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QCE UNITS

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Glenn Amezdroz
Series Editor

Geoff Hosford
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Macmillan Physical Education QCE Units 1 and 2

1st edition

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Geoff Hosford is a graduate of Loughborough University, UK, and the University of Western Australia, and taught Physical Education in secondary schools in Victoria, Western Australia and Tasmania. He is presently a director and biomechanist with Accident Analysis, a forensic movement science company operating in the field of personal injury litigation. He has acted on behalf of players at the AFL Tribunal, and has written and published widely in biomechanics.

Angela Kelso (BEd) has been a Health and Physical Education (HPE) Head of Department for six years and is currently the HPE Head of Department at Stretton State College. She provided advice to the QCAA during the development of the Physical Education (2019) syllabus and assisted to co-present the QCAA Physical Education Implementation workshops in 2018. Having previously presented ACHPER workshops in Central Queensland, Angela is a keen advocate of quality, integrated learning in Physical Education.

Brendan Moy (PhD, M Health Science, Grad Dip Health, Grad Dip Teaching, BHMS) is a lecturer and research academic in HPE pedagogy and motor learning at Queensland University of Technology. He previously worked as a HPE teacher for over 20 years, across all year levels and varieties of schools throughout Queensland. He is keen to share the knowledge he has gained as a researcher with HPE practitioners and students.

Robert Sweeper (BEd) has been a Physical Education teacher for 10 years. He began his career in Charters Towers and is currently the HPE coordinator at St Joseph's College, Gregory Terrace, where he has taught since 2011. Robert has presented at ACHPER conferences and is passionate about the development of inclusive, integrated and engaging HPE curriculum.

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Geoff Hosford

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Angela Kelso

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Brendan Moy

This resource has emphasised to me the depth and breadth of content within the discipline of Physical Education. Teaching HPE certainly goes far beyond the common stereotype of standing on an oval and blowing a whistle. I would like to thank Glenn Amezdroz for giving me the opportunity to be involved, the many HPE teachers and university academics that have guided my learning, and my wife Ruth and daughter Maddie for their interest and encouragement.

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INTRODUCTION

Macmillan Physical Education QCE Units 1 and 2 deals with all objectives, topics and subject matter for Units 1 and 2 of the Queensland Physical Education 2019 General Senior Syllabus.

Developing strategies

The senior Physical Education course is very different to the Health and Physical Education (HPE) subjects you may have previously studied. The focus of the course is on developing **strategies** to address situations.

Throughout your course, you will need to create, evaluate and refine strategies for overcoming problems and improving outcomes. These strategies might be developed to solve movement problems, to enhance performance or promote participation.

Key features

Your textbook contains a number of important features that are designed to support your learning, help you develop effective strategies and prepare you for your assessments.

- The **Data essentials** section is a toolkit of information on gathering and analysing data, which is particularly relevant for your assessment tasks.
- Every chapter starts with a list of **key questions**, so that you understand what concepts you're about to study, as well as a chapter plan to guide you through the text.
- **Key terms** are highlighted in the text, with definitions provided in the margin nearby.
- At the end of each numbered section of a chapter is a short set of **Check your understanding** questions, which focus on the major concepts introduced in that section.
- Every chapter ends with a **review** of the key information, as well as a series of exam-style questions.

Online support

Use the code on the inside front cover of your textbook to access the digital version of the book.

Your online resources also include additional support materials:

- There are short, interactive **review quizzes** for each chapter, to help you revise key concepts.
- The **Download** icon in the margin shows when a data recording template or other document is available for use with movement activities.
- The QR codes and weblinks at the end of some **Integrating Movement** activities open **IM coaching videos**. These short tutorial videos will step you through the preparation, performance and analysis stages of those activities.

http://mea.digital/qpe12_1

DATA ESSENTIALS

The inquiry approach

Senior Physical Education is based on an inquiry approach to learning. You will learn facts in your study, and will also be encouraged to ask questions, conduct research and gather data. You'll then analyse and evaluate the data you gather to come up with your own movement and learning strategies.

The information in this section will help with your data and inquiry learning throughout the year. Look for the reference markers in activities that will direct you back to this section for support.

Stages of inquiry

The inquiry approach is based around three stages of activity:

1. *Engage and understand* involves learning about body and movement concepts, demonstrating movement sequences and gathering primary data.
2. *Apply and analyse* applies the knowledge you've gained to create movement strategies.
3. *Evaluate and justify,* the final stage, evaluates your strategies to see how effective they are.

Throughout this textbook you'll find **Check your understanding** questions. These all work at the *Engage and understand* level; they're a way for you to double-check that you've understood the information you've just studied.

You'll also find many **Learning Experience** activities in this textbook. Each of these focuses on a particular stage of inquiry, which is shown in the title of each activity. Completing these activities will help develop your understanding of specific topics at each stage.

Learning about, through and in movement

The other major component of Physical Education is movement – playing sport and engaging in physical activities. For each topic in the course, your school or teacher will select specific sports and activities for your class. These will be where you gather primary data, apply the information you've learnt in class and test your movement strategies.

The **Integrating Movement** activities in this book focus on learning firsthand through movement and sport. They all have a specific, consistent structure, so that you can easily see what each activity involves and how to complete them. They involve all three stages of inquiry – gathering, analysing and evaluating data.

DE 1 Primary data

Primary data is data – raw facts – that you observe and record yourself. You might gather it by watching a performance, conducting an interview, downloading smart device statistics or filming a physical activity.

Good quality primary data is:

- *reliable* – consistent recording methods should help you collect reliable data.
- *valid* – your recording method measures what it's supposed to measure.
- *unbiased* – your recording method accurately records data.

Gathering primary data

Before gathering data, determine exactly what it is that you need to find out.

- What are the issues you want to investigate?
- What precisely do you want to find out?
- Why is the data important?
- What do you want to do with this data?

Primary data can be gathered using a range of different methods.

Observation

One of the simplest methods for gathering data is to observe an event and record what you see and hear. The better prepared you are, and the more focused your observations, the more likely it is that you'll collect useful data.

It's essential to use an observation sheet, so that you record your data consistently. A Game Performance Assessment Instrument (GPAI) is a particular type of observation sheet used to record game behaviours. These demonstrate a performer's ability to solve game problems and apply body and movement concepts in authentic situations. Evidence obtained through observation, using the GPAI, can be used to inform the development of different strategies.

You can download recording sheets and GPAIs from your online resources.

Reflection

Your own thoughts and reflections are an important form of primary data. When you reflect on a session's activities, don't merely describe what happened during the session. Instead, think of reasons why things happened that way.

Use a reflective journal to keep your notes consistent. You might shape your responses around questions such as:

- What was the purpose of the session?
- What tasks were performed?
- How did the tasks connect to the topic I'm currently studying?
- Did the tasks reflect the purpose?
- What did I learn?

Interviews and surveys

Interviews gather information from one subject. When conducting an interview, you should create most of your questions during the session, allowing both you and the subject the flexibility to fill in details or discuss issues.

Surveys and questionnaires gather data from a group of participants – a sample. Your target group will respond best to surveys when they're easy to understand and require minimal time to complete. Some tips:

- Distribute the survey to everyone at the same time.
- Make sure that questions are clear and unambiguous.
- Use closed questions, for example – multiple-choice questions.
- Don't lead your sample towards a particular answer.
- Test and trial the survey before submitting to your sample.

Online platforms such as SurveyMonkey include tools that can help improve your survey's validity and reliability.

Digital capture

Digital capture, such as recording video, is a powerful way to gather primary data. This data is also a requirement for the development of your folio project. In Units 1 and 2, the primary focus is on video. There are many other digital capture tools, from GPS to heart rate monitors, but they don't come into play until Unit 4.

Social and ethical issues

You gather primary data yourself, but that doesn't mean you can do what you like with it. The principles of privacy and confidentiality state that the identity of participants must remain anonymous, and the information they supply must be respected. You must make sure their personal data remains private and confidential.

If recording someone's data, such as filming a performance or distributing a survey, you must provide them a full explanation of what will be done with their data. They have the right to opt out of your research process for any reason.

DE 2 Secondary data

Secondary data is data you obtain from other sources, such as journal articles, newspapers, online sources or this textbook. The purpose of secondary data is to provide supporting evidence to justify your analysis of your primary data. It's not a replacement for primary data.

Good quality secondary data is:

- *credible* – it comes from reliable and trustworthy sources.
- *relevant* – it supports the argument or conclusion you're presenting.

Gathering secondary data

Before searching for secondary data, consider what kind of information you need. Different research tasks require different evidence to support findings.

Most tasks require you to access textbooks and journal articles that summarise the body of knowledge in question. When searching for sources, think about whether the research is appropriate for your needs.

Evaluating your sources

Using credible sources to support your research gives your writing credibility. High-quality resources are more likely to give better results for your investigations. It's important to know the difference between types of sources:

- *Scholarly sources* are written by experts in the field. Most sources in your school reference library are likely to be scholarly, but you should still critically assess the information.
- *Non-scholarly sources* of information are freely available online. Content from the internet can be written by anyone, for any purpose, without any expectation of trustworthiness. It might be right – but it might not.

Assessing credibility

When assessing the credibility of secondary data, you should be able to say 'yes' to all the following questions:

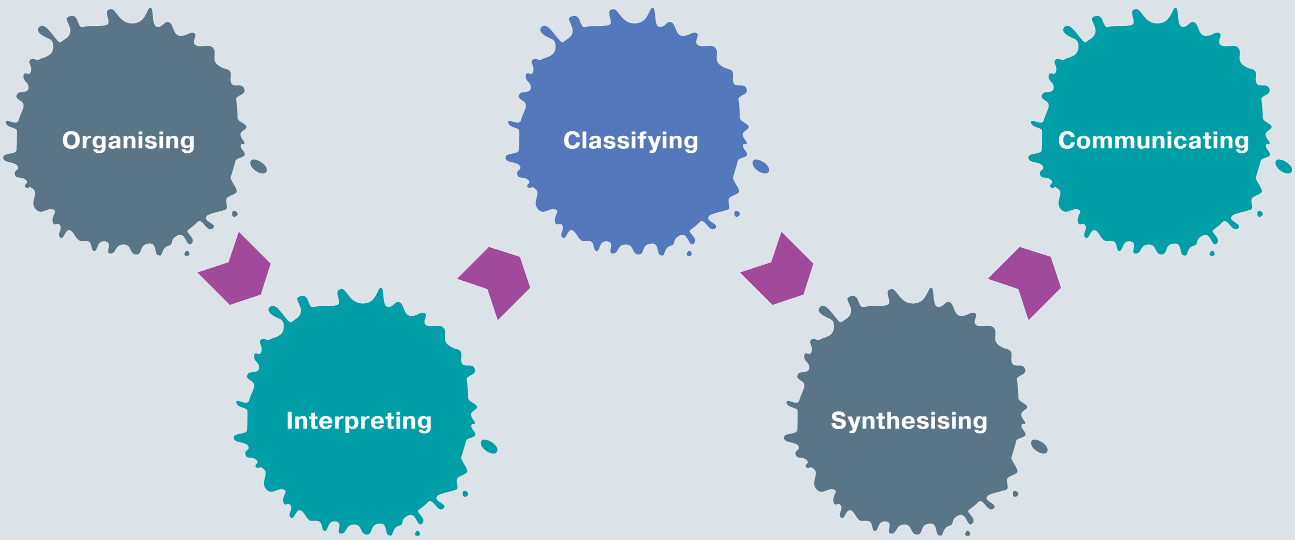
- [ ] Is the information supported by evidence?
- [ ] Is that evidence referenced by the source?
- [ ] Has the content been peer reviewed or edited by a publisher?
- [ ] Can the information be verified by other literature on the same topic?
- [ ] Is the tone objective and impartial?
- [ ] Is the source free from obvious errors such as spelling or grammatical errors?
- [ ] Is the source written by someone with expertise in the field?

DE 3 Analysing data

Analysis is the process by which raw data is transformed into useful information. It helps you interpret data about your strategies so that it's understandable and makes sense. A simple example of analysis is extracting data from a table, then transforming it into a graph or chart to visually describe any trends or relationships.

Steps in analysis

Analysis is a process that can be broken down into several steps. In the inquiry approach, questions determine each of the stages.



Step 1: How will you organise the data?

Different situations require you to organise your data in different ways. However, there's a logical order you should always follow:

1. Collect all the relevant data that you have gathered.
2. Sort the data into different categories.
3. Use those categories to arrange and identify the essential elements.

Step 2: What are the similarities and differences?

Interpreting similarities and differences helps you examine the fundamental parts and their relationships to each other. This step can take a number of forms, including:

- tallying data from different categories
- taking note of any similarities (what does the data indicate?)
- comparing and contrasting any differences within and across categories
- identifying similarities within and across categories
- identifying any relationships that may exist between categories.

Step 3: What is the quantitative and qualitative data?

Quantitative data (numbers) can be presented using tables or graphs, while qualitative data (descriptions) can be specific examples, case studies or scenarios. Both types of information can be integrated to complement and support each other.

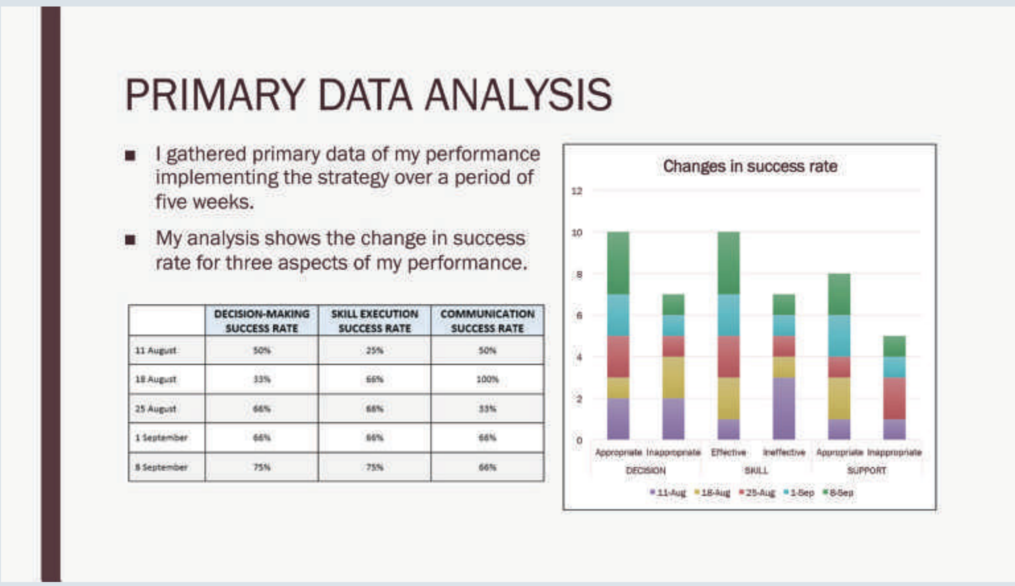
Step 4: How can you synthesise the data?

When data is synthesised, different elements are combined to form new ideas or information. It's where information is put back together again to look for connections. Synthesis helps to link evidence, and develop and draw logical conclusions about the data. This stage uses techniques such as:

- combining the different categories of the data into a whole
- creating information from the data
- examining for trends and new information.

Step 5: How is new information communicated?

Communicating the new information from your analysis is a critical part of drawing meaning from the data. This might involve using graphs, tables, diagrams or images. You can catch your audience's attention by communicating the data in interesting ways.



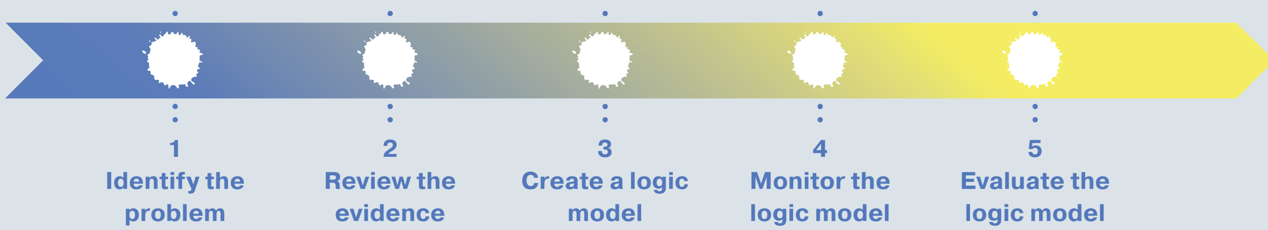
DE 4 Evaluating information

Evaluation is where your research and learning align, allowing you to make decisions about the impact and effect of the strategies you used.

The purpose of evaluation is to help you ask questions, consider evidence, interpret the evidence and communicate information. Most importantly, evaluation allows you to make informed decisions that you can justify using evidence.

Steps in evaluation

Like analysis, the evaluation process can be broken down into five simple steps.



Steps 1–3 should be carried out at the start of your investigation. Steps 4 and 5 should continue throughout the investigation.

Step 1: Identify the problem

Before you can design a strategy, you must understand what you're trying to achieve. Ask yourself:

- What's the problem I'm trying to solve?
- Why is this problem important?
- What's the aim of the outcome?

Step 2: Review the evidence

You need to consider all the data and information you've gathered throughout the inquiry process and the investigation itself. This 'evidence base' will help you make appropriate decisions about your strategy.

To make the most informed decisions about your strategy, use a range of different evidence, which might include both quantitative data and qualitative data.

A good way to organise your evidence base is to use a table such as this to help you develop your strategy.

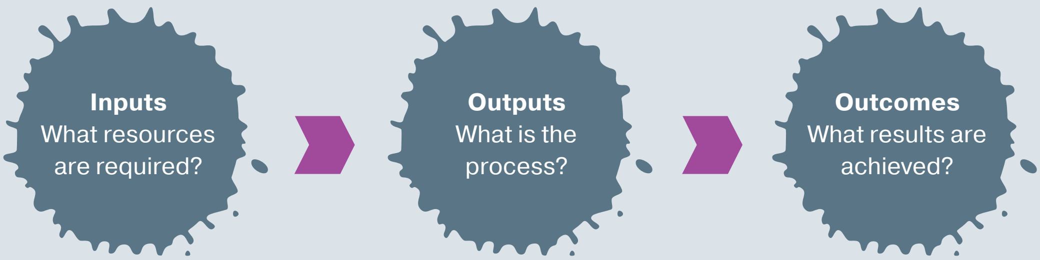
Strategy – what are we doing?	Evidence – why are we doing this?

