves recalling information from memory with some cues or hints for assistance. For example, being asked to name the 4 lobes of the cerebral cortex but being given the first letter for each of the lobes.
7 The group asked to write names were using recall, a measure of retention that involves retrieving stored information using few or no cues for assistance. The group shown the photograph before they were asked to name their workmates was using recognition, a measure of retention that involves identifying previously learnt information from a list or group of alternatives.

CHECK YOUR UNDERSTANDING 5.5

1 A
2 C
3 A
4 You could use relearning to track your progress in Psychology by taking a test of a topic you have studied for the first time and recording your score. Then, without re-reading the information, take the test again 4 weeks later and record your score. Then, re-read the information 4 weeks later and take the test again and record your score. Compare your three scores.
5 Schemas are preconceived ideas that represent aspects of the world or the things in it, influenced by culture and experience.
6 Show the person a video clip of an event (for example, a car approaching an intersection and colliding with another car) and then ask them to write down their recollections of the event as accurately as possible.

CHECK YOUR UNDERSTANDING 5.6

1 A
2 C
3 C
4 A
5 Amnesia is a temporary or permanent, partial or complete loss of memory. Amnesia can result from physical injury to the brain or from traumatic experiences that either consciously or unconsciously motivate a person to forget the experience.

CHECK YOUR UNDERSTANDING 5.7

1 D
2 C
3 D
4 D
5 D
6 Amnesia is not a progressive neurodegenerative disease, it is a loss of memory than can result from brain damage caused by disease, brain trauma or psychological trauma. Dementia is a general term to describe a condition caused by neurodegenerative disease (e.g. Alzheimer's disease) that destroys brain cells and results in amnesia, but it also involves other significant cognitive and behavioural decline.
7 Amyloid plaques collect on the outside of and between nerve cells. They destroy the synapses, therefore they disrupt the conduction of nerve impulses between brain neurons. Neurofibrillary tangles form in the centre of dead and dying nerve cells and cause brain volume to shrink. They disrupt the normal organisation of brain cells, therefore they

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disrupt the conduction of nerve impulses within a brain cell. Acetylcholine is a neurotransmitter that carries information between the synapses of cells. Because Alzheimer's disease systematically destroys the neurons that produce acetylcholine, reduced levels of acetylcholine disrupts the conduction of nerve impulses between brain neurons.

CHECK YOUR UNDERSTANDING 5.8

1 A
2 C
3 D
4 Retrieval cues help us to remember because they supply information present when the memory was formed or encoded that help to access memories stored in long-term memory and bring them to conscious awareness. The absence of retrieval cues increases the chance of forgetting because it is more difficult to locate the memory stored in LTM.
5 If Gizelle visualises (mentally revisits) the swimming pool where she won the race, details of this location may provide context-dependent cues that help her remember who came second and the colour of her bathing costume. If Gizelle can mentally recreate how she was feeling (physiologically and/or psychologically) when she won, these state-dependent cues may also assist her memory of who came second and the colour of her bathing costume.

CHECK YOUR UNDERSTANDING 5.9

1 B
2 B
3 D
4 D
5 C
6 Any two of the following reasons:
   - Elaborative rehearsal organises new information according to meaning, so it adds more detail to the dates; maintenance rehearsal does not add meaning.
   - Elaborative rehearsal adds more detail to the dates so it creates more potential retrieval cues because it links the dates to information already stored in Conrad's LTM; maintenance rehearsal does not add detail or create potential retrieval cues.
   - Elaborative rehearsal requires deeper processing and this increases his understanding; maintenance rehearsal involves shallow processing and does not increase understanding.
7 Psychologists believe the serial position primacy and recency effect demonstrates that STM and LTM are separate memory subsystems. The primacy effect is believed to occur because the STM is empty when the first items on a list enter it, so there is no other information in the STM to interfere with them. They receive full attention and are able to be rehearsed, which increases their chances of being transferred to LTM. When recall immediately follows learning, the last few list items can be accessed because they are still stored in STM and still undergoing rehearsal, therefore they are readily available for recall.

CHECK YOUR UNDERSTANDING 5.10

1 D
2 B
3 C
4 B
5 Factors that might influence the accuracy of eyewitness testimony include expectations, beliefs, past experiences, ideals and mood at the time the memory was formed and the introduction of leading questions introduced at the time of recall.
6 Leading questions can cause eyewitness testimony to be inaccurate because they manipulate memory by adding information after the event that is incorporated into the memory during retrieval.

APPLY YOUR KNOWLEDGE AND SKILLS

SECTION A: MULTIPLE-CHOICE ANSWERS

1	D	6	D	11	B
2	C	7	B	12	A
3	B	8	C	13	A
4	A	9	B	14	C
5	B	10	B	15	C

CHAPTER 6

CHECK YOUR UNDERSTANDING 6.1

1 Consciousness is personal because it consists of your understanding and perceptions of the world around you. It is unique for each individual. Consciousness is selective because you pay attention to some things in the environment while ignoring others. For example, while reading an interesting novel you are completely focused on it, so you don't notice the TV on in the background or the birds chirping outside your window. Consciousness is continuous because its contents are blended into one another with no specific beginning or end. Your consciousness is never empty. Consciousness is also considered to be constantly changing, as your thoughts are always moving from topic to topic.
2 A psychological construct is a concept used to describe something that we believe exists but we cannot measure its effects because they cannot be directly observed. Consciousness is an example of a psychological construct because we all know it exists as we are able to think about and manipulate information. For example, if someone was asked to work out a simple maths equation in their heads most people are able to mentally manipulate the equation and solve the problem; however, we could not directly observe a person completing this task.
3 C
4 B
5 D
6 C

CHECK YOUR UNDERSTANDING 6.2

1 Normal waking consciousness (NWC) is state of consciousness characterised by clear and organised alertness to internal and external stimuli. Other characteristics of NWC include moderate to high levels of awareness, good memory and cognitive abilities, selective attention on specific tasks, appropriate emotions, a degree of self-control, and an accurate perception of time, sensations and reality. An altered state of consciousness (ASC) is a state of consciousness that is characteristically different from NWC in terms of awareness, sensation and perception. Some characteristics of an ASC include low levels of awareness, memory difficulties, reduced cognitive abilities, difficulty paying attention to specific tasks, distorted perception of reality, inappropriate or uncharacteristic emotions, a lack of self-control and difficulty in accurately perceiving time and sensations.
2 A naturally occurring ASC is produced spontaneously, without any conscious effort or decision making (e.g. daydreaming). An induced ASC is intentionally produced (e.g. being under the influence of drugs or alcohol).
3 The electroencephalograph (EEG) is used by researchers to detect, amplify and record the brain's electrical activity, measured in the form of brainwaves. By knowing the particular electrical activity of the brain, we can determine a person's level of awareness and state of consciousness. There are four types of brainwaves, known as beta, alpha, theta and delta waves, all of which indicate different states of consciousness. Beta brainwaves are associated with being awake and alert, alpha brainwaves indicated a relaxed state, and theta and delta brainwaves indicate stages of sleep.