Step 3: Draw a logic model

A logic model is a step-by-step diagram that indicates:

- resources you will need (inputs)
- the process you are going to use (outputs)
- what you are hoping to achieve (outcomes)

This logic model will help you to consolidate the design of your strategy.



A well-structured strategy includes:

- evidence-based activities
- a clear understanding of purpose
- structured and sequenced activities
- data collection opportunities
- a clear understanding of body and movement concepts and specialised movement sequences.

Step 4: Monitor the logic model

Once you develop your logic model, you need to gather relevant primary data to test the viability of your strategy. This step should be ongoing throughout your entire investigation.

Using the logic model helps identify evidence that shows whether your strategy is or isn't working. Evidence may include:

- feedback from your partner or peers about what the strategy provided
- what was most or least useful about the strategy
- whether or not the strategy was able to be completed by the user
- observations of enhanced outcomes when using the strategy.

Step 5: Evaluate the logic model

Evaluating the logic model requires you to investigate your data to determine whether your strategy is working or not. Ask yourself:

- What does the data tell me?
- Why am I observing these results?
- How can I enhance outcomes?
- Does anything about the strategy need to be changed?

By evaluating the logic model, you can determine whether your strategy worked as it should. Review the initial questions you developed when you identified the problem in the first step of the process. Your quantitative and qualitative data will help you evaluate the effectiveness of the strategy.

DE 5 Data and assessment

Your folio project

As part of your assessment for both Units 1 and 2, your teacher may require you to create and submit a folio project. This folio will be a presentation that demonstrates your ability to develop and implement strategies relating to the physical activity that you are studying in each unit.

In Unit 1, the folio task may focus on motor learning (Chapters 1–3) or biomechanics and functional anatomy (Chapters 4–6). In Unit 2, the folio task may focus on sport psychology (Chapters 8–10).

Your online resources include a video that demonstrates how to create an effective folio project.

http://mea.digital/qpe12_DE

Using data in your folio

In your folio, you need to demonstrate both how you developed your strategy and the effect that it had upon your performance. To do this, you need to gather, analyse and evaluate relevant primary data. Most of this data will be about your own performance of specialised movement sequences and your application of body and movement concepts. The primary data could be videos and screenshots of your performance, completed GPAI documents, tables of data, or graphs summarising your data.

Secondary data is also required to help you to evaluate and justify your strategy. Journal articles, readings and textbook chapters will help you develop your learning, look for relationships and devise your strategy.

Many of the Integrating Movement activities in your textbook involve capturing primary data that will be useful for your folio.

STRATEGY – DRAWING A DEFENDER

- In football (soccer), my motor learning goal is to enhance my capacity to set up an attack, to draw a defender to maintain possession when performing specialised movement sequences as a mid-fielder.
- I gathered primary data using digital capture of the specialised movement sequences and movement strategies as a midfielder in a range of authentic football environments, including small-sided games.
- In addition, I developed a game performance assessment instrument (GPAI) to gather additional primary data, and graphed my performance as part of analysing this data.

	DECISION		SKILL		SUPPORT	
	Choice to pass, shoot or dribble to draw the defender		Pass, shoot or dribble to draw the defender		Communicating plans to teammates when off the ball	
Date	Appropriate	Inappropriate	Effective	Ineffective	Appropriate	Inappropriate
11 August	✓✓	✓✓	✓	✓✓✓	✓	✓
18 August	✓	✓✓	✓✓	✓	✓✓	
25 August	✓✓	✓	✓✓	✓	✓	✓✓
1 September	✓✓	✓	✓✓	✓	✓✓	✓
8 September	✓✓✓	✓	✓✓✓	✓	✓✓	✓

Presenting your folio

Your folio is a multimodal presentation, meaning that it needs to include several modes of communication – usually text, video and audio. It could be:

- a digital portfolio of video, images and diagrams with annotations or commentary
- a multimedia movie or slideshow
- a presentation conducted in front of an audience
- a pre-recorded presentation, submitted electronically.

The folio should be around 9–11 minutes long. You will need to demonstrate analysis, synthesis and evaluation of your primary and secondary data relevant to your strategy. You will also need to reference correctly, using in-text citations and a reference list at the end of your presentation.

Your investigation report

As part of your assessment for Unit 2, your teacher may require you to write and submit a research report. This report will be an investigation into an equity and access issue within your class, school or community, and relating to the physical activity you are studying in the unit.

Using data in your report

In your report, you need to present meaningful primary and secondary data relating to the equity and access issue. As well as gathering primary data from the group in question, you will need to do independent research to find supporting secondary data. You might investigate an issue in a class, school or community physical activity setting to devise a strategy.

Many of the Learning Experience activities in your textbook involve researching secondary data that will be useful for your investigation. You will also find some of the Integrating Movement activities useful as well.

Presenting your report

Your investigation is a written report, 1500–2000 words long. It will include the following elements and headings:

- Title page
- Table of contents
- Introduction – define the equity and access issue, and describe the class, school or community group that will be the focus of the investigation.
- Discussion – this is the main part of the report, in which you analyse and synthesise your primary and secondary data, describe the relationships between the data, then evaluate your findings. These steps will help you to devise and present your strategy and course of action for addressing the issue. You will also need to justify the development of your strategy, using the evidence you have obtained from your primary and secondary data.
- Conclusion
- Reference list – acknowledge all sources cited in your investigation. (This does not count toward the word limit.)

Make sure that you use these headings and carefully reference your research. Use in-text citations and a reference list, and use a recognised referencing system.

DE 6 Capturing video data

Capturing video data is an important part of your Physical Education course. As part of your assessment, you need to create a folio of video evidence to show that you've developed and can apply effective movement strategies. You'll also need to capture video data as part of many movement activities, whether of yourself or of other students.

The good news is that you don't need special equipment for this; you can capture effective data using your own camera, smartphone or tablet. The following tips will help you capture the most useful and effective data for your studies.

Know what you need to film

Read movement activities thoroughly before starting so that you know what kind of data you have to collect. Are you filming a specific movement or technique? Do you need to follow a particular player around the field? Make sure you're clear on exactly what you need to do so that you gather relevant data.

Use a tripod

A tripod will provide you with a stable platform, especially if you want to pan and zoom to gather your data. The tripod will help provide smoother images for you to analyse and evaluate performance. It also makes it much easier to film yourself – just set it up, hit record and then stand in front of the camera to start performing.

If possible, get a tripod that has bendable legs. These can be wrapped around poles and posts, which are easier to find out in the field than stable flat surfaces.

Use wider shots over close-ups

It's natural to want to use close-up shots. However, close-ups aren't good for capturing fast-motion physical activities. If your shot is too zoomed-in, it will be difficult for you to follow the action.

Unless you're focused on an individual player for specific purposes, try to use shots as wide as possible when framing your subjects. The most important thing to capture is the passage of play or strategy itself.

Find high ground when you can

The best perspective you can capture video data from is as high as possible. This creates the most top-down view of the playing area. By doing this, the spatial relationships from one player to another are more obvious and aren't distorted by the camera lens.

Shoot in landscape

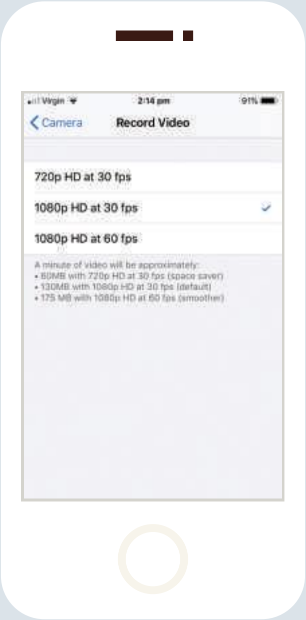
Use landscape orientation, not portrait, when capturing data. This will ensure that you capture more of the action you want to record.

Film at a high frame rate and fast shutter speed

Shutter speed is how long the shutter in your device exposes its sensors to light. Slow shutter speeds create too much motion blur to accurately capture high-speed action. Using a fast shutter speed effectively freezes the action. Similarly, high frame rates capture more of the action, as more frames are created per second.

Your best option is to capture at 60 frames per second (fps) and 1/120th of a second shutter speed. This will give the video much smoother motion and allow you to freeze the video or slow it down, which will help to analyse individual strategies.

Check your camera or phone and get to know its settings. Some devices have a separate sports mode setting, which enables high-speed capture.



Check your device's battery and memory beforehand

Make sure you have plenty of battery power before you begin recording. You don't want to run out halfway through the process and have to start again.

Similarly, make sure your device has plenty of available memory. Even a relatively short video may take up several gigabytes of memory – do you have enough to spare? You should shoot in a minimum of 720p resolution (1280 × 720 pixels); this will give your images enough clarity without making your files too large.

Save and share your videos properly

Your school will let you know where to store your video files. Make sure you understand how and where to upload them, so that they don't wind up lost in the wrong place. Upload your files as soon as you can after filming – this will let you free up memory in your device.

It's best practice to also keep a backup of all your files as well. You should store them on a portable drive, the hard drive of your device and another device, if possible. This is known as the 'rule of three'.

Some activities involve you filming other students. Make sure you share your videos with them, so that they can use them in their folio assessments.

Video analysis apps

There are several video analysis apps available for smartphones and tablets. These can let you zoom in on images, annotate or tag elements, or synchronise different videos. If you use an app, take some time to get familiar with its functions before you start using it for class activity. Your teacher may want you to use a specific analysis app, or you may be able to choose your own.

UNIT 1

Motor learning, functional anatomy, biomechanics and physical activity

Unit 1 examines motor learning, functional anatomy and biomechanical concepts, in the context of specific physical activities. In addition to demonstrating movement sequences and strategies, you will also observe, collect and analyse data to devise strategies around motor learning and biomechanics.

Unit objectives

In Unit 1, you will:

1 recognise and explain motor learning, functional anatomy and biomechanical concepts and principles about selected physical activities
2 demonstrate specialised movement sequences and movement strategies in selected physical activities
3 apply concepts to specialised movement sequences and movement strategies in selected physical activities
4 analyse and synthesise data to devise strategies about motor learning and biomechanics
5 evaluate motor learning, biomechanical and movement strategies
6 justify motor learning, biomechanical and movement strategies
7 make decisions about and use language, conventions and mode-appropriate features for particular purposes and contexts.

Physical activities

In Unit 1, the physical activities you explore must come from the following categories:

- Aesthetic
- Invasion
- Net and court
- Striking and fielding
- Performance
- Target.

Topic 1
Motor learning

1 Exploring motor skills
2 Investigating motor learning
3 Examining practice and feedback

Topic 2
Functional anatomy and biomechanics

4 Assessing force and motion
5 Appraising functional anatomy concepts
6 Creating momentum
7 Evaluating air and water forces

1 EXPLORING MOTOR SKILLS

Figure 1.1 Motor learning is a sports science.

Just like sports psychology or functional anatomy and biomechanics, motor learning is a sports science. Specifically, it's concerned with the science behind how we learn to move. Understanding the principle of motor learning is essential for anyone studying human movement, physical education or sport.

In this chapter, you'll begin the journey of discovery by exploring fundamental motor learning concepts used to explain how we learn to move.

KEY QUESTIONS

1.1 How do you distinguish between the different types of motor skills?

1.2 How do you know if someone has learnt?

1.3 Does learning occur in a predictable and sequential series of steps?

YOUR CHAPTER PLAN

1.1 What is a motor skill?

When you sprint, throw a frisbee, perform a handstand, hammer a nail or dance, you are performing a **motor skill**. 'Motor' in this context means that these activities require voluntary muscular movement of the body and/or limbs to complete a task. For example, running fast requires you to voluntarily move the muscles in your legs and arms at a rapid rate.

motor skill
an activity that requires voluntary muscular movement to achieve a goal or task

Just how well you perform a movement or motor skill depends on a number of factors. These include how often you practise, the type of practice, how much you learn through that practice, and how well you apply that learning to make the movement more efficient.

Consider throwing a ball at a target with your dominant arm. You've probably practised this movement many times, so the result is a smooth, efficient movement. Compare this with the throwing action of your non-dominant arm – how significant is the difference? Even a seemingly effortless motor skill such as throwing a ball requires practice and learning before it becomes proficient.

Figure 1.2 Striking a ball is an example of a motor skill.

Classification of motor skills

There are three methods used to classify motor skills. These classifications help to determine how particular motor skills are best learnt, controlled and analysed.

Each method presents a **continuum** of possible classification, rather than just two categories. No matter how you classify a skill, it will almost always fall somewhere within that continuum, rather than at one extreme or the other.

continuum
a continuous sequence of progression from one extreme to another

Gross and fine motor skills

This classification method distinguishes motor skills by the size of the muscles required to perform the motor skill.

Gross motor skills involve movements that primarily require large muscle groups, such as the muscles of the legs and arms. They require little precision.

gross motor skill
movement requiring the large muscles of the body

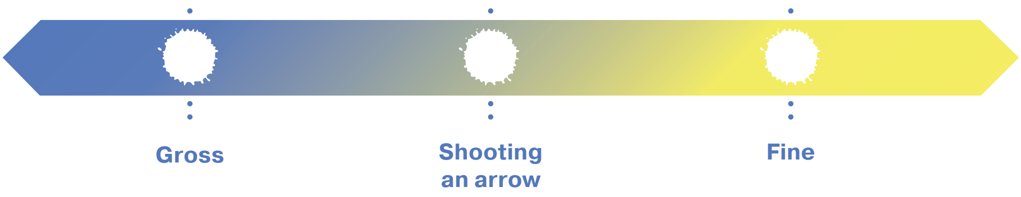
Examples of gross motor skills include walking, performing a somersault or tackling an opponent in football.

fine motor skill
movement requiring the small muscles of the body

Fine motor skills involve controlled movements that primarily require small muscle groups, such as the muscles of the hands and fingers. They require a high degree of precision. Examples of fine motor skills include handwriting, threading a needle and throwing a dart.

Some motor skills primarily involve both large and small muscles, and cannot be exclusively classified as either gross or fine motor skills. For example, shooting an arrow at a target requires precise finger movements, but it also requires larger movements of the shoulder and arm. Skills such as these fall somewhere in the middle of the gross-fine continuum.

Figure 1.3 The continuum for gross and fine motor skills



Closed and open motor skills

This classification method distinguishes motor skills based on the stability of the environment in which they're performed. The environment consists of three features:

- the *supporting surface* on which the skill is performed (e.g. a wooden floor)
- the *objects* involved in performing the skill (e.g. a ball)
- *other people* involved in the performance (e.g. defenders).

Stability refers to whether the environment context is stationary (stable) or moving (unstable).

closed motor skill
movement performed in a highly predictable, stationary environment

When the supporting surface, object or other people in the performance of a skill are stationary, the skill is classified as a **closed motor skill**. A closed motor skill is performed in a highly predictable environment in which you don't have to consider environmental changes, such as the changing positioning of opponents. You're in full control of the timing of your movements and can commence the action when you're ready. Examples of closed motor skills include hitting a golf ball off a tee, platform diving or a basketball free throw.

open motor skill
a movement performed in a highly unpredictable, moving environment

At the opposite end of the continuum is an **open motor skill**. An open motor skill is performed in an unpredictable environment in which the supporting surface, object, and/or other people are moving. Examples include driving a car, striking a moving ball or passing a ball between opponents.

Team games such as netball, football and rugby primarily involve open motor skills. The unpredictability of defenders and the movement of the ball are factors to which the performer must respond.

Motor skills are rarely classified neatly as open or closed, particularly in sport. They frequently fall into the continuum between the two extremes.

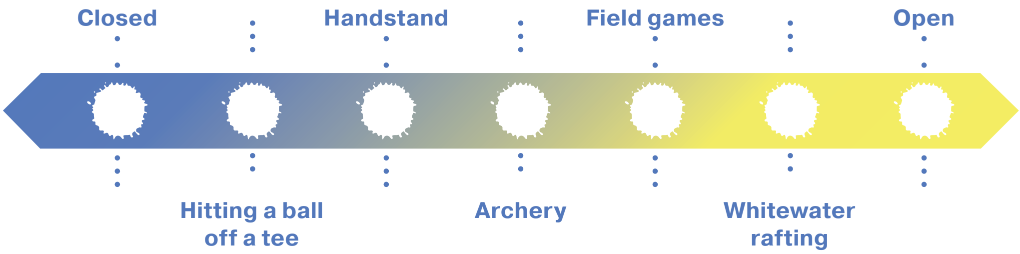


Figure 1.4 The continuum for closed and open motor skills

Discrete, continuous and serial motor skills

This classification method distinguishes motor skills based on whether the movement has a specific beginning and ending.

A **discrete motor skill** is one that has a clearly defined beginning and ending. They're typically simple, one-movement skills. Examples include throwing a ball, kicking a football and swinging a bat.

At the opposite end of the classification continuum are **continuous motor skills**. These skills are typically repetitive movements that don't have a clearly defined beginning or ending. Examples include swimming and walking.

If discrete skills are linked together in a continuous movement sequence, they're classified as **serial motor skills**. These skills are typically repetitive movements with specific beginning and end points. Because of this, serial skills are located on the continuum between discrete and continuous skills. Examples include performing the triple jump and playing a guitar.

discrete motor skill a movement with clearly defined beginning and end points

continuous motor skill a movement with no clear beginning and end points

serial motor skill a movement involving a series of discrete movements with clearly defined beginning and end points

Figure 1.5 The continuum for discrete and continuous motor skills

Classifying a specific motor skill

Each of these three methods classifies skills against different criteria, with no overlap between methods. This means that any specific motor skill can be classified using all three methods, allowing you to identify multiple aspects of that skill.

For example, long distance running is a combination of gross, open and continuous motor skills. This is because running involves the large muscles of the legs, is performed in an unpredictable environment as runners are constantly moving, and is a repetitive cycle.

Figure 1.6
Long distance running is a gross, open, continuous motor skill.

1.1 Check your understanding

1. Explain why playing the drums would be classified as a motor skill.
2. Explain the difference between gross and fine motor skills. Give specific examples of each from the physical activity you're studying in this topic.
3. Explain the difference between closed and open motor skills. Give specific examples of each from the physical activity you're studying in this topic.
4. Explain the difference between discrete, continuous and serial motor skills. Give specific examples of each from the physical activity you're studying in this topic.

Apply and analyse
classifying motor skills

LEARNING EXPERIENCE

Classify the following motor skills as either gross or fine; closed or open; discrete, continuous or serial:

1. bowling a leg spin delivery with a cricket ball
2. running on a treadmill for 30 minutes
3. throwing a ball at a moving target
4. taking a conversion in rugby league
5. walking along a footpath with a crowd travelling in the opposite direction
6. running a 100-metre race
7. playing a video game

1.2 What is motor learning?

Motor learning is the acquisition of motor skills through practice, instruction and feedback. It's often also used as the term for the study of that acquisition, so it's important to check the context when you see the term being used.