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4 Frequency in relation to brainwaves refers to the number of brainwaves per second, whereas amplitude refers to the size of the peaks and troughs (or the intensity of the brainwave) from a baseline of zero activity.
5 B
6 D
7 The EMG detects, amplifies and records the electrical activity created by active muscles. This is done using electrodes attached to the skin's surface. EMG electrodes are typically placed under the chin, arms and legs, since muscles in this area show changes that are associated with different levels of consciousness.

CHECK YOUR UNDERSTANDING 6.3

1 A psychometric vigilance test is used to measure behavioural alertness. It requires participants to respond to a visual stimulus and measures their speed and accuracy. It is often used to see if they are experiencing any impairments due to being in an ASC; for example, in a sleep-deprived state.
2 C
3 Sleep diaries are an example of a subjective recording because they enable a person to keep a record of their own psychological and behavioural experiences leading up to their sleep, during their sleep and when they wake up in the morning.
4 C
5 One limitation is inaccurate recordings. Often people don't remember all the things they did during the day or they forget to write them down, so when they try to remember later, their recollections may be incomplete or distorted. Also, we don't recall what we do when we sleep, so our estimates of how much sleep we had may be unreliable. People may also neglect to record things out of fear or embarrassment because they may be worried about how it will be interpreted and may only want to record what they believe the experimenter or sleep scientist will want to read.
6 An individual may need to be videotaped while they sleep to record any observable disturbances in their sleep. An individual may not even be aware of these disturbances and therefore will not report them in their sleep diary or the disturbances may not be detected by another physiological recording device.

CHECK YOUR UNDERSTANDING 6.4

1 A controlled process is an action that requires a high level of conscious awareness, attention and mental effort (e.g. writing an essay or preparing for an English SAC). An automatic process is an action that requires little conscious awareness or mental effort (e.g. washing dishes).
2 *Selective attention* involves attending to a particular stimulus while ignoring others; it requires a high level of awareness and is usually needed when performing a controlled process. *Divided attention* is when an individual simultaneously focuses on two or more stimuli, or simultaneously undertakes two or more tasks; it is used when completing an automatic process.
3 A
4 D
5 B

CHECK YOUR UNDERSTANDING 6.5

1 When in NWC we have the ability to control what content enters our consciousness; for example, we can block wildly bizarre thoughts such as those that make us embarrassed, upset, distressed, afraid or hurt. When in an ASC we have less control over 'blocking' these thoughts; our thoughts are also more illogical compared to NWC.
2 *Perceptual distortions* refer to mistakes that are made when internally processing our external environment. In an ASC, sensations and perceptions can be dulled or blunted, or they can be sharpened. For example, individuals in a drug-induced ASC may experience hallucinations where they see images or hear voices that do not exist or are not real. *Cognitive distortions* refer to mental processes that are disorganised, illogical, fragmented and lacking sequence. One example of a cognitive function is memory. Memory can be distorted when in an ASC because it tends to be disrupted and less accurate.
3 D
4 A
5 Example: falling asleep and waking up feeling as if you have been asleep for hours, only to find you slept just a few minutes; or being woken by your alarm in the morning and feeling as if you have been asleep only a few hours, when in reality you have had a full night's sleep.
6 D

CHECK YOUR UNDERSTANDING 6.6

1 Psychoactive drugs are effective at altering consciousness because the drugs cross the blood–brain barrier. The blood–brain barrier is a mechanism that prevents or slows the passage of certain molecules in the blood from entering the brain but allows other molecules to enter. Psychoactive drugs enter the brain and therefore affect neural transmission. Some psychoactive drugs alter brain chemistry by mimicking the activity of neurotransmitters; others block neurotransmitters by binding to receptor sites.
2 Tolerance occurs when a person builds up a resistance towards a specific drug and needs to take a higher dose in order to feel the drug's effects. This tends to occur when a person has been abusing a drug or using a drug for an extended period of time. Extended drug use can also lead to dependence, where the person's drug use has become part of their bodily functions and if discontinued, symptoms of withdrawal may be experienced.
3 Stimulants are a group of drugs that elevate mood, energy levels, increase alertness and reduce fatigue. They do this by exciting neural activity in the brain which increases bodily functions. Drugs in this category tend to increase blood pressure and heart rate, constrict blood vessels and increase blood glucose. Drugs in this category include caffeine, nicotine, amphetamines, methamphetamines and cocaine.
4 Consuming over 400 milligrams of caffeine per day is considered to be over the daily limit, although individual differences such as metabolism, body mass and state of health need to be considered when considering excessive amounts. Excessive amounts of caffeine can lead to anxiousness, sleeplessness, rapid heart palpitations and trembling.
5 A
6 Amphetamines and methamphetamines both have similar effects on consciousness, such as increasing your ability to stay awake and alert, and increasing your focus and attention. They both affect the brain by stimulating the chemicals noradrenaline and dopamine in the brain. Differences include the way each drug is manufactured, their use and their potency. Methamphetamines derive from amphetamines. Methamphetamines are more potent and have a stronger effect on the body.
7 The experience of the euphoric rush is due to the neurotransmitters dopamine, serotonin and noradrenaline in the brain, which all have mood-lifting properties. When they are released into the synapse, cocaine binds to the pre-synaptic neuron, inhibiting the process of re-uptake. As a result these neurotransmitters remain in the synapse, intensifying their normal mood-elevating effects.

CHECK YOUR UNDERSTANDING 6.7

1 D
2 Research has found the following:

The use of caffeine increases beta brainwaves.

The use of nicotine increases alpha brainwaves.

The use of amphetamines and methamphetamines increases beta brainwaves.

The use of cocaine increases beta and alpha brainwaves.

3 Depressants are a class of drug that calm neural activity and slow down bodily functions. Some of the effects of depressants include increased fatigue and drowsiness, lowered heart rate, reduced anxiety and calmed nerves. Drugs in this category include alcohol, barbiturates, benzodiazepines, opioids and cannabis.

4 C

5 Some of the effects of moderate alcohol consumption include reduced inhibitions; feeling relaxed, calmer and more confident; loss of self-control; impaired mobility and coordination; and slower reaction times. Some of the effects of excessive alcohol consumption include blurred vision, nausea, vomiting, aggression, confusion, memory loss and even unconsciousness.

6 Benzodiazepines work by binding to the receptor site of post-synaptic neurons to increase the functioning of GABA. GABA works by blocking neural transmission, therefore producing a calming effect on the body.

CHECK YOUR UNDERSTANDING 6.8

1 A

2 When a person takes heroin, the CNS is in a depressed state – breathing rate, blood pressure, body temperature and heart rate all drop. A person's breathing may sometimes stop altogether, causing coma, unconsciousness or even death. The drug is also dangerous because of its highly addictive properties.

3 Cannabis is often difficult to classify due to the mixed effects of the drug. In smaller doses it is classified as a depressant because it produces effects such as feeling relaxed, drowsy and excited. When taken in larger doses, cannabis is considered a hallucinogen because its effects include blurred vision, bloodshot eyes, hallucinations, delusions and paranoia.

4 B

5 Research has found the following:

- The use of alcohol increases alpha brainwaves.
- The use of barbiturates in high doses increases delta brainwaves.
- The use of benzodiazepines increases beta brainwaves.
- The use of opiates increases theta and delta brainwaves.
- The use of cannabis increases alpha brainwaves.

6 B

CHECK YOUR UNDERSTANDING 6.9

1 B

2 In 1959, Peter Tripp deprived himself of sleep for 201 hours. After 100 hours, he began to experience hallucinations, including seeing cobwebs in his shoes. After 170 hours, he struggled with simple thoughts and reasoning, and had memory problems. His brainwave patterns looked like those of someone asleep, and he was no longer sure who he was. By the end of 201 hours, Tripp was unable to distinguish between his waking nightmares, hallucinations and reality.

In 1964, Randy Gardner went 264 hours (11 days) without sleep. At various times, Randy experienced irritability, memory lapses, difficulty concentrating and difficulty in naming common objects.

3 D

4 A

5 Sleep deprivation impairs working memory. Research has shown reduced activity of the frontal lobe when sleep deprived, consistent with the location of working memory functions. Long-term memories (particularly declarative memories) are also affected by sleep deprivation, with research showing significantly lower activity in the hippocampus and medial temporal lobe regions in forming declarative memories in a sleep deprived state.

6 B

7 Research has shown that sleep deprivation can increase a person's vulnerability to developing a mood disorder such as depression. Researchers have found a link between sleep deprivation and the onset of mood and anxiety disorders. One study reported that chronic insomnia sufferers are more likely to develop depression and anxiety disorders.

CHECK YOUR UNDERSTANDING 6.10

1 Blood alcohol concentration (BAC) refers to the amount of alcohol present in the bloodstream to determine how a person may be affected by alcohol. BAC is measured using a breathalyser or saliva or urine sample, with breathalysers being the most commonly used in Victoria.

2 In Victoria the legal BAC when driving is under 0.05 for drivers with a full licence and 0.00 for probationary drivers and professional drivers such as heavy truck drivers, taxi drivers and bus drivers.

3 D

4 C

5 The aim of the study by Williamson & Feyer (2000) involved investigating the difference between the effects of sleep deprivation and equivalent BACs.

6 It was hypothesised that participants who went without sleep for 17–19 hours would have reduced performance on tasks measuring attention, memory and reaction times comparable to participants with a BAC of 0.05.

7 The results of the study found that going without sleep for 17–19 hours is the equivalent of having a BAC reading of 0.05.

APPLY YOUR KNOWLEDGE AND SKILLS

SECTION A: MULTIPLE-CHOICE ANSWERS

1	A	6	D	11	B
2	D	7	A	12	D
3	D	8	A	13	B
4	B	9	C	14	B
5	B	10	A	15	C

CHAPTER 7

CHECK YOUR UNDERSTANDING 7.1

1 A

2 When spending a night in a sleep laboratory, an individual will sleep in a controlled environment that enables the electronic recording and measurement of sleep. A patient may be hooked up to an EEG to record brainwave activity during sleep, an EMG to record the muscle movements, an EOG to record the eye movement or even an electrocardiograph to record the activity of the heart during the night. As well as these physiological measures, an individual will also be asked to self-report their activity of their sleep.

3 During REM sleep the EOG will detect high activity because rapid eye movement will be present. During NREM the EOG will detect low activity because little or no eye movement is detected.

4 C

5 As the night progresses, REM sleep lasts much longer; by the end of the night it may last up to one hour.

6 A

CHECK YOUR UNDERSTANDING 7.2

1 D

2 C

3 Sleep spindles occur during Stage 2 NREM. These are are short bursts of high-frequency brainwaves. Spindles seem to mark the true boundary of where sleep begins.

Stage 2 sleep is also characterised by K-complexes, which are single, large bursts of high-amplitude brainwaves that are thought to be involved in memory consolidation.

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4 C

5 C

6 As we progress though NREM stages, our heart rate and breathing rate slow down.

7 We spend approximately 80 per cent of the night in NREM sleep, although the amount of time spent in NREM sleep may increase after physical exertion such as running a marathon, which suggests that NREM sleep helps us recover from fatigue incurred during the day.

CHECK YOUR UNDERSTANDING 7.3

1 D

2 A

3 C

4 To describe something as 'paradoxical' means that it seems to be the opposite of what you expect, or self-contradictory. REM sleep is often described as paradoxical sleep because brainwaves during this stage resemble alertness; however, REM sleep is actually quite a deep sleep because it is difficult to wake an individual in this stage. During REM sleep, the heart beats faster, breathing is more rapid and irregular, blood pressure varies, the genitals become aroused and the eyes dart around in their sockets. Yet with all of this internal activity going on, the body appears totally relaxed, with the muscles in a state of atonia, or paralysis.

5 The main characteristic of REM behaviour disorder is a lack of muscle paralysis during REM sleep. This disorder could potentially be dangerous if a person begins to act out their dream, especially if they are dreaming about something such as driving, cooking or even bungee jumping.

6 Approximately 80 per cent of dreams are experienced during REM sleep compared to NREM. Dreams experienced during this stage tend to be longer, clearer and more detailed than thoughts and images that occur in NREM sleep.

7

	EEG	EMG	EOG
Awake	High level of activity; beta brain waves present when the person is active and alert	High level of activity as the person's muscles are moving frequently	High level of activity as the person is constantly blinking
Stage 1 NREM	Alpha and theta brain waves present	May be a burst of activity due to a hypnic jerk	Little to no activity as eyes are not moving rapidly
Stage 2 NREM	Theta brain waves are present; the EEG may also record sleep spindles and K-complexes	Progressively less activity	Little to no activity as eyes are not moving rapidly
Stage 3 NREM	Theta and delta brain waves are present	Progressively less activity	Little to no activity as eyes are not moving rapidly
Stage 4 NREM	Delta brain waves are present	Progressively less activity	Little to no activity as eyes are not moving rapidly
REM	Beta-like (saw-tooth waves) brainwaves are present	Little to no activity as muscles are not moving at all	High activity as eyes are moving rapidly

CHECK YOUR UNDERSTANDING 7.4

1 A

2 The term 'endogenous' means that circadian rhythms are controlled by internal biological processes. Zeitgebers are external cues such as light, temperature, noise and food, which can also influence cyclical changes in circadian rhythms.

3 For humans, the dominant circadian rhythm is the sleep–wake cycle. Throughout the 24-hour day there are periods of time when we are awake, active and alert, and periods of time when we are inactive, asleep and resting.

4 A

5 The suprachiasmatic nucleus (SCN) is found in the hypothalamus. The SCN is a cluster of 20 000 nerve cells found deep within the brain, located just above the optic chiasm, which is where the optic nerves from the two eyes cross. The SCN receives information from the optic nerve about light at night; the lack of light stimulation activates the SCN to trigger another brain region, the pineal gland, to release a hormone called melatonin. Melatonin levels in the bloodstream respond to cycles of light and dark, making us feel drowsy when released, which helps us to fall asleep.