An important characteristic of motor learning is that it must occur as a direct result of practice or experience. If improvement or change in the performance of a motor skill occurs as a result of maturation (growing up) or physiological training, it's not classified as 'learning' but as a **motor development** change.

For instance, a baby starting to walk is an example of motor development, not motor learning, because it's a result of growth. Learning to kick a soccer ball requires practice, so it's an example of motor learning.

motor learning
the process and study of how we learn (or acquire) motor skills

motor development
the change in the performance of a motor skill as a result of maturation or physiological training

How do you know if someone has learnt?

Suppose you're a physical education teacher, and you're teaching your students to do a basketball lay-up. How do you know if they've learnt the technique you're teaching them? If a student successfully performs two lay-ups in a row, have they permanently learnt the technique, or will it disappear before the next practice session?

When assessing learning we need to keep two important concepts separate: performance and learning.

Performance is the act of executing a motor skill at a specific time and in a specific situation. For example, if you observe a player scoring using a lay-up at basketball training, you're observing the performance of a skill. However, this doesn't necessarily mean that they've permanently learnt the lay-up technique. Their performance throughout practice could be highly inconsistent.

This contrasts with **learning**, which is a relatively permanent change in a person's ability to execute a motor skill as a result of practice or experience. Learning suggests that some underlying mechanisms involved in the execution of a motor skill, such as muscles and nerves, have been developed. A player who has learnt the lay-up should be able to consistently perform the technique successfully, whether in training or in a competitive game.

To put it another way, performance is an observable behaviour, and learning is inferred from the performance.

performance
the act of executing a motor skill

learning
a relatively permanent change in performance as a result of practice and experience

Figure 1.7
A beginner practising a basketball lay-up.

Characteristics of motor skill learning

You can normally observe or experience five performance characteristics as you learn motor skills. These characteristics can be used to determine if learning has occurred.

Let's consider all five characteristics in the context of high jumping.

Figure 1.8 Five performance characteristics determine if someone has learnt how to high jump.

Improvement

Your performance of the skill shows improvement over a period of time.

After two weeks of high jump practice, you're able to jump 20 centimetres higher than you could before.

Consistency

As learning increases, your performance becomes more consistent.

Over weeks of practice, you consistently jump higher than before; you don't just occasionally fluke clearing the greater height.

Stability

As learning progresses, your performance becomes more stable. That is, you aren't affected by internal or external conditions that can disrupt performance.

Your high jump performance is stable in a variety of conditions, such as under the stress and pressure of competition.

Persistence

Your improved performance capability is marked by an increased level of persistence or repeatability. This means that as you progress in learning, your improved performance capability lasts over increasing periods of time, and becomes relatively permanent.

Your improvement in the high jump can be demonstrated today, tomorrow and next week.

Adaptability

Your improved performance is adaptable to a variety of performance contexts. Something is different each time you perform a motor skill; as you progress in learning a skill, you become more capable of performing successfully under these variable conditions.

When high jumping, you perform successfully regardless of your fatigue level, the wind direction or the type of run-up surface.

Linear versus nonlinear learning

For a long time, experts thought that when someone learnt a motor skill, the changes or improvements followed a linear progression. This means that learning occurs in a predictable, gradual series of steps. Your performance continually improves with practice, sometimes progressing at a steady, proportional rate, but at other times progressing rapidly or slowly.

A typical teaching sequence based on linear learning would follow a simple-to-complex progression. For example, when learning to dribble a basketball, you would progress through a series of steps. You'd start from practising dribbling in a stationary position, and progress through to dribbling in game movement patterns.

However, recent advancements in motor learning research have provided strong evidence to suggest that learning a motor skill is complex and follows a nonlinear progression. This means that learning is more dynamic, unpredictable and erratic; it doesn't follow a pre-set pathway.

For example, when learning a new skateboard trick, you might experience a large improvement in performance followed by a sudden decline. You might also experience periods of little or no improvement or learning as you adapt to the constantly changing environment.

From a nonlinear perspective, learning is about the result or outcome of the technique, rather than how the technique is performed. Learners should be given the opportunity to explore the environment and discover their own solutions. This is because learners can use various techniques to achieve an outcome. For example, no two sprinters run in exactly the same way to achieve the outcome of running fast.

Figure 1.9 Pat Cummins, Mitchell Starc and Holly Ferling all use a different technique to achieve the outcome of fast bowling.

Check your understanding 1.2

1. Explain the difference between learning and performance.
2. Identify the five characteristics used to determine if someone has learnt a motor skill.
3. Explain the difference between linear and nonlinear learning.

Apply and analyse performance characteristics

LEARNING EXPERIENCE

Categorise each of the following statements into one of the five performance characteristics to determine if the player has learnt to drive a golf ball from a tee:

1. They rarely slice their drive (i.e. ball travels straight).
2. They can hit the ball further than they could six weeks ago.
3. They can drive as well during a game as they can at practice.
4. They can hit their drive straight and accurately from each of the 18 tees.
5. They missed playing for two weeks but their ability is unaffected.

CASE STUDY

Hole in the wall

In 1999, Professor Sugata Mitra (a university professor of educational technology) carved a hole in the wall that separated his office from the adjoining slum in Kalkaji, New Delhi. In this hole he placed a freely accessible computer, connected to the internet.

The computer proved to be popular among the slum children. Within minutes, with no prior experience, children figured out how to point and click. By the end of the day they were browsing the internet. Within three months, the local children had learnt all the mouse operations, could open and close programs, save files, and were going online to set up email accounts and download games, music and videos. The young kids figured out how to use a computer on their own — and then taught other kids.

This prompted Professor Mitra to propose the following hypothesis: When working in groups, children do not need to be 'taught' how to use computers. They can teach themselves through incidental learning, provided the learners are given access to a suitable computing facility, with entertaining and motivating content and some minimal (human) guidance. Their ability to learn seems to be independent of educational background, literacy level, social or economic status, ethnicity and place of origin, gender, geographic location or intelligence.

The 'Hole in the Wall' project demonstrates that an environment that stimulates curiosity can cause learning through self-instruction and peer-shared knowledge.

QUESTIONS

1. Describe how you have learnt to use a device on your own without being 'taught'. Justify your comments using specific evidence.
2. Recall how you have learnt a motor skill on your own without being 'taught'. Assess the role of the environment in your learning (e.g. peers, backyard landscape). Justify your comments using specific evidence.

1.3 Understanding types of movement

No matter what the sport or activity, there isn't just one movement or action you need to perform to achieve your goal or reach your outcome. There are a variety of approaches to each situation, and these are referred to as **movement strategies**.

movement strategy
an approach that helps an individual or team successfully achieve a movement outcome or goal

Successfully executing a movement strategy, such as a drop shot in a game of badminton, requires the interaction of many types of movements:

- First, you need to force your opponent to hit from deep into their own court by using a clear shot.
- You then shuffle across the court quickly to the path of the returning shuttlecock.
- Then you stop, get into a balanced and stable position, and strike the shuttlecock with the exact amount of force and accuracy for it to land just over the net.

While you're executing the strategy, you also need to be aware at all times of your and your opponent's court positioning.

To understand the development of complex movement strategies, we need to distinguish between various movement types.

Figure 1.10 Executing a drop shot requires the interaction of many types of movements.

Fundamental movement skills

Fundamental movement skills (also known as foundational movement skills) are the basic skills that lay the foundation for more specialised, complex skills. These include skills such as sliding, hopping, dodging, throwing, catching, kicking or bouncing.

fundamental movement skill
a basic skill upon which movement sequences and strategies are created

In the case of a badminton drop shot, the fundamental skills used are running, shuffling and striking.

Body and movement concepts

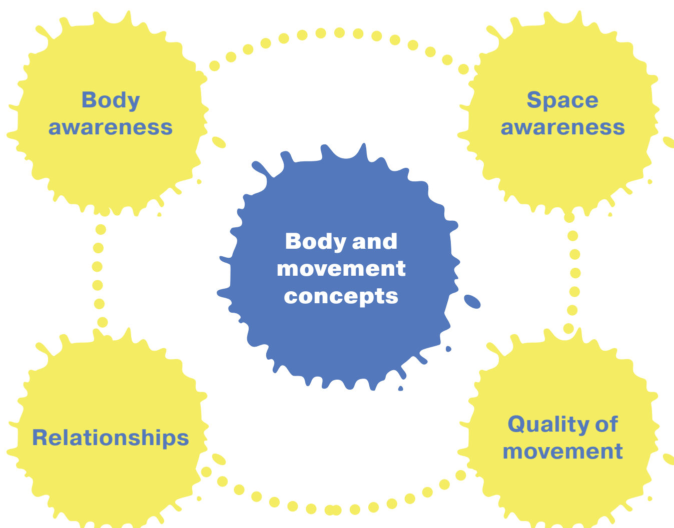
There are several key body and movement concepts that provide a framework for enhancing movement performance. These concepts are:

- **body awareness** — what movements the body can perform: balance, weight bearing, stability, transfer of weight, and flight
- **space awareness** — where the body can move: using general or personal space, direction, pathways of movement, and levels and planes of movement
- **quality of movement** — how the body moves: time and speed, accuracy, force development, effort, efficiency, effect, flow, sequence, continuity and outcome of movement
- **relationships** — connection with implements, interaction with opponents, objects and other players.

These body and movement concepts are applicable to all forms of movement. Each concept can be considered on its own or in conjunction with the others.

Consider the badminton drop shot example. When playing the drop shot, you must execute a quality strike on the shuttlecock – that is, impart the exact amount of force and accuracy for it to land just over the net. This relates to the concept of quality of movement.

Figure 1.11 Key body and movement concepts



specialised movement sequence
a combination of specialised fundamental movement skills and sequences relative to the position or event in a selected physical activity

Specialised movement sequences

Specialised movement sequences represent the combination of specialised fundamental movement skills and sequences, relative to the position or event in a selected physical activity. In other words, they are a set of movements that are specific to a particular position or event – you wouldn't use those movements in a different situation. Examples include a softball pitcher pitching a curve ball, a netball goal shooter rebounding and gaining possession, or a wicketkeeper stumping a batter.

In badminton, playing a drop shot from the front court is an example of a specialised movement sequence. The shot combines the fundamental movement skills of footwork (shuffling, stopping) and striking (direct shuttle downwards but decelerate speed) in a sequence, and this sequence is only used in that position.

Principles of play

Movement strategies address general **principles of play** – the fundamental strategies used in performance environments to achieve goals (i.e. win games). An example of a movement strategy for water polo is to deny space and apply pressure to your opponent to achieve the outcome of gaining possession of the ball. This movement strategy addresses the principle of play of defending against an attack.

In the badminton drop shot example, the movement strategy is to control the rally and draw your opponent deep into their court. This will achieve the outcome of creating space at the front of the court to exploit using a drop shot. This movement strategy addresses the principle of play of setting up an attack.

principle of play
a fundamental movement strategy used to adapt to tactical situations in authentic performance environments

Check your understanding 1.3

1 Describe an example of a fundamental movement skill used by a middle player in touch football.
2 Describe an example of a specialised movement sequence used by a hitter in volleyball.
3 Give an example of a movement strategy used by an attacker in any invasion game.

The interaction of types of movements

INTEGRATING MOVEMENT

DE 5

Category: Invasion
Physical activity: Touch football

Purpose

1 This activity involves observing movement sequences and strategies in a game of touch football.
2 The primary data collected in this activity could be used to support your folio task.

Preparation

Time: 1–2 lessons
Location: 50 m x 35 m field
Equipment: Football, markers, bibs; response tables

Setup

1. This is a whole-class activity.
2. Select twelve students; they will play a modified 6 v 6 game.
3. The remaining students will observe and document the game. Digital capture can be used but is not essential.

Performance

1. Students play a game of 6 v 6 touch football using the following modification: After effecting a touch, the defender must bob down and stay down for the entire set of six touches.
2. This should result in a gradual change in the number of defenders from 6 v 6 to 6 v 5, to 6 v 4 and so on.
3. After completing a full game, students swap roles; observers become players and vice versa.
4. Teachers should not provide any performance-related instruction. They can explain the rules (what to do, not how to do it) and then adopt a 'hands-off' approach. Ensure that rules are strictly enforced by a referee.

Data recording

Observers gather primary data about the types of movements evident in the modified game, and record the data in Tables 1.1 and 1.2. (These tables are available in your online resources.)

DE 1

Table 1.1 Specialised movement sequences observed

Specialised movement sequence	Observed? (tick if yes)
forward and backward movement	
sidestep and swerve	
switching and wrapping	
dump-and-split	
dummy passing, passing	
effecting a touch	
roll ball	
scoop	
scoring	

Table 1.2 Attacking movement strategies observed within the modified touch football game

Movement strategies **Principle of play: setting up attack**	**Observed? (tick if yes)**
maintain possession of the ball by providing attacking options to the ball carrier	
create space by dumping, 3-person rucking, 2-person rucking, wrapping, switching, dump-and-splitting	
use variations in the speed of attack (slow then fast) to set up and advance play	
Movement strategies **Principle of play: creating and exploiting space**	**Observed? (tick if yes)**
use the width of the field to create space in attack	
change the point of attack to create space between the defence	
Movement strategies **Principle of play: attacking opposition line and scoring**	**Observed? (tick if yes)**
stretch the opponent's defensive shape to draw players and create scoring opportunities	
use switches, wraps and dump-and-splits to create scoring opportunities	
use set plays to create scoring opportunities	

Tasks

DE 3

1 Analyse the primary data.

- **a** What specialised movement sequences were observed in the modified touch football game?
- **b** What movement strategies did the attacking players adopt to exploit the defence?
- **c** Identify which body and movement concepts were applied by players when performing the specialised movement sequences:
  - body awareness
  - space awareness
  - quality of movement
  - relationships.
- **d** What fundamental movement skills were used by players in the modified touch football game?

DE 4

2 Evaluate the effectiveness of the movement strategies adopted by the attacking team in the modified touch football game. Were the strategies successful in exploiting the opportunities created by the rule that defenders had to bob down after effecting a touch?

3 Justify your evaluation by providing specific evidence from the modified touch football game.

http://mea.digital/qpe12_1

Chapter review

[1.1] Motor skills are activities that require voluntary muscular movement to achieve a goal or task. They can be classified against three different sets of criteria: whether they are gross or fine skills; closed or open skills; and discrete, continuous or serial skills.

[1.2] Motor learning is the acquisition of motor skills through practice, instruction and feedback, as well as the study of that learning. It occurs as a direct result of practice or experience, and can be assessed against five performance characteristics. Motor learning is complex and most likely a nonlinear progression.

[1.3] Fundamental movement skills are the basic skills that lay the foundation for more specialised, complex skills. Body and movement concepts provide a framework for enhancing movement performance. Specialised movement sequences are specific combinations of movement skills and sequences in a physical activity. Movement strategies help an individual or team successfully achieve an outcome or goal.

Review questions

Section A: Multiple-choice questions

1 Which of the following activities is a motor skill?
- **a** driving a car
- **b** playing the piano
- **c** riding a bicycle
- **d** all the above

2 Which of the following activities is an example of a fine motor skill?
- **a** drawing a picture
- **b** performing a cartwheel
- **c** throwing a javelin
- **d** serving a tennis ball

3 Which of the following activities is an example of a closed motor skill?
- **a** taking a soccer penalty kick in extra time
- **b** serving a tennis ball at a target on the court
- **c** taking a free hit in a game of hockey
- **d** all the above

4 Which of the following activities is an example of a discrete motor skill?
- **a** taking a soccer penalty kick in extra time
- **b** jogging around an oval
- **c** performing a dance routine
- **d** riding a bicycle

5 Which of the following practice sessions focuses on learning in a closed environment?
- **a** a softball coach hits balls to a fielder at second base
- **b** a volleyball player receives an opponent’s serve in position 6
- **c** a swimmer practises starts off the blocks
- **d** a hockey player practises shooting for goal against two defenders

6 Which of these classifications is most accurate for the motor skill of bowling a tenpin bowling ball?
- **a** fine, closed, discrete
- **b** gross, open, serial
- **c** gross, closed, discrete
- **d** gross, closed, serial

7 Which of these statements is *incorrect*?
- **a** Motor learning is a change in performance as a direct result of practice.
- **b** Motor learning is a change in performance as a direct result of maturation.
- **c** Motor development is a change in performance as a direct result of practice.
- **d** Motor learning is a change in performance as a direct result of experience.

8 Which of the following statements about performance and learning is incorrect?
   - **a** Performance is observable whereas learning is not.
   - **b** Learning is a temporary change in the capability to execute a skill.
   - **c** Performance is about execution of a motor skill at a point in time.
   - **d** Learning suggests that some physiological change has taken place.

9 Which performance characteristic is demonstrated by a cricket player who can score runs on a variety of wickets against a variety of bowlers?
   - **a** improvement
   - **b** consistency
   - **c** persistence
   - **d** adaptability

10 Pressuring the ball carrier to try to regain possession is an example of which of the following movement types?
   - **a** fundamental movement skill
   - **b** body and movement concept
   - **c** specialised movement sequence
   - **d** movement strategy

Section B: Short-response questions (150–250 words)

1 Write a reflection on the following statements based on your perspective of the learning of motor skills:

A coach or physical education teacher must accept that when exploring the environment an individual will make mistakes, but will learn from them. Thus, it is good for an individual to make mistakes.

Individuals need to purposely operate at the edges of their ability so they 'screw up'; in turn, this will make them better.

2 Choose a movement strategy from the physical activity you're studying for this topic. Describe the types of movements that interact to allow the strategy to be successfully executed. Your response must include relevant fundamental movement skills, body and movement concepts, and specialised movement sequences.

Section C: Extended response (400 words)

There are five performance characteristics that can be used to determine if motor learning has occurred: improvement, consistency, stability, persistence and adaptability. Choose a motor skill from the physical activity you're studying in this topic. Use the five performance characteristics to determine whether you have learnt that skill. Give specific evidence to justify your reasoning.

2 INVESTIGATING MOTOR LEARNING

Figure 2.1 How do we learn to move?

Moving may seem simple, but it's not. As an infant, you learn how to control and coordinate basic physical movements. As you get older, you learn more complex ways to move – especially when you start learning the movement skills and strategies involved in a sport.

In this chapter, you'll look at several theories and models of how we learn to move. You'll explore the roles played by your body and the environment to understand how your own sporting skills have developed.