6 C

CHECK YOUR UNDERSTANDING 7.5

1 D

2 Eye-blinks, heart beats and sleep patterns

3 Sleep cycles are considered to be ultradian rhythms because they follow a cycle that is less than 24 hours. Each sleep cycle lasts for approximately 90 minutes. One full sleep cycle will include periods of REM and NREM sleep. The amount of time spent in NREM and REM for each cycle will differ depending on how many hours we have been asleep. We will typically experience five ultradian sleep cycles each night.

4 D

5 C

CHECK YOUR UNDERSTANDING 7.6

1 NREM sleep is essential to restore biological processes, such as restoring hormone levels depleted by daytime activity, repairing muscles and tissue that may have been damaged as a result of daytime activity, and detoxifying muscles.

2 D

3 Three research examples include:
- Studies indicate that lack of adequate sleep weakens our immune system, thus we become more susceptible to illness and disease as the body cannot repair itself during NREM sleep.
- Children and young people (who are generally more physically active during the day than older people) spend a larger portion of their sleep in slow-wave sleep than older people because NREM sleep restores the body and replenishes energy.
- Research has found that individuals who partake in strenuous daytime physical activity, such as running a marathon, will spend more time in NREM sleep because their body will likely need more time to repair and recover from their daytime activities.

4 The restoration theory suggests that REM sleep is essential for the restoration (or renewal) of mental processes because it allows the brain time to replenish itself, regenerate and refocus.

5 Supporting evidence for REM's restorative functions comes from the amount of time we spend in REM sleep over our lifespan. During our life, the amount of time spent in REM sleep is greatest during periods of development, such as infancy, when the brain is growing rapidly or undergoing reorganisation. Supporters

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of the restoration theory suggest that this reduction in time spent in REM sleep as we age indicates that REM sleep provides the neural stimulation necessary for the brain to develop neuronal circuits early in life.

6 A

CHECK YOUR UNDERSTANDING 7.7

1 D

2 Large grazing animals such as elephants need to consume a lot of calories to obtain the energy they need to live. Because the type of food (vegetation) they eat contains few calories, they must consume a lot of it to meet their requirements, and this consumption takes time. Elephants only sleep 3–4 hours a day; if they slept 8 hours a day, they probably wouldn't have enough wake time for all their necessary activities (eating) required for survival.

3 Adults spend approximately 8 hours asleep and 16 hours awake. (The rest of the answer is based on the student's opinion.)

4 One criticism of the evolutionary theory is that if small animals sleep a lot, they are left defenceless and are more vulnerable to attack, therefore it is safer for them to be awake, not asleep. If the evolutionary theory states that we need to be awake to conduct activities important for survival, then small animals with many predators should spend most of their hours awake rather than asleep, which is not always the case.

5 B

CHECK YOUR UNDERSTANDING 7.8

1 C

2 On average, newborn babies sleep approximately 16 hours a day, and 50 per cent of that time is spent in REM sleep. By the end of infancy, the amount of sleep drops to 12–13 hours, with the proportion of sleep in REM also dropping.

3 B

4 C

5 Differences: Adolescents require approximately 9 hours of sleep compared to adults, who require 7–8 hours. Adolescents also experience a sleep–wake cycle shift, which prevents them from feeling tired until late in the evening; adults do not experience this phenomenon. Similarities: Both adults and adolescents spend 20 per cent of their sleep in REM and 80 per cent of their sleep in NREM.

6 Elderly people sleep less compared to any other stage of the lifespan; they sleep on average 6 hours a day. They will also wake frequently throughout the night and spend less time in Stages 3 and 4 NREM (deep sleep).

7 Adolescents often report feeling sleep deprived because they try to maintain a balance between the demands of school, work, sport and social commitments. Also, many don't feel sleepy early in the night and often stay up late. Some suggestions to improve sleep include making sleep a priority, ensuring a regular sleep cycle by going to bed and waking up at the same time every day, managing stress, having a relaxed atmosphere in the bedroom, not drinking caffeine within 6 hours of bedtime and avoiding screen time before bed.

APPLY YOUR KNOWLEDGE AND SKILLS

SECTION A: MULTIPLE-CHOICE ANSWERS

1	B	6	D	11	C
2	D	7	B	12	B
3	C	8	D	13	C
4	B	9	B	14	D
5	C	10	A	15	B

CHAPTER 8

CHECK YOUR UNDERSTANDING 8.1

1 B

2 C

3 D

4 C

5 Circadian rhythms are regular automatic physiological changes (influenced by regular variations in the environment) controlled by the suprachiasmatic nucleus that occur during a 24-hour cycle to regulate bodily processes.

6 The automatic circadian rhythms that regulate a range of physical, mental and behavioural processes are synchronised to a 24-hour day–night cycle. The amount of external light acts as an environmental cue that signals to our body when to be alert and active and when to rest.

7 The suprachiasmatic nucleus (SCN) receives messages from the visual system about the strength and duration of light received by the eyes' retinas. The SCN then sends signals to the pineal gland indicating that the external light level is high or low. In response, the pineal gland adjusts its secretion of melatonin, the hormone that induces sleepiness. The less external light there is, the more melatonin is secreted and the sleepier we become. When the light level increases, melatonin secretion reduces and we become more aroused and alert.

CHECK YOUR UNDERSTANDING 8.2

1 A

2 C

3 During adolescence there is a natural shift forward, by approximately 1–2 hours, in the release of melatonin. This means that the adolescent finds it difficult to sleep before 11 p.m. As dawn approaches and there is more external light, melatonin secretion slows and the secretion of cortisol increases, signalling to the adolescent's brain that is time to wake up. However, because adolescents need approximately 9 hours of sleep per night, they are not ready to wake and be alert before 8 a.m.

4 A circadian phase disorder results from disruptions to a person's circadian rhythms that cause them to operate out of alignment with rhythms in the external environment, particularly the natural day–night cycle.

5 The adolescent is regularly tired and irritable during the day because they are sleep deprived. During adolescence there is a natural shift in the sleep–wake cycle causing melatonin, the hormone that induces sleep, to be released later. This means their adolescent does not feel sleepy until approximately 11 p.m. Because adolescents need roughly 9 hours of sleep per night, they are not ready to wake up before 8 a.m. However, since the demands of their daily schedule require them to wake around 7 a.m., they are losing sleep each night. As this sleep loss accumulates, they become sleep deprived, and one of the symptoms of sleep deprivation is daytime tiredness and irritability.

6 Television emits light and the more light there is in the bedroom, the less melatonin is secreted and the more aroused we are. Attempting to sleep with a television on may delay the onset of sleep or make staying asleep difficult.

7 Possible symptoms of a delayed sleep phase disorder include difficulty falling asleep at the desired time, difficulty maintaining sleep and waking frequently during the night, chronic tiredness during waking hours, difficulty trying to follow a daytime schedule and not feeling refreshed or energised when waking.

CHECK YOUR UNDERSTANDING 8.3

1 D

2 D

3 D

4 Shift work disorder is a circadian phase disorder caused by a person's work hours being scheduled during the normal sleep period (at night), causing their circadian rhythms to be out of step with their work patterns.

5 Shift work disrupts circadian rhythms. It requires people to be active and alert when their natural circadian rhythms prepare them for sleep and for them to

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sleep when their natural rhythms prepare their body to be active and alert.

6 Working on rotating shifts causes greater interference to circadian rhythms than working on a set shift because the person's circadian rhythms don't have a chance to adjust to the frequent changes.

7 Possible reasons: body temperature is naturally higher during the day; melatonin secretion is naturally suppressed during the day; environmental factors also make it harder for shift workers to sleep during the day (e.g. more noise and natural light, external temperature is higher than at night); eating at night when the body is biologically programmed for sleep; on their days off shift workers often resume a normal day–night schedule to spend time with family, and this disrupts any adjustments their circadian rhythms may have made; many shift workers work indoors, where the artificial light is too weak to shift their circadian rhythms towards a natural day–night schedule.

CHECK YOUR UNDERSTANDING 8.4

1 A
2 B
3 C
4 D
5 Jet lag is a temporary extrinsic circadian phase disorder characterised by fatigue and sleep disturbance that result from a disruption of the body's normal circadian rhythm following long periods of air travel through several time zones in one day.

6 Possible things you can do to avoid or minimise jet lag: if you arrive late in the day or during the night, avoid light so your circadian rhythms can move 'ahead' of local time, then expose yourself to as much light as possible during the following day so that your body clock shifts forward and synchronises with local time; change eating and sleeping times to fit the time these activities would occur in your place of arrival; during transit, try to recreate the desired environmental cues to suit adjustment to destination time; take synthetic melatonin to help resynchronise circadian rhythms; slowly adjust sleep patterns by an hour each day before you travel.

7 Travelling in a westerly direction helps reduce jet lag because countries west of where you begin are behind in time. So, travelling west lengthens your day. You gain an hour for each time zone you cross and this causes a delay in your biological clock because it extends the time you need to stay awake.

CHECK YOUR UNDERSTANDING 8.5

1 A
2 B
3 Partial sleep deprivation involves getting some sleep in a 24-hour period but less than normally required for optimal daytime functioning. Total sleep deprivation involves not getting any sleep in a 24-hour period.

4 Acute partial sleep deprivation refers to a lack of adequate sleep time required for optimal daytime functioning; usually lasting 1–2 days. Chronic partial sleep deprivation refers to regularly sleeping less than the normal time needed for optimal daytime functioning.

5 Possible emotional effects of partial sleep deprivation: an inability to regulate emotions; mood swings; increased irritability and anger; a lack of motivation, and feelings of sadness and depression; an inability to process emotional information and put it into context.

CHECK YOUR UNDERSTANDING 8.6

1 D
2 B
3 D
4 Sleep deprivation affects performance on simple tasks more than complex tasks because it is more difficult to maintain attention when undertaking a simple task.

5 Microsleeps are short periods of sleep where the individual appears to be awake. Microsleeps are dangerous because the person loses awareness of their environment so they may not notice any potentially dangerous environmental changes.

6 Possible *physiological effects*: a lack of energy, extreme tiredness, lethargy, trembling hands, drooping eyelids, an inability to focus the eyes, increased sensitivity to pain, headaches, slowed reflexes. Possible *psychological effects*: mood swings, an increase in negative emotions, irritability, reduced motivation, easily bored, reduced empathy towards others, an inability to cope with stress, memory lapses, difficulty maintaining attention and concentration, difficulty processing information, difficulty thinking logically and problem solving, reduced creativity, distorted perceptions, poor decision making, slowed reaction rate, reduced spatial awareness.

CHECK YOUR UNDERSTANDING 8.7

1 A
2 D
3 Three effects of total sleep deprivation that are not associated with acute partial sleep deprivation are sleep-deprivation psychosis, hallucinations (after 72 hours) and psychomotor impairments equivalent to those induced by alcohol consumption at or above the legal limit.

4 REM rebound is the process whereby an individual experiences extra amounts of REM sleep after being deprived of it. Its purpose is to make up for lost REM sleep.

5 If a person suffered from sleep-deprivation psychosis they might experience a loss of connection to reality characterised by psychological behaviours such as confusion, disorientation, paranoia, anxiety and depression.

CHECK YOUR UNDERSTANDING 8.8

1 B
2 C
3 B
4 D
5 D
6 Dysomnias are a group of sleep disorders characterised by persistent difficulty falling asleep, remaining asleep or waking up too early, and by hypersomnia.

7 Possible symptoms of sleep-onset insomnia include an inability to fall asleep at the beginning of the night, or at the point of normal 'sleep onset'; not feeling refreshed on waking; feeling tired and lethargic during waking hours; a reduced sense of wellbeing; difficulties with concentration and memory; mood swings; a lack of motivation; feeling depressed or anxious; irritability; and increased clumsiness and impaired performance.

CHECK YOUR UNDERSTANDING 8.9

1 C
2 D
3 B
4 C
5 Possible similarities: in both CSA and OSA, breathing stops between 20 seconds and up to 2 minutes while the person is asleep; both are characterised by loud snoring; both occur hundreds of times a night; both disrupt the sleep cycle; both can result in hypersomnia.

Possible differences include:

- CSA occurs because the brain stops sending signals to the diaphragm muscles that control breathing to maintain normal breathing. OSA occurs as a result of an obstruction or blockage in the upper airways, making it impossible for the person to breathe.
- In the case of CSA the chest and abdomen do not move, so the person does not attempt to breathe. In OSA the chest and abdomen move, but no air gets through to the lungs.

6 During REM sleep, a person's voluntary muscles are temporarily paralysed, so they would not be able to sleepwalk. During NREM sleep, they are able to move, so they are able to sleepwalk during this stage of sleep.

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CHECK YOUR UNDERSTANDING 8.10

1 B
2 B
3 D
4 A
5 The cognitive component of CBT focuses on changing the way a person thinks (correcting faulty cognitions) about an issue that causes problems for them. The behavioural component of CBT involves identifying any negative or maladaptive behaviours they may have developed in response to their faulty cognitions and then developing strategies to modify or remove these behaviours and replace them with positive adaptive behaviours.
6 The aim of bright light therapy therapy is to adjust the person's circadian rhythm so their sleep–wake pattern is in sync with environmental shifts in natural light that occur during an external day–night cycle.

APPLY YOUR KNOWLEDGE AND SKILLS

SECTION A: MULTIPLE-CHOICE ANSWERS

1	A	6	B	11	B
2	C	7	D	12	B
3	A	8	B	13	A
4	C	9	D	14	C
5	D	10	C	15	C

CHAPTER 9

CHECK YOUR UNDERSTANDING 9.1

1 D
2 *Mental health* is the psychological state of someone who is functioning at a satisfactory level of emotional and behavioural adjustment. *Mental disorder* is the psychological state of someone who has emotional or behavioural problems serious enough to require psychiatric intervention.
3 a F
b F
c T
d T
e F
4 B
5 Hypochondria is a preoccupation with minor bodily problems and the presence of illnesses that appear to be imaginary.