KEY QUESTIONS

2.1 What models of motor learning explain how we learn to move?

2.2 How is our movement controlled and coordinated?

2.3 Do learners progress through distinct stages as they acquire skill?

2.4 What role does the environment play in learning to move?

2.5 What factors influence our movement?

YOUR CHAPTER PLAN

2.1 Approaches to motor learning

Several theoretical models have been created over time to explain how we learn – not just how we learn mental actions like reading and writing, but how we learn physical actions. That includes complex physical actions like playing a sport, as well as things we might consider 'simple' actions like walking.

There are two major approaches to investigating motor learning, each of which is associated with a number of different models.

The cognitive systems approach

cognition
the mental process by which knowledge is acquired through perception, thinking and learning

cognitive psychology
a branch of psychology that proposes that the behaviours of individuals are a function of their internal mental processes

Cognition is the process of acquiring knowledge and understanding through perception, thinking and learning. The cognitive systems approach assumes that learning happens in the brain, and that our actions can be understood as the result of mental decision-making processes. This approach is associated with **cognitive psychology**, and dates back to the ancient Greek philosopher Plato and the theories of 17th-century philosopher René Descartes.

The cognitive model took over from behaviourism as the dominant model in modern psychology. Behaviourism proposes that we are 'programmed animals' that respond to a stimulus without thinking or using our brain.

The cognitive systems approach explains the learning of motor skills in terms of the information processing model. This model likens the human brain (and central nervous system) to a computer. This is because of the similarities between how a computer processes information and how psychologists proposed that the brain processes information and programs movement.

The stage model is a further development of the information processing model, proposed in 1967. It describes three distinct stages that individuals progress through when learning a motor skill.

The dynamic systems approach

ecological psychology
a branch of psychology that proposes that behaviours are a function of the interactions between an entity and their environment

dynamic
involving constant change and activity

Another more recent approach to understanding motor learning developed from **ecological psychology**. The dynamic systems approach suggests that learning occurs as a reaction to external environmental changes. When the environment changes, we adapt to that change and develop the skills necessary to the new situation.

According to this **dynamic** systems approach, our movements are not the result of unconscious mental decisions, but emerge naturally from the interactions of the individual, the environment and the task being performed.

The dynamic systems approach explains the learning of motor skills in terms of an ecological model, which is based on the principles of dynamical systems theory and ecological psychology. This is a relatively recent model that originated from attempts to address some perceived limitations of the cognitive model, which doesn't consider the effect that the environment can have on learning.

The development of motor learning models

Science involves creating theories based on current evidence, and then revising them (or even abandoning them) in response to new evidence. These approaches to motor learning have gone through similar processes. Figure 2.2 shows how the cognitive approach was a response to behaviourism, and how the dynamic systems approach was a response to the cognitive systems approach.

Behaviourism

- The brain is not involved in learning to move
- Learning occurs as a result of training, not thinking
- Instruction and reinforcement produce a trained movement response

Cognitive systems approach

- The brain is involved in learning to move
- Learning occurs as a result of information processing in the brain
- The brain processes information and selects a movement response

Dynamic systems approach

- The entire body and the environment are involved in learning to move
- Learning occurs as a result of interactions between individual, task and environment
- The body reorganises itself and movement emerges

Figure 2.2 The development of motor learning models

None of these approaches are necessarily ‘right’ or ‘wrong’, and nor are the models associated with them. They are all attempts to explain how we learn, based on theories and sets of evidence.

Over the rest of this chapter, you’ll explore the two major cognitive models, and investigate the environmental factors that might affect movement.

Check your understanding 2.1

1. Explain the basic assumption of the cognitive systems approach to learning.
2. Explain the basic assumption of the dynamic systems approach to learning.
3. Describe the two main models associated with the cognitive systems approach.

2.2 The information processing model

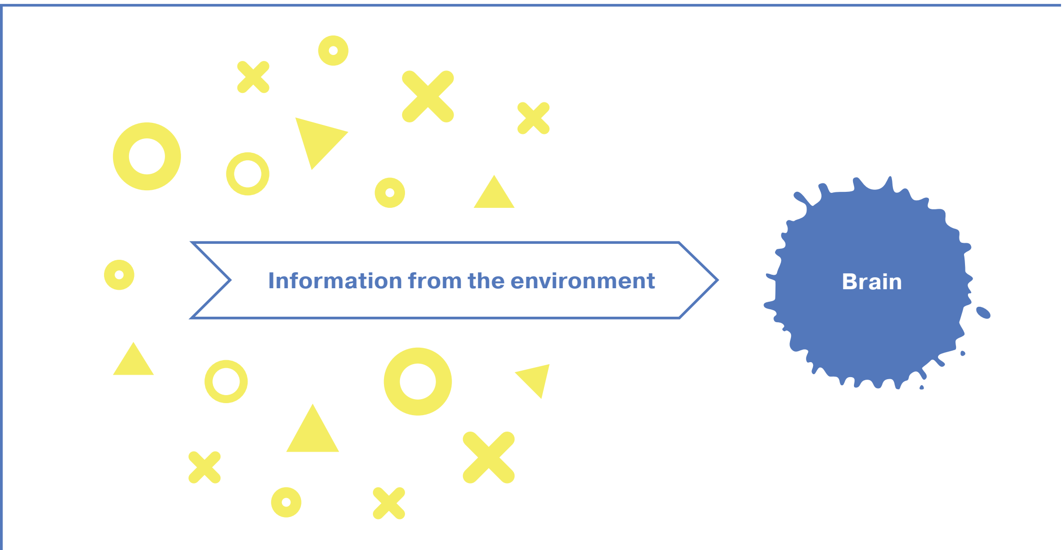
The core basic assumption of the information processing model of motor learning is that the movement of the body is mainly controlled by the brain.

perceptions what you become aware of directly through your senses, especially sight or hearing

This model says that your brain processes information – your **perceptions** of the environment – and then selects a movement response to that information. This response is selected from multiple movement plans, or **motor programs**, stored in your memory.

Motor programs are acquired through practice. Your brain then programs your muscles to execute the movement response.

Figure 2.3 The cognitive model gathers information from the environment.



motor program a movement plan that contains all the commands for the muscles to execute a motor skill

How information is processed

The cognitive model assumes that three specific information processing stages occur in the brain between the stimulus (input from the senses) and the response (output to the muscles).

Stage 1: stimulus identification

In this stage, information received through the senses is identified, such as a soccer player seeing a gap between defenders. The player's brain then processes the information into 'patterns' of electrical signals.

Stage 2: response selection

The primary purpose of this stage is deciding how to respond to the information. Does the player dribble through the gap or pass the ball to a teammate? The player's brain selects a response, such as dribbling through the gap, and prepares to plan for the movement.

Stage 3: response programming

At this stage, the brain retrieves an appropriate motor program from its memory stores to carry out the selected response, such as the specific instructions associated with dribbling the ball with speed and control. The brain then sends commands to the muscles to execute the movement response (output).

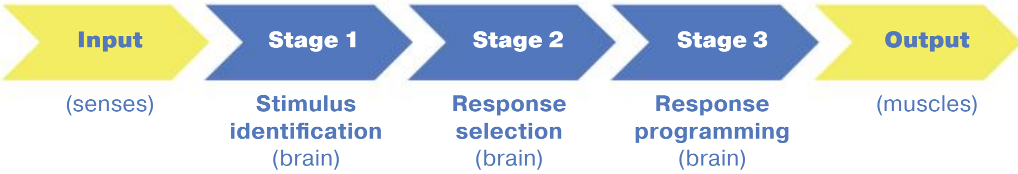


Figure 2.4 The three stages of information processing

Check your understanding 2.2

1. What is the basic assumption of the information processing model of motor learning?
2. According to the model, what are the three stages of information processing that occur in the brain?
3. What is the main difference between behaviourism and the cognitive systems approach in terms of the role of the brain?

Figure 2.5 Matildas striker Sam Kerr responding to a gap between defenders.

Evaluate and justify the three stages of information processing

LEARNING EXPERIENCE

Determine which stage of information processing is **most likely** to be the main cause for the following errors in a game of Australian football. Justify your response for each scenario.

1. A player takes an unsuccessful shot at the goal from an 'impossible' angle, not noticing an unmarked teammate in the goal square.
2. A player notices an unmarked teammate in the goal square, but decides to take a shot from an 'impossible' angle, and misses.
3. A player notices an unmarked teammate in the goal square and attempts a pass, but the kick clears the player's head and is marked by the opposition.

CASE STUDY

Murali made Gilly 'feel like a 10-year-old'

Adam Gilchrist says legendary subcontinent spinners Muttiah Muralidaran and Harbhajan Singh were the bowlers that caused him the most difficulty during his decorated career. Gilchrist compiled 33 centuries in all formats across his 12 years at international level and enjoyed success around the world, including in the subcontinent. But the former wicketkeeper-batsman says the rubber-wristed Murali, Test cricket's most prolific wicket-taker, provided him the biggest challenge. 'I could never read the delivery from Murali's finger movements. He always made me feel like a 10-year-old'.

Murali removed Gilchrist four times in six matches at Test level. Gilchrist says he employed a horizontal bat to counter Murali's vicious and unpredictable turn. 'Whenever I was in doubt, I promptly swept,' Gilchrist said. 'There was this Test innings where I had gone out with this mindset to sweep. First ball, I swept and the ball went for four. Second ball, I swept again. This time, it went straight up in the sky and I was caught. Next match, again I swept Murali the first ball and was caught plumb in front of the stumps.'

Adapted from cricket.com.au, 8 April 2016

QUESTIONS

1. Explain what you think Adam Gilchrist meant by his statement, 'I could never read the delivery from Murali's finger movements. He always made me feel like a 10-year-old'.
2. Consider the physical activity your teacher has selected for this topic. Describe how an elite performer may disguise information available to their opponent to gain an advantage.

Figure 2.6 Elite cricketers like Muttiah Muralidaran can disguise their bowling, making it difficult for their opponents to predict the ball's movement.

Information processing

INTEGRATING MOVEMENT

Category: Net and court
Physical activity: Tennis

Purpose

This activity involves observing and recording how players process information during a game of tennis.

Preparation

Time: one lesson
Location: tennis court
Equipment: three tennis racquets and 5 balls per group; digital capture devices

Setup

1 Form groups of six to eight students.
2 Allocate group members to each of the following roles:
   - T (thrower)
   - R (receiver with racquet)
   - A (opponent with racquet)
   - B (opponent with racquet)
   - O (information processor) – this should be a novice tennis player
   - D (data recorder) – all remaining group members.
3 Set up the group members as shown in Figure 2.7, with A and B facing *away* from the net.
4 Recorders should place themselves around the court at different spots.

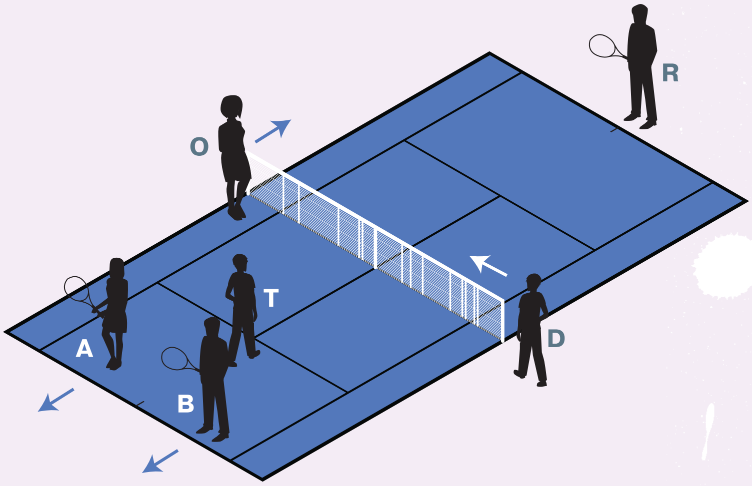


Figure 2.7 The roles and court positions

Performance

Go through the following process five times:

1. T throws a ball deep to R's forehand.
2. R hits the ball towards one of their opponents.
3. O watches R, and when they detect the pathway of the ball, they call out to the player that the ball has been hit towards. For example, if O detects that the ball is going to the forehand court, O calls out the name of player B.
4. The player receiving the ball turns around towards R and attempts to return the ball over the net.

Once five returns have been made, replace O with an experienced tennis player, and go through the process five times again.

Data recording

1. The first data recorder should digitally capture how and when O detects the pathway of the ball. DE 6
2. Any additional recorders should capture how effectively A and B react to O's call. DE 3
3. After the performance, all players should review the recorded data.

Tasks

1. Explain how O imitates the actions of the brain using the three stages of information processing.
2. Determine what specific sources of information were used by each of the information processors to detect the pathway of the ball. DE 3
3. Assess the impact of the information processor's ability to use advanced signals (i.e. information gained before the ball is hit) on the success of their opponent's ball return.
4. Evaluate the ability of the opponents (A and B) to successfully return the ball over the net. Justify your comparison with reference to the three stages of information processing. DE 4
5. Devise a strategy that a tennis player may use to make it more difficult for their opponent to use advanced signals to anticipate the type of serve they are using.

http://mea.digital/qpe12_2

2.3 Fitts & Posner's stage model

Consider a skill in which you're very proficient. Try to remember the time when you first learnt this skill, and the difficulty you had with all its elements. You were probably preoccupied with the techniques associated with the skill itself, and had little concern for other environmental factors.

For example, think about learning to ride a bicycle. The skills required to stay upright and balanced while steering, pedalling and trying not to crash, combine to make riding a bike a very complex task for a **novice**.

novice
a beginner or inexperienced learner

Figure 2.8
Learning to ride a bicycle is a very complex task.

Now reflect on how your skills improved over time to the point where you didn't have to think about the technique of riding. Instead, you could transfer your attention to other details, such as perceiving cars on the road and making decisions about how to get to a destination.

An important characteristic of learning motor skills is that all learners seem to gradually progress through distinct stages as they acquire skill. In 1967, researchers Paul Fitts and Michael Posner developed a cognitive model that described three distinct stages that individuals progress through when learning a motor skill:

1. the cognitive stage (understanding)
2. the associative stage (practice)
3. the autonomous stage (automatic).

The amount of time a person stays in each stage depends on the characteristics of the individual, the skill being learnt and the practice conditions.

The cognitive stage

During the cognitive stage of learning, a beginner or novice discovers what is required to perform a skill. The learner's performance at this stage is distinguished by these features:

- frequent and obvious errors
- inconsistency in terms of accuracy and success
- inefficient movement sequences (i.e. poorly timed, slow and with unnecessary extra movements)
- a high attentional demand (i.e. always having to think about what they are doing)
- rapid improvement in performance.

Learning in the cognitive stage

The best way to learn in the cognitive stage is to have the skill demonstrated to you, so that you can form a rough mental plan. The neurons in the motor-control section of your brain respond when an action is observed (and performed). This could be in the form of a demonstration given by your teacher or coach, or by watching a video of a performance.

Watching others perform the movement is also a way of improving your performance. As a learner, you identify the successes and errors of the observed performer, and this visual feedback assists in correcting your own performance.

Key points for helping novices

Teachers/coaches can help learners in the cognitive stage in several ways:

- providing accurate demonstrations
- allowing time for practice and by re-demonstrating the skill
- relating the skill to other skills previously learnt (**transfer of learning**)
- giving clear instructions—not overloading the learner with information
- allowing the learner to experience the 'feel' of the whole movement
- using short cue words to assist in simplifying the key components of the skill.

transfer of learning
the influence of a skill you already have on the learning of a new skill

The associative stage

Once learners have a clear understanding of what they need to do to execute the skill, they must practise to become familiar with the sequencing and timing of the movement.

The transition from the cognitive into the associative stage occurs with practice and performance improvement. The amount of practice required will depend on the complexity of the task, the player's ability, their experience, and motivation.

Demonstrations and feedback are important in this stage. Feedback is particularly important, but it should not be specifically about what has happened; instead, it should be about what to do next.

The learner's performance at this stage is distinguished by these features:

- fewer and less obvious errors
- some inconsistency in terms of accuracy and success
- more efficient movement sequences (improved timing, quicker)
- less attentional demand (i.e. know 'what to do', learning 'how to do it')
- improvements are less rapid
- an ability to detect their own errors.

Learning in the associative stage

The key element of learning in the associative stage is practice, practice, practice. Consider this statement by halfback Cooper Cronk on how he developed his skills:

Figure 2.9 Queensland and Australian halfback Cooper Cronk spent many hours refining his skills.

> *Cronk began preparing as a pugnacious teen who put himself through searching sessions on his own at a park near his home to find out whether he had the mental resolve needed to make it to the top.*
>
> *'When I was younger, about 15 or 16, I would often compete with myself,' Cronk writes on his website.*
>
> *'I'd get off the train from school, walk to the football fields and I wouldn't go home until I had met the challenge I had set myself.*
>
> *'I had this ritual of kicking the ball through the posts from five different locations on the field. I'd tell myself if I kicked 10 in a row I could go home. There were many times when I kicked seven, eight or nine in a row and then missed the next one, which forced me to start again.*
>
> *'Sometimes I would still be there after dark.'*

Source: 'Origin hero Cooper Cronk shuns praise', *Herald Sun*, 2012

Key points for helping learners

Instructions, demonstrations and feedback become less important for learners in the associative stage, unless they are targeted at specific aspects of the skill.

Practice should be similar to performance or competition, and can be modified gradually to keep the skill at a challenging level.

The autonomous stage

Some performers may only reach the **autonomous** stage after many years of quality practice; others may never reach this stage.

autonomous able to function independently

Performers at the autonomous stage have better response times than novices. This is because they don't have to process individual bits of information. Instead, they process larger chunks of information that occur without their attention.

From a cognitive perspective, an autonomous or expert performer is someone who has acquired and stored large amounts of complex movement representations in their memory, thanks to practice. This stored, sophisticated knowledge allows them to select more accurate movement responses from information they perceive in the performance environment.

Figure 2.10 Queensland Firebird and Australian netballer Gabi Simpson has the qualities of an autonomous or expert performer.

A person's performance at this stage is distinguished by these features:

- rarely made errors
- consistently accurate and successful
- very efficient movement sequences (i.e. perfect timing, high speed)
- little attentional demand (i.e. the performer carries out the skill automatically or without conscious thought)
- improvements are subtle
- the ability to multi-task (i.e. carry out a secondary task without any detrimental effect to the performance of the primary task, such as answering questions while juggling)
- an ability to detect and correct their own errors.