CHECK YOUR UNDERSTANDING 9.2

1 Health is 'a state of complete physical, mental and social wellbeing and not merely the absence of disease or infirmity'.
2 C
3 Characteristics of a mentally healthy person include positive thinking, emotional resilience, optimism, self-confidence, high levels of functioning, and social and emotional wellbeing.
4 D
5 Characteristics of a person that may indicate the presence of a mental health problem or illness include not regularly washing or eating, an inability to hold a job, and a low level of functioning.
6 Actions described by the Better Health Channel to boost wellbeing and stay mentally healthy include connecting with others, taking time to enjoy activities and hobbies, participating and sharing interests, and contributimg to your community.

CHECK YOUR UNDERSTANDING 9.3

1 C
2 Because of the symptoms of their mental illness, sufferers may lack the capacity to understand the research procedure and therefore the ability to provide informed consent.
3 C
4 The placebo effect refers to changes in behaviour of research participants caused by the belief that they have been exposed to a treatment.
5 The researcher is deceiving the participants. This violates the participants' right to be honestly and fully informed of the research procedures employed.

CHECK YOUR UNDERSTANDING 9.4

1 C
2 *Risk factors* impede or have a negative effect on the health of an individual. *Protective factors* enhance or have a positive effect on the health of an individual.
3 B
4 D
5 Someone who maintains good physical and psychological health and maintains a good social support network is promoting their own wellbeing.
6 *Predisposing risk factors* refer to the factors that increase a person's vulnerability to developing a mental health problem. *Precipitating risk factors* refer to the factors that trigger the onset or exacerbation of a mental health problem. *Perpetuating risk factors* refer to the factors that prolong the course of the disorder and inhibit recovery.

CHECK YOUR UNDERSTANDING 9.5

1 The biopsychosocial model is an approach that proposes that health and illness outcomes are determined by the interaction and contribution of biological, psychological and social factors.
2 This model provides a holistic view of health, taking into account the interactive nature of physical, mental and social aspects of a person's health to enable a more comprehensive and personalised diagnosis and treatment plan.
3 Biological risk factors: genetic vulnerability to specific disorders, poor response to medication due to genetic factors, poor sleep, substance use

Psychological risk factors: rumination, impaired reasoning and memory, stress, poor self-efficacy

Social risk factors: disorganised attachment, loss of a significant relationship, stigma as a barrier to accessing treatment
4 A person has a strong family history of mental illness and they then use illegal substances such as marijuana, ecstasy or speed. This interplay can put them at an increased risk of developing a mental illness.
5 D

CHECK YOUR UNDERSTANDING 9.6

1 B
2 Genetic vulnerability means having an increased likelihood of developing a particular disease based on a person's genetic make-up.
3 C
4 Medication is a constant reminder of the disorder, or the side effects of the medication affect the person's life.
5 Limited sleep may cause feelings of stress, anger, sadness and mental exhaustion, all of which may influence mental health.
6 A regular bedtime and waking time are essential, as are avoiding stimulants before going to bed (for example, cigarettes and caffeine), having enough exercise during the day (not too close to bedtime), eating well, and ensuring that the bedroom is quiet and dark and the bed is comfortable.
7 Substance abuse refers to the harmful or hazardous use of psychoactive substances, including alcohol and illicit drugs. Substance abuse can make the symptoms of a mental health problem worse or increase an underlying risk of developing a mental disorder because it may sharply increase symptoms of mental illness or trigger new symptoms.

CHECK YOUR UNDERSTANDING 9.7

1 Rumination is compulsively focused attention on the symptoms of one's distress, and on its possible causes and consequences, as opposed to its solutions.
2 B

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3 Strategies to overcome rumination include engaging in activities that foster positive thoughts and focusing on problem-solving.
4 Reasoning is a cognitive process that involves thinking about information in a logical way in order to understand it and form a realistic conclusion or judgement that will help us solve problems and make decisions. An impairment in reasoning influences a person's mental health by significantly affecting their day-to-day functioning because it results in difficulties including deficiencies in verbal fluency, language processing, interpretation of social situations and the development of delusions.
5 C
6 Emotional effects may range from feeling increased levels of frustration, depression, anxiety, tension, irritability, anger and aggression, to feeling unable to cope with normal activities.

Cognitive effect of chronic stress includes difficulties in focusing our attention and direct our concentration.

Behavioural changes may include interrupted sleeping patterns, causing us to experience excessive tiredness during the day.
7 The release of stress hormones (such as cortisol) over an extended period of time interferes with mood regulation and cognitive processes such as memory and decision-making. Research indicates people who suffer from chronic stress may experience long-term changes in their brain that may make them more susceptible to mood disorders and anxiety.
8 Self-efficacy refers to an individual's belief in their capacity to execute behaviours necessary to produce specific performance attainments. Self-efficacy beliefs make people able to interpret potentially threatening expectations as manageable and help them feel less stressful in such situations. Thus, by reducing the negative thoughts and concerns of potential threats, they can regulate their emotional states.

CHECK YOUR UNDERSTANDING 9.8

1 C
2 Attachment is the relationship between two people who feel strongly about each other so that they exhibit behaviours to continue the relationship.
3 From a biological point of view the main function of attachment is to increase chances of survival by helping the child seek proximity to someone who will take care of their physical and emotional needs so that they feel secure.
4 Disorganised attachment is the instability in a caregiving relationship that interferes with the child's sense of trust and security. A disorganised attachment style increases the risk of children displaying behaviour problems and the development of mental illness later in life, such as low self-esteem, difficulty in trusting others and managing their feelings.
5 D
6 The emotional hurt that results from the of the loss of a significant relationship can lead to ongoing anxiety and unhappiness, affecting physical as well as mental health.

CHECK YOUR UNDERSTANDING 9.9

1 *Labelling* occurs when a certain characteristic an individual possesses is used as a name or brand to describe them. *Stigma* refers to social disapproval of an individual's personal characteristics or beliefs, or social disapproval of a type of behaviour.
2 Stigma arises because people are often uncomfortable or embarrassed by behaviour that is different, and often the mentally ill are incorrectly stereotyped as being violent, unpredictable or scary because of a lack of understanding of mental health problems and disorders.
3 D
4 D
5 Stigma attached to mental illness can be reduced through raising knowledge and awareness about mental health.

CHECK YOUR UNDERSTANDING 9.10

1 Cumulative risk is the accumulation of and exposure to multiple risk factors that increase susceptibility to developing a mental disorder or perpetuates an existing mental disorder.
2 Older people may be at a greater risk because of the cumulative effect of numerous risk factors, including chronic illness and isolation.
3 A biological factor such as a serious illness, which may influence the social factor of isolation because someone is not able to attend social activities, combined with starting a new school may influence psychological factors such as feeling lonely and emotional.
4 Some of the cumulative risk that might be associated with the development of depression include serious physical health problems, abusive or uncaring relationships, a family history of depression, past experiences and side effects from medications.
5 B

APPLY YOUR KNOWLEDGE AND SKILLS

SECTION A: MULTIPLE-CHOICE ANSWERS

1	A	6	D	11	C
2	D	7	C	12	D
3	B	8	D	13	C
4	C	9	A	14	D
5	D	10	D	15	A

CHAPTER 10

CHECK YOUR UNDERSTANDING 10.1

1 D
2 A
3 C
4 Physical reactions that accompany anxiety include nausea, dizziness, a rapid heartbeat, rapid breathing, hyperventilating, shortness of breath, feeling cold or overheated, numbness or tingling in the hands, and excessive perspiration.
5 *Stress* refers to a state of mental or physical tension that occurs when an individual must adjust or adapt to their environment but they do not feel they have the capacity to do so. *Phobia* is an intense and irrational fear of an object, situation or thing. *Anxiety* refers to feelings of apprehension, dread or uneasiness and is a response to an unclear or ambiguous threat.
6 C

CHECK YOUR UNDERSTANDING 10.2

1 Mild levels of anxiety can motivate, produce growth, enhance creativity and increase learning because, at this level, you are alert and perception is increased.
2 A specific phobia is an intense, irrational fear and avoidance of a particular object, activity or situation.
3 Example: Ailurophobia is a phobia of cats. It is considered a phobia because it is an intense and irrational fear.
4 B
5 The four common types of phobias are:
- animal type
- natural environment type
- blood/injection/injury type
- situational type.

CHECK YOUR UNDERSTANDING 10.3

1 D
2 C
3 An individual with naturally low levels of GABA may not be able to regulate anxiety, so they have a greater chance of developing a phobia. People with naturally low serotonin levels have been shown to be more susceptible to anxiety.

4 C
5 The strengthening of synapses based on recent patterns of activity is known as long-term potentiation.

CHECK YOUR UNDERSTANDING 10.4

1 B
2 The acquisition of a phobia may occur through classical conditioning as the consistent pairing of a neutral stimulus with an unpleasant stimulus can cause phobic reactions.

The perpetuation of a phobia may occur through operant conditioning as the avoidance of a phobic stimulus may act as a negative reinforcement and maintain a phobic response.
3 A
4 A person may only be able to recall negative encounters with angry dogs thus influencing the development of a phobia of dogs.
5 Catastrophic thinking occurs when an individual repeatedly overestimates the potential dangers and assumes the worst of an object or event; for example, a person who believes a plane will crash if they travel on it.

CHECK YOUR UNDERSTANDING 10.5

1 D
2 A specific environmental trigger, such as being trapped in a closet, can result in the development of an anxiety disorder because the trauma of the incident may become paired with a fear response.
3 The trauma of an unexpected incident such as being attacked by a neighbour's dog that appears docile may become paired with the fear response and the child may develop an irrational belief that all dogs are dangerous and unworthy of affection.
4 Stigma is social disapproval of an individual's personal characteristics or beliefs, or social disapproval of a type of behaviour.
5 Harmful effects of stigma associated with anxiety disorders may include:
- reluctance to seek help or treatment
- a lack of understanding by family, friends, co-workers or others you know
- fewer opportunities for work, school or social activities or trouble finding housing
- bullying, physical violence or harassment
- the belief that you'll never be able to succeed at certain challenges or that you can't improve your situation.

CHECK YOUR UNDERSTANDING 10.6

1 D
2 A
3 The neurotransmitter gamma-amino butyric acid (GABA) blocks nerve impulses, calming nervous activity.
4 Possible side effects of the use of benzodiazepines in the treatment of anxiety include the risk of addiction; drowsiness, sleepiness and fatigue; slow reflexes; slurred speech; confusion and disorientation; impaired thinking and judgement; memory loss; nausea and loss of appetite; double or blurred vision; and mood swings and aggression.
5 B
6 Breathing retraining is the process of identifying incorrect breathing habits and replacing them with correct ones. Deliberately copying a relaxed breathing pattern calms the nervous system that controls the body's involuntary functions and reduces the physiological effects of anxiety.
7 The mental health benefits of regular exercise include:
- reduced anxiety and positive mood as exercise burns up the natural chemicals that accumulate during stress
- an increase in alertness and concentration
- a boost in confidence and self-esteem
- a release in feel-good brain chemicals such as endorphins
- improved sleep, which in turn reduces stress
- distraction from worries and rumination, which may have a calming effect
- increased social interaction, which can create more support networks
- optimistic feelings and the ability to think more rationally.

CHECK YOUR UNDERSTANDING 10.7

1 Psychotherapies are psychological techniques used in the treatment of mental disorders, they are used to facilitate positive changes in personality, behaviour or adjustment.
2 Medications may have several side effects, whereas psychotherapies do not.
3 D
4 The purpose of CBT in treating phobia is to challenge the irrational and negative thoughts, and replace them with realistic thoughts and examine related behaviours.
5 B

CHECK YOUR UNDERSTANDING 10.8

1 A
2 The goal of psychoeducation for the families and supporters of a phobic person is to help them understand the illness. This helps to reduce the stigma associated with the illness. Additional goals are to teach them the skills needed to help the phobic person cope and recover, and to help themselves adapt to living with a person suffering from a phobia.
3 Avoidance behaviours are behaviours that attempt to prevent exposure to the fear-provoking object, activity or situation.
4 Cognitive distortions are irrational and pessimistic attitudes. For example (fortune-telling): 'It's spring. All the bees are out. If I go outside, I will get stung and have a really bad allergic reaction.'
5 A

CHECK YOUR UNDERSTANDING 10.9

1 C
2 B
3 C
4 An adequate diet and enough sleep are vitally important to us for replenishing and revitalising the physiological processes that keep the mind and body functioning at an optimal level. They can help improve mood, maintain healthy brain functioning and help people cope with a range of adversities.
5 Cognitive behavioural strategies used by health professionals in maintaining a person's mental health include:
- educating patients about the body's natural reactions to threatening objects and situations
- helping patients recognise the difference between unhelpful and productive thoughts
- identifying situations that are often avoided and confront these through gradual exposure
- teaching relaxation and breathing techniques to manage stress and anxiety
- helping patients establish effective daily routines that promote engaging in enjoyable activities and exercise.
6 Community support organisations that offer support, training and education in maintaining a person's mental health include Beyond Blue, the Black Dog Institute, headspace and SANE Australia.

CHECK YOUR UNDERSTANDING 10.10

1 The main focus of treatments for mental disorders (for example, phobia treatments) is to change maladaptive behaviours through the application of learning principles.
2 It is important to understand the different factors that influence behavioural change to enable more effective treatment strategies for sufferers of mental illnesses.
3 B

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4 C

5 Stage 1: Precontemplation (Not ready for change) – Individuals are not currently considering a behaviour change in the near future.

Stage 2: Contemplation (Thinking of changing) – Individuals are intending to change behaviour within the next 6 months.

Stage 3: Preparation (Ready to change) – Individuals at this stage are ready to start taking action within the next 30 days.

Stage 4: Action (Making change) – Individuals at this stage have made specific behaviour modifications in their lifestyles within the past 6 months.