Key points for helping performers

When 'expert' performers focus on the internal mechanics of their body segments, such as the correct positioning of the hips during a golf swing, it actually tends to make their performance worse. This is because it interrupts the normal, efficient subconscious or automatic learning process.

This preoccupation with thoughts of how the body should be positioned to perform the skill is referred to as 'paralysis by analysis'. To avoid this, teachers and coaches should provide performers with an alternate focus that distracts the brain, rather than fill it with information.

For instance, instructions should redirect the performer's attention towards the effects of a movement, and minimise the focus on the execution of the skill. Metaphors for performance, such as 'hit the ball so that the flight is like a rainbow', can also stop the performer from thinking about their internal movements when performing the skill.

Relearning a skill

Once someone reaches the autonomous stage of learning a motor skill, you might think that they've reached the peak of performance. But even expert performers can have bad habits.

For expert performers, modifying bad habits is a frustrating task from a skill-acquisition perspective. They need to 'unwire' the learnt bad habit and 'rewire' a new motor program. The autonomous stage enables the old skill to be performed subconsciously, so its execution 'feels' right – even if it's not. However, when the athlete tries to adapt to the 'new' technique, it feels wrong.

This is a common complaint of athletes when learning a modified or more efficient skill, and they have to keep going during this stage of learning. The new technique not only feels wrong, but it's also not as efficient as the old method and has a high rate of errors. Athletes often revert to old habits when their performance suffers because the new skill isn't at the autonomous stage. Transition to a new technique requires great perseverance from an athlete and even greater feedback from their coach.

Engage and understand
categorising the stages of learning

LEARNING EXPERIENCE

Determine which stage of Fitts and Posner's stage model is most likely represented by the following players' performances in lawn bowls.

1. A player's bowl consistently comes to rest within centimetres of the jack.
2. A player's bowl consistently curves in the opposite direction to that intended, coming to rest a long way from the jack.
3. A player's bowl consistently curves in the intended direction, but still comes to rest a relatively long way from the jack.
4. A player takes one or two bowls to read the speed of the green, then starts bowling with consistent accuracy.
5. A player rarely has a bowl closer to the jack than their opponent's bowl, but occasionally flukes a bowl that comes to rest against the jack.

Figure 2.11 Learning in the stage model explains the ongoing development of information processing, resulting in improved movement responses.

Autonomous performers and dual tasking

dual task
a task that combines a cognitive task with a motor task

Experts are more successful than novices in maintaining their motor performance while performing a **dual task**. A dual task is when a cognitive task (e.g. a maths calculation) is performed at the same time as a motor task (e.g. golf putting).

For example, in the early 1980s, researcher Helen Parker examined participants' performance of a ball catching/throwing task while performing a light detection task. She used groups of highly skilled, average and less-skilled netball players.

The results showed that there were no differences between the three groups when performing the catching/throwing task on its own. However, there were reductions in performance for *all* groups when they had to perform both tasks simultaneously. Another important finding was that the highly skilled group made significantly fewer errors than their less-skilled counterparts.

The conclusion from Parker's work, and other similar research, is that highly skilled players who are at the autonomous stage need to pay far less attention to perform motor tasks than novice players at the associative stage. This means the highly skilled players can focus their attention on other sources of information within the performance environment.

For example, a highly skilled basketball player at the autonomous stage of learning can dribble without much thought. Their skill level gives them the freedom to focus their attention on scanning the court and making decisions about how to get through the opposition's defence.

Becoming a more autonomous performer

When novices are learning motor tasks, practice should be made easier by reducing the number of factors that they have to think about. This allows them to focus their attention entirely on the motor task without distraction. For example, when a novice basketballer is learning to dribble, the task can be made easier by taking away defenders, and asking the player to just dribble the ball around markers.

Once a task is mastered and becomes partly automated – when it can be performed using less attention or thinking – the basketballer can devote additional attention to other areas of skill development. For example, adding defenders means the player needs to incorporate decision-making, such as deciding how to dribble around an opponent.

Figure 2.12 Expert Australian basketballer Rohanee Cox is able to perform dribbling skills while focusing her attention on her opponent and teammates.

Check your understanding 2.3

1 Identify Fitts and Posner's (1967) three stages of learning.
2 From a cognitive perspective, how is practice made easier for novices when learning motor tasks?
3 Highly skilled or autonomous performers need minimal thought to perform motor tasks. Explain how this is an advantage when playing a game.

Fitts and Posner's stage model

INTEGRATING MOVEMENT

Category: All
Physical activity: All

Purpose

1 This activity involves using data to draw conclusions about performers' stage of learning.
2 This activity focuses on the physical activity your teacher has selected for this topic.
3 The primary data collected in this activity could be used to support your folio task.

DE 5

Preparation

Time: one lesson
Location: depends on activity
Equipment: depends on activity; digital capture devices; GPAI from online resources

Setup

1 Get into pairs (A and B) to play a modified version of the physical activity.
2 Before you start, choose a specific motor skill (e.g. passing, catching, kicking, striking) to observe and document, using the GPAI from your online resources.

Performance

1. Player A participates in a modified version of the physical activity, one with a smaller number of players or in a different play environment. Player B documents A's performance of the motor skill.
2. Once A has finished and B has recorded, change roles and play again.

Data recording

1. Each player should use digital capture to record the other's performance of the chosen motor skill. DE 6
2. Once all data is recorded, each student should complete the GPAI using their own data. DE 1

Tasks

1. Analyse the primary data in terms of: DE 3
   a. errors (frequent, few, rare)
   b. accuracy and success (very inconsistent, some inconsistency, very consistent)
   c. efficiency: coordination, speed (slow/poor, satisfactory, high)
2. From this primary data, evaluate and categorise the stage of learning that you and your partner are currently at for that motor skill. Justify your decision using primary and secondary data. DE 4
3. Devise a motor learning strategy to improve your partner's performance.

Motor skill	Overall errors (number)	Accurate and successful execution (number)	Efficiency (tick one box)		
			Slow/poor speed and coordination	Satisfactory speed and coordination	High level of speed and coordination
Student A					
Student B					

2.4 The dynamic systems approach

The cognitive systems approach proposes that how you move is mainly controlled by your brain. In contrast, the dynamic systems approach proposes that your entire body and the environment are jointly responsible for shaping how you move.

The dynamic systems approach explains learning using an ecological model. This model is based on modern motor learning theory that combines ecological psychology and dynamical systems theory. Ecological psychology proposes that human behaviour – including movement – cannot be understood without considering the specific environments, both physical and social, in which it happens. Consider a basketball player who shoots from inside their own half. This behaviour would be understandable in the last seconds of a match, but not in the first minute of play.

According to ecological psychology, the interactions between your body and the information you perceive about the environment shape your thinking, and you act as a result. For example, before crossing the street, we rely on our senses, specifically our hearing and sight, to detect if a car is coming. With this sensory information, we can decide when it is safe, then we cross the street. In sport, a golfer uses their perceptions of the surroundings, such as the slope of the green, to decide and execute the appropriate putting action.

Figure 2.13 We rely on all our senses to determine when it is safe to cross the street.

Learning is therefore the process of an individual becoming better able to detect and interpret relevant information from the environment, from which associated movement solutions or actions emerge.

In this ecological model, an expert performer is someone who is adaptable. This means that they are successful in a variety of environments. An expert performer is better able to detect and interpret information from the environment for determining their response. For example, a tennis player who is successful on many court surfaces such as grass, clay and hard court is an expert performer.

CASE STUDY

How do actors memorise their lines?

We worked with about 30 actors over nearly three years on the Royal Shakespeare Company's last complete cycle of the history plays. All the actors were in at least seven of those plays and learnt a huge number of roles. Halfway through the project, we left the first four plays behind for nearly a year. And we had to revive them. The actors began to get anxious about whether they would remember them: not only their principal roles, but the roles they understudied – thousands of lines, hundreds of states of emotions. An extraordinary feat of spatial memory was required, too: they had to remember where to go. Where am I? Backstage or front of house?

This process started with actors on their own going through their lines. They didn't remember them. We then moved on to working together in a room, sitting down doing a line-run. It wasn't very good. Then we decided to cut to the chase and just fling all four plays onto the stage – without costume, without décor, without all the effects. And the actors were very nearly word-perfect straightaway. It was clear that what they were trying to retrieve was no more than a broken bit of memory, only complete when the actions of their bodies and the emotions were combined with the recall of the line. And there was a further improvement when they were not only together on stage, but also together with an audience. Then they became absolutely pitch-perfect and word-perfect, with an urgent need to communicate. I think that says something about where we keep our memory. Maybe our memory is in our body as well as in our cranium.

Source: *The Sunday Times*, 23 November 2008

QUESTIONS

1 Identify, from least to most successful, the environments in which the actors attempted to remember their lines.
2 'It seems that the cognitive task of remembering is more effective when the brain, body and environment are involved.' Justify this statement using evidence from the case study.
3 An important point to take from this case study is that the actors' lines made no sense to them without a role, and especially one that relates to other roles. In sport, the same is true for basic motor skills. Motor skills make no sense to the performer without a role or a context. Imagine you are the coach of a hockey team. What would you incorporate into your practice task design to help ensure that the motor skill of passing made sense to the player?

Constraints

According to dynamic systems theory, human beings are a complex dynamic system composed of many interacting parts (such as the senses, nerves and muscles) and unique individual characteristics (such as height and fitness). When this complex dynamic system interacts with the environment, instability is created, resulting in the system reorganising itself and movement emerging.

For example, your individual hurdling technique emerges as a result of the dynamic interactions between your speed and flexibility (individual characteristics), the distance between hurdles (task) and the running surface (environment). Researcher Karl Newell called these three categories of interacting factors **constraints**.

constraint
a boundary that shapes each learner's movement by limiting the number of available actions

Individual learner, task and environmental constraints provide a framework to understand how coordinated movement emerges. Table 2.1 lists some examples of constraints.

Table 2.1 Constraints can be classified into three different categories.

Individual learner	Task	Environmental
height	game rules	Physical
weight	scoring procedures	playing conditions
coordination	team size	crowd
cardiovascular fitness	field dimensions	temperature
prior experience	equipment	lighting
personality	attacking strategies	altitude
confidence	defensive strategies	presence of opponents
motivation	opposition strategies	referee/umpire/judge
cognition	game situation	Social
		culture
		peers
		teachers and coaches

Figure 2.14 Sally Pearson's individualised hurdling technique emerges from the interaction of individual, task and environmental constraints.

Individual learner
e.g. flexibility, speed, confidence

Task
e.g. hurdle height, interval between hurdles, event rules

Environmental
e.g. grass track, coach, peers watching, competitive race

Evaluate and justify
constraints

LEARNING EXPERIENCE

1 Predict what influence the following constraints may have on an individual player's behaviour during a game. Give one example for each and include your reasoning:

- **a** playing soccer on a very wet field
- **b** batting in a softball game with the rule, 'One strike and you are out'
- **c** playing futsal with a soccer ball
- **d** playing against opponents who are continually offside in a game of touch football
- **e** the awarding of nine points for a Super Goal in Australian Rules Football (i.e. a successful shot taken from outside the 50-metre arc)
- **f** playing tennis on a long, narrow court
- **g** your team is one goal behind in a netball game with 10 seconds to play
- **h** batting in a game of cricket with an umpire who never gives a player out Leg Before Wicket (LBW)

2 Justify your predictions in Question 1, using primary and secondary data.

Modifying practice environments

Modifying the practice environment through the introduction of **task constraints** can shape the way you move or play.

An example of a task constraint in basketball would be modifying the scoring so that three points are awarded for successful shots within the key, and one point for successful shots from outside the key. This scoring change would shape the way that you shoot in a game in a variety of ways. For example, you may now decide to drive to the basket to secure the extra points. But, because of the scoring change, defenders may defend the keyway, thus offering you the opportunity to shoot from outside with less pressure.

It is difficult to predict what impact a task constraint will have on an individual. This is because shooting behaviour, for example, is also shaped by an individual's characteristics, such as their confidence, and the social environment, such as their coach's instruction.

task constraint
a boundary applied to a game or activity that shapes movement (e.g. rules, playing dimensions)

Figure 2.15
A wet soccer field can influence the way we play a game.

Check your understanding 2.4

1 According to the ecological model, what is responsible for shaping how we move?
2 Describe an example of how your movement is determined by what you see when playing in a game of touch football.
3 Identify the three categories of constraints, and give an example of each.

Introducing task constraints

INTEGRATING MOVEMENT

Category: All
Physical activity: All

Purpose

1. This activity involves analysing data to determine how task constraints shape performance.
2. This activity focuses on the physical activity your teacher has selected for this topic.
3. The primary data collected in this activity could be used to support your folio task. DE 5

Preparation

Time: one lesson
Location: depends on activity
Equipment: depends on activity; digital capture devices

Setup

1. Allocate the class into groups with the help of your teacher. Each group needs enough members to play the chosen activity, plus one or more members to record data.
2. Each group modifies a practice environment by introducing a task constraint of their choice, such as a rule, a scoring procedure, modified equipment or adjusted field dimensions.
3. Each group predicts how the task constraint may shape the individual players' actions in both attack and defence.

Performance

1. A set of members from each group participate in the modified environment, while the other members digitally capture the activity.
2. During the activity, your teacher must adopt a 'hands off' approach and allow you the freedom and time to actively explore the environment, and for solutions to emerge without explicit instruction (such as telling you what to do, not how to do it).
3. Rules must be strictly enforced by a referee and the environment must be competitive.

Data recording

1. Data recorders should digitally capture how the task constraint shapes players' actions. DE 6
2. After the performance, all players in each group should review the recorded data. DE 1

Tasks

1. Analyse the primary data to determine how the task constraint shaped individual players' actions in both attack and defence. DE 3
2. Evaluate any new actions or playing styles that emerged. Propose how the interactions between a player's individual characteristics and those of the task and environment shaped their play. DE 4

2.5 Rate limiters

As you saw earlier, constraints influence the way we perform under different conditions. **Rate limiters** are constraints that specifically influence how you learn, and that can restrict or impede your performance. For example, muscle strength is a rate limiter that restricts an infant's ability to walk. Until their muscle strength reaches an appropriate level, the infant will not be able to take their first steps.

There are many rate limiters, but they can be grouped into the same three categories as other constraints:

- **individual –** factors such as technique, coordination, perceptual ability, decision-making ability, tactical knowledge, height, limb length, strength, confidence, motivation, speed, flexibility, experience
- **task –** weight, size, or height of equipment; size of the playing area; rules
- **environmental –** surface, coach or teacher instructions, weather, umpire or referee, culture, teammates' ability.

rate limiter
a factor that influences how an individual learns and potentially restricts their performance in a specific context.

An understanding of rate limiters and how they influence learning is essential for anyone involved in the learning of motor skills.

For example, imagine you're a touch football coach. You're worried that the players in your team do not run from acting half when the defence is disorganised and retreating. To solve the problem, you need to understand possible rate limiters responsible for this behaviour. These could include your players' lack of perceptual awareness (they don't scan the defence before passing the ball) or personalities (they aren't willing to run at the risk of being tagged and losing possession).

A common rate limiter in junior sport is the equipment used. This is because equipment size isn't changed (scaled) for all individuals. Research has found that when sports equipment is scaled for children, they acquire skills faster.

Figure 2.16
The size of a discus relative to the size of an athlete's hand is a rate limiter that restricts throwing performance.

Overcoming rate limiters

When we identify the rate limiters to someone's performance, we can change the practice environment to overcome their impact and help the person to learn.

In our touch football example, you could incorporate a rule (task constraint) that in each set of six touches, the acting half can get touched once and not lose possession. This 'free go' could help overcome the rate limiter of the players' personalities (not wanting to take risks). You could also introduce a rule that the defence must retreat 10 metres after effecting a touch. This could help overcome the rate limiter of the players not scanning, since it makes the opportunity to run more obvious to the acting half.

Combined, these rules or task constraints should result in the players having more opportunity to learn about exploiting a defence from the acting half position.

Evaluate and justify
identifying rate limiters

LEARNING EXPERIENCE

1. Consider Figure 2.17 below. Identify the key rate limiters that are restricting this player's ability to learn how to shoot a basketball like a player would in a game.
2. Predict how the player's shooting technique may be shaped by this environment.
3. Design a strategy to overcome key rate limiters and allow the opportunity for the player to learn how to shoot more like a player would in a game.

Figure 2.17 A young basketball player learning to adapt his shooting technique due to practising on an adult court

Because rate limiters restrict the performance of a skill, they affect a player's potential learning of associated movement strategies or principles of play. For example, if a young player has difficulty hitting a shuttlecock with a badminton racquet because the racket isn't scaled appropriately for them, they will have difficulty learning the strategy of moving an opponent around the court to create space.

Clearly, we need to identify and understand individuals' rate limiters, so that we can alter the practice environment to overcome them and allow the best opportunity for learning.

Figure 2.18 Rate limiters, such as speed, strength and height, restrict Australian football performance.

Check your understanding 2.5

1 What is a rate limiter?
2 Describe three rate limiters that would influence your chances of winning an Olympic weightlifting medal.
3 Identify possible rate limiters that may restrict your skill development in the physical activity your teacher has selected for this topic.

Rate limiters and performance

INTEGRATING MOVEMENT

Category: Invasion
Physical activity: Australian football

Purpose

This activity involves drawing conclusions from data about rate limiters in a game of Australian football.

Preparation

Time: two lessons
Location: 30 m x 15 m field (mark field every 5 metres)
Equipment: Australian Rules ball, markers, bibs; digital capture devices; GPAI from online resources

Setup

1 This is a whole-class activity.
2 Select twelve students who are novice Australian football players; they will play a modified 6 v 6 game.
3 Up to four students will document the game using digital capture.
4 The remaining students will observe the game.

Performance

Students play a 10-minute game of 6 v 6 endball using the Australian football handpass with the following conditions:

1 Use Australian football handpasses only.
2 The aim of the modified game is for your end-zone player to catch the ball on the full in the opponent's end zone (the area beyond the goal line).
3 The end-zone player can move anywhere in the end zone.
4 No defenders are allowed in the end-zone (only the attacking end-zone player is allowed).
5 The person with the ball cannot run (defenders must stay 1 metre away).

Data recording

DE 6

1 Students recording the game will have better results if they can record from an elevated position (such as standing at the top of the bleachers).

DE 1

2 After the performance, all students watch the footage of the game and record in a GPAI:
   a the number and length of passes attempted; for example, number of passes less than 2 metres, 2–5 metres, 5–10 metres, 10–15 metres, more than 15 metres
   b the distance between the player with the ball and the two closest attacking players (freeze recording at 30-second intervals to calculate)
   c the number of passes successfully executed
   d the number of passes unsuccessfully executed
   e the total number of passes attempted.

Tasks

DE 3

1 Analyse and synthesise the primary data.
   a What was the average length of passes attempted during the game?
   b What was the average distance between the three closest attacking players during the game?
   c What percentage of total passes were successfully executed?
   d What percentage of total passes were unsuccessfully executed?
   e What was the most successful passing distance?

DE 4

2 Use your analysis of the primary data to evaluate the effect of the rate limiters involved in the game.
   a Draw conclusions as to the possible individual learner, task and/or environmental rate limiters that restricted players' individual performance during the game.
   b Assess the impact of these rate limiters in restricting players' opportunity to learn the following movement strategies or principles of play associated with invasion games:
      i penetrate defence by passing forward to an unmarked teammate
      ii play with width (spread out) to stretch opponents defensive shape, to create space in middle of field and between or behind defenders
      iii support the player with ball (teammates provide forward, backward, and sideways options).
3 Play the same game but change the rule to only allow rugby or netball type passes.
   a Identify which specific rate limiter(s) the rule change is designed to overcome.
   b Assess the effectiveness of this rule change in overcoming the rate limiter and allowing opportunities for players to learn the movement strategies.

Chapter review

[2.1] A number of different theoretical models, based on schools of psychology, seek to explain the process of motor learning.

[2.2] The information processing model proposes that movement is predominantly controlled by the brain. Within the brain, three stages of information processing occur before movement is executed – stimulus identification, response selection and response programming.

[2.3] Fitts and Posner (1967) proposed a stage model of learning, with gradual changes becoming evident as the learner progresses through three stages – the cognitive (understanding) stage, the associative (practice) stage, and the autonomous (automatic) stage.

[2.3] When novices are learning motor tasks, practice should reduce the cognitive demand on the learner. Highly skilled performers need minimal thinking to perform motor tasks.

[2.4] The dynamic systems approach proposes that the entire body of the individual (not just the brain) and the environment are jointly responsible for shaping how we move. An individual perceives information from the environment, which is used to determine their movement.

[2.4] The interacting factors or boundaries from which coordinated movement emerges are called constraints. There are three types of constraints: individual learner (e.g. agility), task (e.g. game rules) and environmental (e.g. coach).

[2.5] Rate limiters are constraints that influence how an individual learns and potentially restricts their performance in a specific context. Identifying rate limiters to an individual's performance allows us to manipulate the practice environment to overcome their impact and allow the opportunity for learning.

Review questions

Section A: Multiple-choice questions

1 The cognitive systems approach:
- **a** is likened to psychology.
- **b** proposes that movement is programmed or automated.
- **c** proposes that information is processed by the senses.
- **d** proposes that movement is predominantly controlled within the brain.

2 Motor programs:
- **a** are inherited.
- **b** are stored in the memory.
- **c** exist for every possible movement response in sport.
- **d** are used to process information from the environment.

3 According to Fitts and Posner, the stage which requires the learner to refine a basic motor pattern is known as:
- **a** variable.
- **b** cognitive.
- **c** associative.
- **d** trial and error.

4 According to the information processing model, expert performers:
- **a** can successfully adapt to a variety of environments.
- **b** often revert to the understanding stage when correcting bad habits.
- **c** have acquired and stored increased amounts and complexity of motor programs.
- **d** can use their senses efficiently to detect and interpret information from the environment.

5 From a cognitive perspective, when novices are learning motor tasks:
- **a** the cognitive demand should be increased.
- **b** they should be given time to explore their own technique.
- **c** they devote far more attention to the motor task than expert performers.
- **d** they should be allowed the freedom to focus their attention on other sources of information in the performance environment.

6 The dynamic systems approach is distinguished by:
- **a** a complex relationship between players.
- **b** dynamic and constantly changing physical activities.
- **c** constant interactions between the individual and the environment.
- **d** the processing of perceived information from the performance environment.

7 According to ecological psychology, an individual's performance is determined by the:
   a physical and social environment.
   b processing of information by the brain.
   c sensory information from the environment.
   d individual characteristic they possess.

8 Rate limiters:
   a are constraints that restrict performance.
   b can be manipulated to shape outcomes.
   c are individual factors that determine how quickly we process information.
   d are used to evaluate motor learning and determine success in performance.

9 Task constraints:
   a are specific only to the environment.
   b interact dynamically during performance.
   c influence movement behaviour and performance.
   d comprise individual, task and environmental elements.

10 A referee who does not enforce foul play is an example of:
   a a rate limiter.
   b a task constraint.
   c an individual constraint.
   d an environmental constraint.

Section B: Short-response questions (150–250 words)

1 Determine which stage of information processing is most likely to be responsible for the following errors in a tennis player's game. Justify your decision for each scenario:
   a During a rally, the player is consistently left flat-footed and stranded at the back of the court when their opponent lands a drop shot at the front of the court.
   b During a rally, the player consistently hits the ball straight back to their opponent's forehand, which is their opponent's strength.
   c When their opponent attacks the net, the player attempts a lob but cannot land it in the court.

2 Propose which individual constraints would prevent or enable you to replicate an 'ideal' hurdling technique in a 100-metre race over 10 hurdles, each with a height of 84 centimetres. Explain your reasoning.

3 Determine the individual learner, task and environmental constraints that interacted to shaped the emergence of the cut shot for the cricket player outlined in the following quote:

Growing up, my next-door neighbours and I used to play backyard cricket. But the pitch was a narrow driveway to the side of the house. On my leg side the man next door would confiscate our ball if it was hit into his yard. This fear prevented me from playing the pull shot, but space on the offside allowed me to play shots such as the straight drive and cut shot. This shaped how I played club cricket as I was able to work any delivery onto the offside and my most successful scoring shot was the cut shot.

Section C: Extended response to stimulus (400 words)

Analyse Figure 2.19 and identify examples of individual learner, task and environmental constraints within the playing environment. Predict a unique behaviour that may emerge from this learning environment through the interaction of these constraints. Justify your prediction.

Figure 2.19
What constraints can you identify in this image?

3 EXAMINING PRACTICE, FEEDBACK AND INSTRUCTION

Figure 3.1
What type of practice best improves your sporting performance?

Whether or not you're gifted with unique sporting ability, you still have to spend a considerable amount of time improving your skills through practice. But what type of practice is the most effective in improving your skills?

In this chapter, you'll consider how practice works to build and improve physical skills. You'll examine different types of practice, feedback and instruction, and how they achieve different purposes.

KEY QUESTIONS

3.1 Why is practice important?
3.2 How much rest should you have between practice trials?
3.3 Is it useful to practise the components of a skill separately?
3.4 Does swapping between skills make practice less effective?
3.5 How do changing conditions affect your practice?
3.6 What is the purpose of doing drills?
3.7 How do we gain feedback about our practice?
3.8 What is the most effective form of instruction?

YOUR CHAPTER PLAN

3.1 The importance of practice

Your skills can improve through practice, but how much practice do you need in order to improve?

Multiple research studies have found that elite performers in sports, arts and sciences accumulate more than 10 000 hours of practice before reaching an international level of performance. For example, Helsen, Starkes and Hodges (1998) studied soccer players in Belgium. They found that when professional soccer players were around 23 years old – 18 years into their careers – they had accumulated a total of 9332 practice hours. In comparison, amateur players had accumulated 5079 practice hours.

Very few people have the obsessive desire and opportunity to undertake the quantity of practice that elite performers do. This means that the quality of practice becomes the focus. To ensure high-quality practice, it's vital that the design and delivery of practice is based on sound theories about how people learn. In addition, anyone who organises sports practice needs to consider how effectively skills learnt in practice transfer into the performance environment.

Practice and transfer of skills

One of the main reasons you practise is to improve your performance in the competition environment. For example, if you were an elite javelin thrower, you would practise your throwing technique with the aim of performing to the best of your ability at the Olympic Games. It's the responsibility of a coach or physical education teacher to design and implement practice conditions that will lead to the greatest chance of successfully transferring skills from practice to the performance environment.

In the rest of this chapter, you will explore the different classifications of practice, how they enhance the learning of motor skills, and how well these learnt skills transfer to the performance environment.

Figure 3.2 Players at British Premier League academies believe that commitment to practice is more important than initial talent in achieving success.

3.1 Check your understanding

1. Describe how many hours of practice are thought to be needed to become an elite performer.
2. Describe the key factors to consider when developing practice programs.
3. Suggest a key reason for practice.

3.2 Massed and distributed practice

The distribution of practice within a session has been a popular research topic since the 1930s. The main issue investigated has been the amount of rest individuals need between practice trials (or groups of trials) to optimise learning. Is it better to have minimal or no rest between practice trials (known as **massed practice**) or a long rest period between practice trials (**distributed practice**)?

Evidence indicates that massed practice is preferable for highly skilled and motivated performers. Distributed practice is more effective in improving performance in these situations:

- the learner is in the cognitive stage of learning
- the energy demands are high
- motivation is low
- the task is boring.

Distributed practice is more effective in these situations because the rest period allows you time to recover physically, gather feedback and mentally rehearse your performance. All these factors have been shown to improve performance. However, if another skill is performed in the rest period, this interferes with the retention of knowledge and thus reduces the level of performance.

massed practice
a practice schedule with short or no rest periods between trials

distributed practice
a practice schedule with relatively long rest periods between trials

Figure 3.3
Is it better to practise your volleyball serve continuously for 30 minutes, or for three separate 10-minute blocks with a 10-minute rest between each block?

Comparing massed and distributed practice

Studies of practice distribution also consider the amount of practice within each session and the amount of rest between sessions. Is it better to have a smaller number of longer sessions, or a larger number of shorter sessions?

The available evidence suggests practising skills for shorter periods over more frequent sessions results in better learning than practising for fewer, longer sessions. Massed practising makes it more difficult to learn because long, continuous sessions cause fatigue and can gradually reduce concentration and effort due to boredom.

A 2004 research study compared massed and distributed practice for novice golfers learning to putt. One group followed a mass practice schedule of 240 putts in one day, performed in 24 blocks of 10 putts with very short breaks between blocks. The second group followed a distributed schedule of 60 putts per day for four consecutive days. During testing, the distributed practice group performed at a higher level than the mass practice group. More importantly, when tested again the next day, and then again one week later, this difference was still evident.

Figure 3.4 Distributed practice has been found to be superior to massed practice for novice golf putters.

3.2 Check your understanding

1. Explain the difference between massed practice and distributed practice, using examples from the physical activity you're currently studying.
2. Explain why it is preferable to distribute practice within a session.
3. If you were allocated 20 minutes within a 60 minute session to practise a specific motor skill, what would be an efficient distribution of this time to optimise learning?

CASE STUDY

Scheduling training sessions

A 1978 study attempted to determine the best way to schedule training sessions for postal workers to learn to operate a keyboard. The total allocated training time was 60 hours, which needed to be scheduled over 5 days each week.

The researchers distributed the 60 hours of training time in four different ways (see Table 3.1). For example, Group 1 trained for one 1-hour session each day for 12 weeks (5 hours a week × 12 weeks = 60 hours).

The goal of the research was to compare the number of hours of training it took each group to learn to type at 80 keystrokes a minute. If this typing speed wasn't achieved within the allocated 60 hours of training time, the training schedule continued until it was reached.

Group	Training (practice) schedule	Number of hours
1	1-hour session, one session per day (12 weeks in total)	55
2	1-hour session, two sessions per day (6 weeks in total)	75
3	2-hour session, one session per day (6 weeks in total)	67
4	2-hour session, two sessions per day (3 weeks in total)	80+

Table 3.1 Number of hours required to achieve a typing speed of 80 keystrokes a minute

QUESTIONS

1 Which group experienced the most massed training (practice) schedule?
2 Which group experienced the most distributed training (practice) schedule?
3 Which group reached the 80 keystrokes a minute target in the least number of training hours?
4 Which group reached the 80 keystrokes a minute target in the most number of training hours?
5 Interpret the results and draw a general conclusion about the most effective way to schedule training to learn to operate a keyboard.
6 Apply these results to make a recommendation about the most efficient scheduling of two hours of practice for you to learn a motor skill in physical education. Justify your response.

Practice distribution

INTEGRATING MOVEMENT

Category: All
Physical activity: All

Purpose

1 This activity involves observing how the distribution of practice sessions can impact learning of a motor skill.
2 This activity focuses on the physical activity your teacher has selected for this topic.
3 The primary data collected in this activity could be used to support your folio task.

DE 5

Preparation

Time: two lessons
Location: depends on activity
Equipment: depends on activity; data recording tables

Setup

1 As a class, choose a specific motor skill that has a distinct beginning and ending, does not require an opponent and is easily scored. Examples include basketball free throw, tennis serve, golf putt or throwing at/kicking/striking a target.
2 As a class, decide on an appropriate method of incremental scoring for this skill. For example, if making free throws in basketball, score two points if the ball goes through the hoop, one point if the ball hits the rim and misses.
3 Form into two equal-sized groups. Group 1 will conduct massed practice; Group 2 will conduct distributed practice.

Performance

1 In the first lesson, the two groups conduct practice as follows:
   - **Group 1 (massed practice):** Conduct one session, consisting of 100 practice attempts in 4 sets of 25, with 2 minutes rest in between sets.
   - **Group 2 (distributed practice):** Conduct one session, consisting of 100 practice attempts in 4 sets of 25, with 8–10 minutes rest in between sets.

2 During the next lesson, both groups must re-test themselves with one session of 25 attempts.

Data recording

1 Download the recording tables from your online resources.
2 Each player must record their own scores after each set of 25, using Table 3.2.
3 Record the average (mean) scores for both groups in Table 3.3.
4 Update both tables after completing the retest at the end of the week.

DE 1

Practice attempts	1–25	26–50	51–75	76–100	Total score
Massed/Distributed (please circle) Personal practice scores					
Personal retest score (next lesson, 25 attempts)					

Table 3.2 Individual practice scores for each set of 25 attempts

	Group's average total score	Group's average retest score
Massed practice		
Distributed practice		

Table 3.3 Average practice scores for both groups for each set of 25 attempts

Tasks

DE 3

1 Which practice group performed better during the practice (skill acquisition) phase? Justify your response using the primary data gathered.
2 Which practice group performed better during the retention (retest) phase? Justify your response using the primary data gathered.

DE 4

3 Evaluate which type of practice was better for the acquisition and learning (retention) of the discrete motor skill.
4 Comment on any possible impact that mental or physical fatigue had on performance. Justify your answer using the data.

3.3 Part practice and whole practice

whole practice
practice of a motor skill in its entirety

part practice
repetitive practice of parts or components of a motor skill

Is it better to practise a motor skill in its entirety or in parts? For example, should the lay-up shot in basketball be practised as one continuous movement (**whole practice**)? Or should it be broken down and practised in its separate component parts – the dribble, approach, take-off and release (**part practice**)?

Practising parts of a motor skill makes a complex task easier for the learner, because it reduces the number of components the learner must think about when performing. The belief is that parts of a physical action can be practised separately, improved, then reassembled for improved performance of the whole physical action. Part practice is particularly effective when the skill being taught is complex but its parts are relatively independent, such as a choreographed dance routine.

For example, let's assume that you're learning to long jump. You could practise the run-up component by itself, without the distraction of the jump. This makes the task easier by allowing you to devote your full attention to just one part of the whole motor skill.

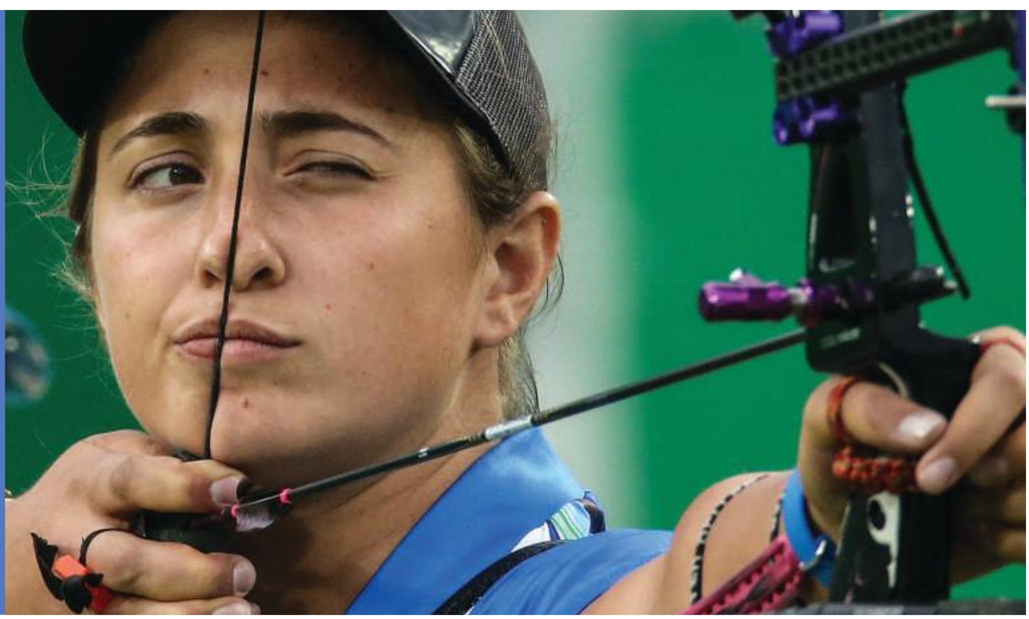
Part practice is commonly used when practising game-related motor skills, such as dribbling a soccer ball. Dribbling in a game of soccer is a complex skill that involves many components. Players need to:

- detect a gap between defenders
- decide to invade the space
- use their dribbling technique to carry out the decision.

Part practice would involve practising the single component of the dribbling technique by itself. This is usually done by practising dribbling around stationary markers. Not having defenders or teammates to distract or complicate things allows the player to devote their attention to the technique of dribbling.

Whole practice, on the other hand, involves the practice of a motor skill in its entirety. Whole practice is particularly effective when the skill being learnt is simple but has highly dependent or related parts, such as putting a golf ball.

Figure 3.5
Shooting an arrow is a motor skill suited to whole practice.



Comparing part and whole practice

The successive parts of a complex motor skill are like a chain of events in which any one part depends on the part performed just before it. For example, when you serve a volleyball, the amount of extension of your serving arm depends upon how high you toss the ball in the air. If you toss the ball just above head height, your serving arm only needs to be partly extended. This means that practising part of a motor skill – such as a ball toss without the other related parts – denies you the opportunity to practise the timing and coordination of the whole motor skill.