Stage 5: Maintenance/Relapse (Staying on track) – In this stage, individuals have sustained their behaviour change for more than 6 months and intend to maintain the behaviour change into the long-term future.

6 Decisional balance is the process of weighing the pros and cons of decision making, e.g. weighing up the pros and cons of starting a weight loss program.

7 Processes that can help individuals successfully progress through the stages of change include:
- *Consciousness-raising* – increasing awareness via information, education and personal feedback about the healthy behaviour
- *Dramatic relief* – feeling fear, anxiety or worry because of the unhealthy behaviour, or feeling inspiration and hope when they hear about how people are able to change to healthy behaviours
- *Self-reevaluation* – realising that the healthy behaviour is an important part of who they are and want to be
- *Environmental reevaluation* – realising how their unhealthy behaviour affects others and how they could have more positive effects by changing
- *Social liberation* – realising that society is more supportive of the healthy behaviour
- *Self-liberation* – believing in one's ability to change and making commitments and recommitments to act on that belief
- *Helping relationships* – finding people who are supportive of their change
- *Counter-conditioning* – substituting unhealthy ways of acting and thinking for healthy ways
- *Reinforcement management* – increasing the rewards that come from positive behaviour and reducing those that come from negative behaviour
- *Stimulus control* – using reminders and cues that encourage healthy behaviour as substitutes for those that encourage the unhealthy behaviour.

APPLY YOUR KNOWLEDGE AND SKILLS

SECTION A: MULTIPLE-CHOICE ANSWERS

1	D	6	A	11	D
2	C	7	C	12	C
3	D	8	A	13	A
4	B	9	B	14	C
5	A	10	A	15	A

CHAPTER 11

CHECK YOUR UNDERSTANDING 11.1

1 C

2 B

3 A *conclusion* relates to the experiment that has been conducted. It states what the results mean for the sample. A *generalisation* states what the results mean for the population as a whole.

4 The types of material found in an appendix include raw data, a sample of the consent form, and a sample of a questionnaire that was used.

5 The abstract allows the reader to get a quick overview of the experiment and its results without reading the whole report.

6 The referencing method used in VCE Psychology is specified by the American Psychological Association (APA).

7 The main headings: Abstract, Introduction, Method, Results, Discussion, References, Appendix

CHECK YOUR UNDERSTANDING 11.2

1 A

2 A

3 D

4 **a** IV = alcohol consumption vs no alcohol consumption; DV = reflex speed
Participants who consumed alcohol would have slower reflexes than participants who did not consume alcohol, as measured by a digital test.

b IV = males exposed to steroids vs males not exposed to steroids; DV = level of aggression
Male participants who took steroids would have increased levels of aggression compared to males who did not take steroids, as measured by a self-report.

c IV = grade of petrol: premium vs standard; DV = mileage
Cars that used premium fuel would increase their mileage compared to cars using standard fuel.

5 An experimental group is exposed to the IV; a control group is not. For example, an experimental group may be given an anti-anxiety medication, while the control group is given a placebo.

6 The main headings for a scientific poster: Title, Introduction, Method, Results, Discussion, Conclusion, Acknowledgements, References

CHECK YOUR UNDERSTANDING 11.3

1 D

2 B

3 B

4 Participant differences can affect an experiment. For example, an IQ test designed for white American people will not be completed successfully by someone from a different culture, such as an Eskimo (indigenous person from Alaska).

5 Possible extraneous variables: the amount of colouring in the red and blue lollies would need to be the same; the size of each lolly would need to be the same; the time of day that the lollies were taken would need to be the same.

CHECK YOUR UNDERSTANDING 11.4

1 B

2 D

3 A

4 B

5 Advantages: There are no order effects. It is quick and easy to complete.

Disadvantages: If the sample is small, it is difficult to get two groups that are similar. Subject variables could occur.

6 A matched-participants design could be used when studying the effect of noisy concerts on hearing. Participants would be matched on their initial hearing ability and placed into a group of good, average and bad hearing. Half of each group would then be exposed to a noisy concert.

7 Disadvantages: It is difficult to perfectly match participants. It is also time-consuming to match each participant with another.

CHECK YOUR UNDERSTANDING 11.5

1 **a** ii; **b** iii; **c** iv; **d** i

2 B

3 B

4 A

5 An experimental group is exposed to the IV. A control group is not. For example, the experimental group would be given a drug intended to improve their sleep, while the control group would receive a sugar pill instead.

6 A sample is taken from a larger population. The sample is used in an experiment and is representative of the population. For example, a sample of 100 students may be taken from all students who are enrolled in the larger population of VCE students.

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CHECK YOUR UNDERSTANDING 11.6

1 D
2 A
3 D
4 **a** v; **b** iii; **c** ii; **d** iv, **e** i
5 Case studies lack formal control groups. They also usually involve cases where the subject is atypical in some way, which makes it difficult to generalise to other, normal individuals.
6 Observational studies may be affected by the observer effect. They can also be affected by observer bias.
7 Advantages: Self-reports can produce large amounts of descriptive data, and they can be administered at home, which removes the pressure of a laboratory setting.
Disadvantages: It can be time-consuming to process the large amount of data, and it can be difficult to work out which answers are significant.

CHECK YOUR UNDERSTANDING 11.7

1 **a** iv; **b** i; **c** ii; **d** iii
2 A
3 A
4 A
5 *Descriptive statistics* only summarise and describe data. There is no interpretation involved. *Inferential statistics* allow for an objective interpretation about what the results mean.
6 **a** mode: 19; median: 19; mean: 30.4
b mode: 13; median: 19; mean: 17.9
c mode: 40; median: 28; mean: 31.2

CHECK YOUR UNDERSTANDING 11.8

1 A
2 C
3 A *conclusion* is a judgement about the meaningfulness of results. A *generalisation* is a judgement about how representative of the population the results are.

CHECK YOUR UNDERSTANDING 11.9

1 **a** iv; **b** iii; **c** ii; **d** i
2 C
3 A
4 D
5 *Deception* is not informing a participant about the true nature of the study. This occurs before the study begins. *Debriefing* is explaining to a participant the true nature of the study, clearing up misconceptions and offering professional support. This occurs after the study is completed.

APPLY YOUR KNOWLEDGE AND SKILLS

SECTION A: MULTIPLE-CHOICE ANSWERS

1	A	6	B	11	D
2	A	7	B	12	A
3	C	8	A	13	C
4	D	9	A	14	C
5	D	10	A	15	C

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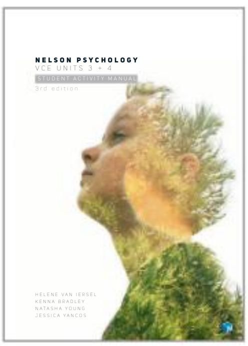

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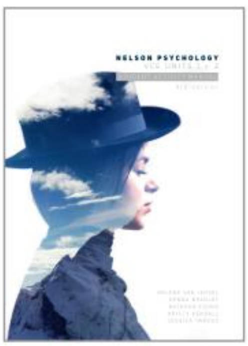

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