A 2010 research study investigated part practice and found that it wasn't an effective way to practise the tennis serve. In fact, part practice was harmful in this situation. The study showed that when players practised the ball toss separately from the racquet swing, they typically tossed the ball 24 centimetres higher, and with greater spin, than they did when they actually hit the ball.

Figure 3.6 Practising the ball toss separately from the racquet swing is not an effective way to practise your tennis serve.

An example of this timing and coordination problem can be seen in the use of a T-ball batting tee to teach novice baseball players the skill of striking. In this part practice environment, the actual striking action is separated from the pitch to make the complex task of batting easier for the learner. The problem is that it doesn't help the batter to learn to coordinate their swing with a moving ball. This results in poor transfer of skills from the practice environment to the baseball game.

To develop appropriate timing and coordination, it's important that the pitch and swing components are practised together. But taking a whole practice approach and practising the skill in its entirety is challenging, as successfully swinging and striking a baseball pitched at them is too complex for many novice players. The principle of task simplification offers a solution by making a complex task easier without breaking it down into parts.

Task simplification

Task simplification gives you the opportunity to learn to time and coordinate your actions. This is done by practising the whole coordinated motor skill in a simplified practice environment that still includes the key information from the game.

In the baseball example, the key information that the batter needs to coordinate their actions with is the wind up and pitch. To simplify the task, the batter could use a cricket bat to strike the moving ball. The bigger hitting surface would allow the batter to learn to successfully coordinate their swing with the pitch in a simpler environment. Alternatively, a bigger and lighter softball could be used, as it moves more slowly through the air. Over time, this simplified environment can be made more challenging for learners. Once the swing movement is mastered at this level, a baseball bat and baseball could be substituted.

Task simplification can also be applied to soccer dribbling practice. Instead of making the complex task easier by dribbling around stationary markers, the environment could be simplified while still containing key information from the game, such as opponents. Practising with opponents is important as players need to learn to coordinate their actions with what their opponents do. The practice task could be simplified by initially using passive defenders who become more active as learning increases.

Other ways to simplify a practice environment include using floating players who can only attack, using zones to ease congestion, and allowing players one touch or three seconds immunity when in possession.

3.3 Check your understanding

1. Describe the difference between whole practice and part practice, using an example from the physical activity studied in this topic.
2. What is the main problem with separately practising parts of a whole action?
3. Summarise the learning benefits of practising a simplified version of the whole action.

Apply and analyse types of practice

LEARNING EXPERIENCE

Classify these activities as either part practice, whole practice or task simplification:

1. practising the javelin throw from a standing position
2. practising the javelin throw using a short run-up
3. practising the javelin throw using the full run-up
4. practising a golf swing without a ball
5. practising hitting a golf ball using a normal-sized club head
6. practising hitting a golf ball using a standard-length club but with an oversized head
7. practising the freestyle kick using a kickboard
8. playing a full game of soccer
9. practising netball ‘moves’ without any opposition
10. practising the overhead volleyball serve over a lower net

CASE STUDY

Practising against a machine

A cricket bowling machine is a good example of a part-practice environment that results in poor transfer of batting skills from practice to the game. This is because facing a bowling machine and facing a real bowler are completely different experiences.

A study of cricket batting by QUT researchers Renshaw, Oldham, Davids and Golds (2007) found that batting against bowling machines, compared to real bowlers, changed the timing and co-ordination of the forward defensive shot. For example, batters exhibited a shorter front foot stride, lower backswing and slower bat speed when facing the bowling machine compared to a bowler.

A later QUT study by Pinder, Davids, Renshaw and Araújo (2011) found that cricket players started their movements later against a bowling machine compared to a bowler. This change is probably due to a lack of visual cues gained from the bowling machine, which increases the batter's reaction time. When facing a bowling machine, players rely on information from early ball flight to time their movements. In contrast, when facing a bowler, the batter can pick up visual cues during the bowler's delivery action, enabling them to anticipate the ball flight and bounce position. This allows the batter to get into position earlier.

These findings show why it's important for practice to incorporate the same visual cues that are present in the performance environment.

QUESTIONS

1 What specific information source is your batting action coordinated with when you face:
- **a** a bowling machine?
- **b** a bowler?

2 Explain why your reaction time would be slower when facing a bowling machine.

3 Recommend a practice design that would help you to develop a coordinated batting action for transfer to a cricket game. Justify your recommendation.

Part practice and simplified whole practice

INTEGRATING MOVEMENT

Category: All
Physical activity: All

Purpose

1 This activity involves observing how part practice and simplified whole practice can impact learning of a motor skill.
2 This activity focuses on the physical activity your teacher has selected for this topic.
3 The primary data collected in this activity could be used to support your folio task. DE 5

Preparation

Time: two training sessions
Location: depends on activity
Equipment: depends on activity; digital capture devices

Setup

1 Form small groups of about four or five students.
2 As a group, design a part-practice session and a simplified whole-practice session to develop a motor skill associated with the physical activity.

Performance

1 Participate in each training session.
2 Every player should have an opportunity to have their performance recorded, and to record the performance of other players.

Data recording

Each player should use digital capture to record the other players' performance during both practice sessions. DE 1 DE 6

Tasks

1 Analyse the primary data as a group. DE 3
2 Evaluate which type of practice would better aid the transfer of your chosen skill to the performance environment. DE 4
3 Justify your decision using specific evidence from your practice sessions and your knowledge of the actual performance environment.

3.4 Blocked practice and random practice

Is it better to practise the same motor skill repeatedly for one block of 30 minutes, or to practise many skills randomly throughout the 30 minutes?

In a **blocked practice** session, you repeat one specific movement pattern for a set period of time. This enables you to refine a skill by rehearsing the same movement over and over again in a relatively predictable environment.

Random practice involves randomly alternating between two or more skills during practice. For example, in a tennis practice session, you may perform one forehand, one backhand and one volley, and then repeat this process. You don't practise your forehand, backhand or volley repeatedly by itself.

blocked practice
the repeated practice of one skill in a block of time

random practice
the practice of two or more skills in a random order

Comparing blocked and random practice

Blocked practice leads to better performance of a motor skill within the drill practice environment, but random practice results in longer-lasting learning of motor skills. This is thought to be because nerve pathways develop when you change between skills. Research has also found that the transfer of learning from practice to the game is more effective when athletes use random practice.

A 1994 study examined the free-throw shooting accuracy of elite basketballers in practice and in the game. During free-throw practice, players shot seven or eight free throws in a row, even though during a game the maximum number of free throws is two. As a result of their blocked practice, the players' shooting accuracy in the game did not improve. This highlights that how well your skills transfer from practice to the game depends on how closely your practice conditions resemble the game. For example, basketball players should practise two free throws in a row during the practice of other basketball skills.

The clear message is that to promote learning of motor skills for use in a performance environment, teachers and coaches should avoid repetitious, blocked practice by presenting a variety of skills within same session. This can be done by practising in game-like environments that require you to use a variety of skills throughout the game.

One exception may be that beginners, who are at the very early cognitive stage of learning, will benefit more from blocked practice than random practice. Blocked practice allows them to solely focus their attention on getting a feel for the movement, and establish a basic movement pattern, before progressing to random practice.

3.4 Check your understanding

1 Explain the difference between blocked practice and random practice using examples from the physical activity you're studying in this topic.
2 Why is it preferable to practise skills randomly within a session rather than repeatedly practise a single skill in one block?
3 What type of practice more closely resembles the performance environment?

Figure 3.7 Johnathan Thurston normally practised 12–15 kicks once a week after formal training. How well did this blocked practice prepare him for the task of kicking a pressure goal to win the 2015 NRL Grand Final?

Evaluate and justify
rugby and AFL goal-kicking practice

LEARNING EXPERIENCE

Many goal kickers in rugby league, rugby union and Australian rules football use blocked practice to refine their kicking technique. For example, after formal training, many goal kickers stay back and take 20 kicks at goal in a row.

Using your knowledge of blocked and random practice:

1 evaluate this type of practice in terms of the potential transfer of learning to the actual game.
2 recommend how you could modify the practice to more closely resemble game conditions.

Blocked and random practice

INTEGRATING MOVEMENT

Category: All
Physical activity: All

Purpose

1. This activity involves observing how blocked practice and random practice can impact learning of a motor skill.
2. This activity focuses on the physical activity your teacher has selected for this topic.
3. The primary data collected in this activity could be used to support your folio task. DE 5

Preparation

Time: two training sessions
Location: depends on activity
Equipment: depends on activity; digital capture devices

Setup

1. Form small groups of about four or five students.
2. As a group, design a 15-minute blocked practice session and a 15-minute random practice session to develop a motor skill associated with the physical activity.

Performance

1. Participate in each training session.
2. Every player should have an opportunity to have their performance recorded, and to record the performance of other players.

Data recording

Each player should use digital capture to record the other players' performance during both practice sessions. DE 1 DE 6

Tasks

1. Analyse the primary data as a group. DE 3 DE 4
2. Evaluate which type of practice would better aid the transfer of your chosen skill to the performance environment.
3. Justify your decision using specific evidence from your practice sessions and your knowledge of the actual performance environment.

3.5 Constant practice and varied practice

constant practice repetitive practice of one variation of a skill in one context

varied practice practice of several variations of a skill in several different contexts

Is it better to practise one variation of a skill under the same conditions (**constant practice**), or many variations of the same skill under varying conditions (**varied practice**)?

An example of constant practice is to repeatedly pass a netball from the same spot to the same teammate 5 metres away. An example of varied practice is to pass a netball to several different teammates at varying distances away, using a variety of passes.

Figure 3.8 Repeatedly handpassing a ball to the same person over the same distance is an example of constant practice.

Comparing constant and varied practice

An important feature of practice is to provide opportunities for you to experience variable conditions. This helps you adapt to the variable conditions of the performance environment.

Research has conclusively shown that varied practice results in better learning and skill transfer to the performance environment than constant practice. This is because a varied practice environment prepares you for the variability and the unpredictability of the performance environment.

For example, when Bruno Travassos and colleagues studied futsal (indoor soccer) players in 2012, they found that when the players practised passing in a constant practice environment, the players passed at a constant speed. In contrast, in a competitive game, the players passed at different speeds. This shows that constant practice did not prepare players for the variability of the game. To enable the best transfer of skills, practice conditions should match the variations experienced during a match.

Figure 3.9 Australian rugby star Ellia Green has the ability to be in the right place at the right time on the rugby field, thanks to practising against a variety of opponents.

Evaluate and justify
practising skills for the competitive environment

LEARNING EXPERIENCE

Imagine you're a tennis player, and you have the choice of practising in two ways. The first way is always practising against a right-handed, weak, slow opponent. The second way is to practise against a variety of opponents, including both left- and right-handers, strong and weak servers, fast and slow movers.

1. Describe each type of practice.
2. Evaluate which type of practice would better help you to succeed as a professional tennis player. Justify your response.

The 'perfect' technique

Some coaches try to make their players follow the 'perfect' technique from the coaching manual through constant practice of the exact same movement pattern. But it's impossible for anyone to repeat exactly the same movement pattern over and over again. Studies show that even a task as repetitive as hitting a metal sheet with a chisel is achieved via many different swing paths.

In a sporting context, Olympic-level long jumpers aren't capable of placing their feet in the same place for every run up. They actually adjust their step patterns as they approach the take-off board. This is because each time a long jump is executed it's under slightly different conditions, such as weather, visibility and the athlete's own changing fatigue levels. What's important is to repeat the outcome of a movement (in the case of a long jump, this would be jumping from the take-off board), rather than constantly repeating the movement pattern (the exact foot placements during the run-up). Rather than aiming for mechanical consistency of a technique, you should aim for a variable technique that can adapt to changing conditions.

There seems to be no such thing as the one 'perfect' technique for everyone, as we all differ physically. In fact, there's a lot of evidence that suggests you can be successful with a technique that's far from 'perfect', as long as it is biomechanically sound and doesn't cause you injury.

For example, American swimmer Janet Evans' straight-arm freestyle recovery action resembled a windmill rather than the classical high-elbow recovery. Luckily, her coach adopted an 'if it ain't broke, don't fix it' attitude, and Evans went on to win world championships and Olympic gold medals, and break world records in the 400-, 800- and 1500-metre distances. She is one of the greatest long-distance swimmers of all time.

3.5 Check your understanding

1 Clarify the difference between constant practice and varied practice using examples from the physical activity you're studying.
2 Explain why there is better skill transfer to the performance environment from varied practice than there is from constant practice.
3 Why is it better for you to have a variable technique rather than a mechanically consistent technique?

Constant and varied practice and performance

INTEGRATING MOVEMENT

Category: Invasion
Physical activity: Soccer

Purpose

1 This activity involves observing how constant practice and varied practice can impact performance in a game of soccer.
2 This activity involves two separate activities, which need to be set up and performed in order.

Preparation

Time: one lesson
Location: soccer field
Equipment: soccer ball, four practice markers (witch's hats); GPAI from online resources

Activity 1: A constant practice environment

Setup

1 Select a group of five students to participate in a constant practice environment (passing square soccer drill).
2 Set up a square with markers 8 metres apart.
3 Start with four students, one at each marker.

Performance

1 Remaining stationary, the four students pass the ball to each other around the square for 3 minutes.
2 The fifth student joins the group and starts with the ball at any marker.
3 The fifth student continues to pass to the student at the next marker and also follows (at a run) the pass to that marker (see Figure 3.10). Students keep passing and following passes for 3 minutes.
4 The students change the direction of the pass, and pass and run the opposite way around the square for 3 minutes.

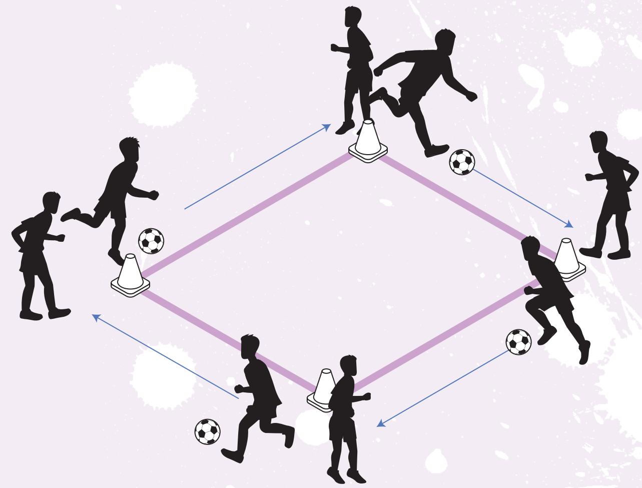


Figure 3.10 The passing square soccer drill

Data recording

DE 1

1 A minimum of five students should observe and gather primary data about passing within the drill. This can be done with or without digital capture.
2 Observing students record the passing data in the GPAI. There should be at least one observing student for each different criterion (row) of data.

Activity 2: The performance environment

Setup

1 Assign 22 students into two teams to play a game of soccer.
2 If there aren't enough students available for full teams, play with teams of six on a half-size pitch.

Performance

The teams play a complete game of soccer.

Data recording

DE 1

1 A minimum of five students should observe and gather primary data about passing within the game. To make this easier, observe the passing of only one team. This can be done with or without digital capture.
2 Observing students record the passing data in the GPAI. There should be at least one observing student for each different criterion (row) of data.

Table 3.4 Passing data

	Constant practice environment (passing square drill)			Performance environment (game)		
Passing distances (distance between passer and receiver)	**0–10 m**	**11–20 m**	**More than 20 m**	**0–10 m**	**11–20 m**	**More than 20 m**
Ball trajectory	Along ground	Between ground and head height	Above head height	Along ground	Between ground and head height	Above head height
Ball speed	Slow	Medium	Fast	Slow	Medium	Fast
Foot contact with ball	Inside foot	Toe	Outside foot	Inside foot	Toe	Outside foot
Passing recipient	Same	Few	Many	Same	Few	Many

Tasks

Distribute the completed GPAI to all students to analyse.

DE 3

1. How variable was the passing in the constant practice environment (passing drill)? Give a rating from 1 to 5 (1 = repetitive; 3 = some variability; 5 = highly variable). Justify your rating using the primary data gathered.
2. How variable was the passing in the performance environment (game)? Give a rating from 1 to 5 (1 = repetitive; 3 = some variability; 5 = highly variable). Justify your rating using the primary data gathered.
3. Evaluate the suitability of constant practice (a drill) in preparing a novice player for the variability of passing in the performance environment. Justify your response using primary and secondary data.

DE 4

http://mea.digital/qpe12_3

3.6 Drills and problem-solving

A **drill** is a practice task in which you repeatedly practise a physical action set by your teacher or coach; for example, dribbling a ball around markers.

drill
repetitive practice of the same technique to the same problem in a predictable environment

From a cognitive motor learning perspective, a drill is a method of practice aimed at making a complex task easier for the novice learner. This is done by separating the physical action or technique from the environment in which it's performed. This reduces the number of components you must think about when performing, such as defensive pressure from opponents, allowing you to devote your total attention to the technique.

The assumption is that your technique can be improved through drills. When you have mastered the technique, you can successfully transfer it into the competitive performance environment. Advocates of drill practice argue that you must initially acquire a good technique before you can learn to play a game.

However, techniques developed from a drill fail to effectively transfer to the actual performance environment. This is because the two environments are significantly different. For example, how does dribbling around markers, where you focus your attention at your feet, enable you to learn to dribble the ball in the game with your head up, looking for opportunities to pass?

A drill-based approach is inadequate for developing your problem-solving abilities, which you will rely on in actual competition. This is because drill environments are so predictable they present only very simple problems to solve. Typically, these problems are solved for you by your coach or teacher, and your purpose is just to imitate the demonstrated solution.

Figure 3.11
In a drill, markers don't move and you don't have to deal with the unpredictable actions of other players.

In contrast, to perform successfully in unpredictable performance environments, you need to be able to make your own decisions to solve complex problems. For example, the skill of successfully spiking in a volleyball game extends beyond the physical technique of spiking a ball over the net. It also includes your ability to read and interpret the play (perception), and the ability to choose an appropriate tactical response (decision-making or problem-solving). The technique is just the movement pattern you use to carry out the solution to the tactical problem.

Rather than being separated as they are in a drill, perception, decision-making and technique should be practised together. From a learning perspective, drills are best used in the very early stages of learning, to help you develop a 'feel' for a technique.

Representative practice and skill transfer

The more your practice environment is like the performance environment, the greater the transference of your skills. To achieve the optimal level of skill transfer, your practice should include the key elements that are present in the performance environment such as opponents, goals, sidelines and an umpire.

representative practice
an unpredictable and variable practice environment that contains key elements from the performance environment

This **representative practice**, also known as specificity of practice, will prepare you for the unpredictability, intensity, variability and mental pressure of the performance environment. The aim of representative practice is to create an environment in which you feel, think and act like you would in competition.

In 2016, researchers Adam Gorman and Michael Maloney found that basketballers who practise shooting with no defenders have a different technique from when they practise shooting with a defender. Defended shots were executed faster, the players' jump times were longer, and there was an increase in the amount of time that the ball spent in the air. The shooter was also much less accurate; shooting accuracy declined by more than 20 per cent. Another finding was that a player's shooting technique constantly changed in response to a defender's movements.

Apply and analyse
practising with and without opponents

LEARNING EXPERIENCE

1. Describe what Gorman and Maloney's results suggest about the type of practice you should undertake to improve your shooting for a game.
2. Apply this finding to modify a non-representative practice task often used by coaches or teachers in the physical activity you're studying in this unit.
3. Propose an example of how a player's basketball shooting technique may change in response to a defender's movements.

Perception, decision-making and technique

Like the performance environment, representative environments present you with many problems to solve. This gives you the opportunity to engage with the environment, explore and make decisions to solve problems under competitive pressure in an unpredictable environment.

Using the volleyball spike as an example, representative practice would incorporate key elements associated with spiking in a game of volleyball, such as teammates and the net. The presence of these key elements when practising the spike allows you the opportunity to learn to look for space between opponents to spike into (perception), then decide how hard to spike the ball (decision-making) before executing the action (technique).

When participating in sport, what you do (your action) is tightly linked to what you see (your perception), and what you see is a result of what you've done. This

Figure 3.12 A good representative practice environment for a volleyball spike would include opposition players, teammates, sidelines, a game context and the net.

is known as **perception–action coupling**. For example, consider a two-versus-one situation in a game of touch football:

- You run towards the defender, planning to draw them away and then pass to your unmarked support player.
- Just before you pass, you notice the defender start to move towards your support player. You react by throwing a 'dummy' pass.
- You then notice that the defender is fooled and continues to move towards your support player. In response, you sprint to the try line and score.

perception–action coupling
the link between what you do (action) and what you see (perception)

This ability to react to player movements does not develop automatically. It comes from years of practice in representative environments, such as competitive and backyard-type games. This is why it's important to include in practice what you would normally see in competition, such as opponents, teammates, a moving ball, an 18-yard box or a referee.

The more representative the task, the more unpredictable and variable it is, and the more difficult it can be for novice players. While it's important to ensure that practice is representative and variable, it should also match the ability of the learner. Practice environments for novices should start with low levels of variability and representativeness, then gradually progress.

Check your understanding 3.6

1. Explain the cognitive motor learning reasoning behind the design of a drill.
2. Explain why the drill-based approach is inadequate in terms of developing your problem-solving ability.
3. Describe two main reasons why it is important to include key elements from the competitive environment, such as defenders, in practice environments.

Drills, decision-making and performance

INTEGRATING MOVEMENT

Category: Invasion
Physical activity: Touch football

Purpose

1 This activity involves observing how decision-making within a drill differs from decision-making within a game of touch football.
2 This activity involves two separate activities, which need to be set up and performed in order.

Preparation

Time: one lesson
Location: football field
Equipment: footballs, practice markers (witch's hats); recording tables

Activity 1: A drill practice environment

Setup

1 Form groups of three.
2 Place four markers in a straight line upfield, spaced 10 metres apart.

Performance

1 Ruck the ball up field in a straight line, stopping at each marker.
2 The player who starts with the ball slowly jogs straight to the marker, stops, places the ball on the ground and steps over it.
3 The acting half passes flat and then becomes the runner for the next ruck.
4 The player who rolls the ball goes to acting half for the next ruck.
5 Repeat five times.

Data recording

As each player finishes the drill, they record the rucking-related decisions they made in the recording table.

DE 1

Activity 2: A modified game

Setup

Get into two teams of six.

Performance

1 Play a 6 v 6 modified touch football game for 15 minutes on a 50 m x 20 m field. The modifications are:
- Defenders retreat 10 metres after effecting a touch.
- There must be a referee who makes sure the defenders retreat 10 metres.
- Defenders cannot make consecutive touches.

Data recording

DE 1

Once the game is over, every student records the rucking-related decisions they made in the recording table.

Table 3.5 Decisions associated with rucking in a drill and a game

Decisions	Drill	Modified game
Ball runner		
What to do (ruck, run or pass)?		
Where to run?		
Who to run at?		
What angle to run?		
When, where to place ball?		
How fast to run?		
Acting half		
What to do (run or pass)?		
Where to pass?		
Type of pass?		
Who to pass to?		

Tasks

DE 3

1 Analyse the data you gathered.

2 For each of the following, give a rating from 1 to 5 (1 = low; 3 = some; 5 = constantly making decisions). Justify your rating using the primary data you gathered.
  - **a** How many rucking-related decisions did you make during the drill?
  - **b** How many rucking-related decisions did you make during the modified game?

3 For each of the following questions, give a rating from 1 to 5 (1 = very simple; 3 = reasonably complex; 5 = very complex). Justify rating using the primary data you gathered.
  - **b** How complex were the rucking-related decisions you made during the drill?
  - **d** How complex were the rucking-related decisions you made during the modified game?

4 Compare the amount and complexity of decision-making associated with the two environments. Which required greater mental effort? Justify your decision using primary data.

DE 4

5 Evaluate which practice environment would better prepare a player for the mental effort required in a touch football game. Justify your response using primary data and personal experience.

3.7 Performance-related feedback and learning

performance-related feedback information an athlete receives about their performance of a motor skill

Performance-related feedback is all the information you receive about your performance of a motor skill, either during the performance or at the end.

Performance-related feedback relates to both the outcome of a performance and what caused that outcome. Many research studies have been conducted to determine how feedback influences the learning of motor skills. All confirm that feedback is necessary to the learning process. Performance-related feedback can be acquired in two major ways – intrinsically and extrinsically.

Intrinsic (self-generated) feedback

intrinsic feedback information about movement naturally received from sensory systems

proprioception an awareness of body position through sensory receptors within muscles, ligaments, tendons and joints

Intrinsic feedback is the information you receive from your senses when you move. The information is self-generated and primarily comes from your sensory systems for touch, vision, hearing and body awareness (or **proprioception**).

For example, when you roll a ball (bowl) in lawn bowls, you receive visual feedback from seeing the path of the bowl and where it finishes in relation to the jack. In addition, you receive information about your body position (proprioception) as you prepare to release the bowl, and tactile (touch) information from your hands when you release it. Finally, you receive auditory feedback when you hear the bowl hitting the jack or landing in the gutter.

Extrinsic (augmented) feedback

extrinsic feedback information about movement performance received from an external source

Extrinsic feedback is the feedback that you receive at the completion of a movement. It is also called augmented feedback because it adds to the information you receive from your sensory systems. The information is received from an external source and is divided into two main categories: knowledge of results and knowledge of performance.

Knowledge of results is feedback you receive from an external source about the degree of success of a movement or its result. A judge telling you that you scored 6 out of 10 for a gymnastics routine is an example of knowledge of results. You can also obtain information about the result of a movement from an internal source; for example, seeing a conversion go between the goalposts.

Knowledge of performance is feedback you receive about the quality or technical correctness of a movement, or what you did that caused the result, such as being told that your take-off leg isn't fully extended when jumping. This feedback often comes from a teacher or coach. Video replays and computer programs are also used to provide feedback about the quality of a performance, such as using video analysis software to discover that your sprint stride length is not consistent.

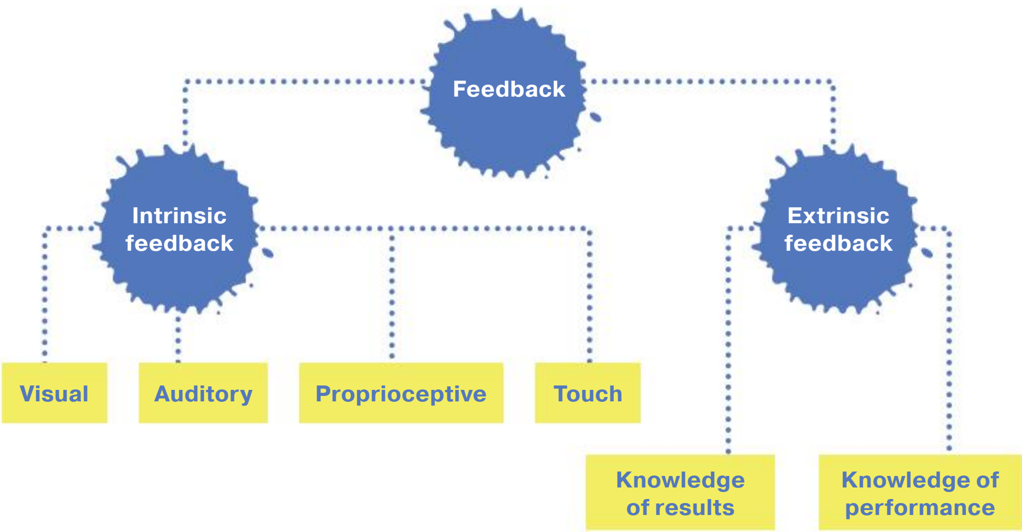


Figure 3.13 Different types of feedback

Check your understanding 3.7

1. Define performance-related feedback.
2. Explain the difference between intrinsic feedback and extrinsic feedback using specific examples from the physical activity you're studying.
3. Explain the difference between knowledge of results and knowledge of performance using specific examples from the physical activity you're studying.

Apply and analyse
classifying feedback

LEARNING EXPERIENCE

Classify each of these performance-related feedback examples as either intrinsic feedback, knowledge of results or knowledge of performance:

1. seeing a softball caught by an outfielder
2. hearing a golf ball landing in water
3. feeling the end of the pool when completing a tumble turn
4. correcting your body position while performing a hand stand
5. hearing your teacher telling you that you ran a time of 14 seconds
6. hearing a tennis linesperson call your shot out
7. seeing your tennis smash hit the net
8. hearing your coach say that your body is too front on when spiking the volleyball
9. watching a video to discover that your forearm is not straight when shooting a basketball

3.8 Instruction and learning

An important task for teachers and coaches is to give you information that helps you to refine your technique and improve your performance. This is done by supplementing feedback about past performance with information about future performance. This information can be provided through explicit instruction or naturally through **implicit learning**.

implicit learning subconscious learning in an incidental manner, without awareness

Explicit instruction

Explicit instruction is clearly defined, specific information related to your performance of a motor skill. It can be delivered in two ways, focusing either on your internal body segments or the external outcome (result) of a movement.

Internal focus

Explicit instruction with an internal focus is directed at the control of your body segments to achieve the desired movement. For example, a hurdles coach may instruct you to 'keep your hips straight and high, and drive your lead leg over the hurdle'. This type of instruction is about telling you what to do (hurdle over obstacles) and how to do it (drive your lead leg). A visual demonstration is often included.

internal focus instruction an instruction that directs your attention to the movement of your body

Internal focus instructions force you to consciously think about what your specific body segments are doing. However, except for early efforts by beginners, most movements aren't consciously controlled this way. Forcing yourself to consciously think about what your body segments are doing can interfere with the natural learning process, which can harm your performance.

External focus

external focus instruction an instruction that directs your attention to the outcome of your movement

Explicit instruction with an external focus is directed at the result or outcome of a movement. **External focus instructions** are about telling you what to do, not how to do it. For example, a coach might instruct a sprinter to run in a straight line, or a golfer to hit the ball so that its flight is like the shape of a rainbow.

A large amount of research has shown that instruction that allows you to focus on the result of a movement, rather than the actual movement itself, leads to superior skill performance and learning. This is because when you focus on the result of a movement, you stop yourself from consciously controlling it. You allow your body to explore and find its own way to achieve the outcome.

Quietening the mind

Sport psychologists recognise that one of the main reasons athletes choke under pressure is because they overthink skill execution, and this interferes with their action. This is often called 'paralysis by analysis'.

Many elite athletes distract or 'quieten' their mind to prevent overthinking, allowing their movements to flow automatically. They often distract their mind or inner voice using music. For example, former Australian Test cricket bowler Glenn McGrath, whenever at the top of his bowling mark, had already decided the ball he wanted to bowl. Then as soon as he started his run-up, he switched everything ‘off’ and sang a song in his head to himself. This distracted his mind from telling him what to do and allowed him to bowl freely, like he was on autopilot.

Implicit learning

Learning is possible without the instruction provided by a coach, teacher or parent. As humans, most of our motor skills are learnt implicitly or subconsciously without conscious thought. When you were an infant you learnt to crawl, walk and run without any external feedback or explicit instruction. You also learnt many motor skills implicitly through backyard, park or playground games, where you could experiment, make mistakes and try again. The environment shaped your behaviour, along with ongoing self-generated intrinsic feedback. There are many advantages to learning implicitly. These include your skills being less likely to break down under competitive pressure (choking) and retained more permanently over time.

The challenge for teachers and coaches is to design practice environments that give you opportunities to discover solutions subconsciously, rather than being told. The teacher or coach needs to step back and allow you the time and space to actively explore practice environments. This will result in you making mistakes, but will also give you the opportunity to learn from your mistakes. The use of questioning can also guide your search process, but should be used after you are given adequate time to explore the practice environment.

As Donald Bradman said in his book, *The Art of Cricket*: tell them what you want them to do, not how to do it, and let them work it out for themselves.

Figure 3.14 Many motor skills are learnt implicitly in the backyard.

Check your understanding 3.8

1 Describe the difference between explicit instruction and implicit learning.
2 Explain the difference between explicit instructions with an internal focus and explicit instructions with an external focus. Give examples to illustrate the difference.
3 Identify the advantages of a coach or teacher adopting implicit learning strategies.

Learning implicitly without explicit instruction

INTEGRATING MOVEMENT

Category: Invasion
Physical activity: End ball

Purpose

This activity involves observing how behaviours emerge in a game of end ball.

Preparation

Time: 1–2 lessons, depending on length
Location: netball court or any 20 m × 10 m area
Equipment: ball; digital capture devices

Setup

1. Form two teams of five players.
2. All remaining students are observers at the start.

Performance

1. The teams play a game of end ball for 10 minutes, using the following rules:
   - The aim is for your end-zone player to catch the ball on the full in the opposing team's end zone (area beyond the goal line).
   - No defenders are allowed in the end zone (just the attacking end-zone player).
   - The player with the ball cannot run.
   - Defenders must stay 1 metre away from the player with the ball.
2. The two teams play a second modified game for 10 minutes, using an additional task constraint: *all passes MUST be below head height*.
3. Swap roles – observers become players and players become observers. The new teams play both games while being observed.
4. Teachers must not give any performance-related instruction. Motivational feedback is allowed, as is ensuring that rules are enforced and that games are competitive.

Data recording

DE 1 DE 6

During all games, observers note and record any behaviour that emerges from both attacking and defending players.

Tasks

DE 3

1. Share and analyse the primary data.
2. What emergent behaviours were demonstrated by the attacking and defending players?
3. Explain how the task constraint 'all passes MUST be below head height' shaped players' behaviour.
4. Evaluate the effectiveness of the task constraint in enabling you and your classmates to learn a technique or tactic implicitly, without explicit instruction. DE 4

Chapter review

[3.1] Motor skills improve through practice. To make sure practice is effective, the design and delivery should be based on sound theories about how people learn. It's the responsibility of a coach to implement practice conditions that give the best chance of transferring skills to the performance environment.

[3.2] Massed practice involves a schedule with short or no rest periods between trials, and is preferable for highly skilled and motivated performers. Distributed practice has a practice schedule with relatively long rest periods between trials. It is more effective in improving performance for novice learners, or learners who have less motivation.

[3.3] A motor skill can be practised in its entirety, or just focused on a single component or part. Practising parts makes a complex task easier to learn, but doesn't let you practise the timing and coordination of the whole motor skill. Task simplification offers a solution by making a complex task easier without breaking it down into parts.

[3.4] Blocked practice involves repeating one movement pattern for a set period of time. Random practice involves randomly alternating between two or more skills during practice. Blocked practice leads to better performance within the practice environment, but random practice results in longer-lasting learning.

[3.5] Practice should provide opportunities for learners to experience variable conditions. This results in better learning and skill transfer, because it prepares learners for the variability and the unpredictability of the performance environment.

[3.6] A drill is a practice task in which learners repeatedly practise a set physical action. While drills allow a technique to be improved, techniques developed from a drill fail to effectively transfer to the actual performance environment. Representative practice is necessary so that learners develop effective decision-making abilities.

[3.7] Performance-related feedback is the information a learner receives about their performance. It can be acquired in two major ways – intrinsically (from the learner's own senses) and extrinsically (from observers).

[3.8] Teachers and coaches give learners information that helps them improve their performance. This can be provided through explicit instruction or naturally through implicit learning.

Review questions

Section A: Multiple-choice questions

1 To ensure high-quality practice, it is important that practice:
- **a** is based on learning theory.
- **b** facilitates the transfer of skills from practice to performance environment.
- **c** is representative of the performance environment.
- **d** all the above are important.

2 Which of the below statements is *incorrect*?
- **a** Massed practice incorporates minimal rest between practice trials.
- **b** Distributed practice incorporates a long rest between practice trials.
- **c** Distributed practice is more effective during the cognitive stage of learning.
- **d** Research has found that better learning results from fewer and longer practice sessions.

3 Which of the below statements is *incorrect*?
- **a** Part practice is effective when practising a complex skill with independent parts, such as a cheerleading sequence.
- **b** Whole practice is effective when practising a simple skill with dependent parts, such as throwing a dart.
- **c** Part practice results in the effective transfer of skills from the practice environment to the performance environment.
- **d** Whole practice allows you the opportunity to practise the timing and coordination of a motor skill.

4 Which of the below statements is *incorrect*?
- **a** The repeated practice of a forehand draw in lawn bowls is an example of blocked practice.
- **b** Random practice has been found to be superior to blocked practice for the learning of motor skills.
- **c** Research has found that the transfer of learning from practice into the game is more effective when using blocked practice.
- **d** The repeated practice of marking a ball then kicking for goal is an example of random practice.

5 Which of the below is an example of constant practice?
- **a** repeatedly practising driving off a tee at a golf driving range
- **b** practising the same touch football move at different parts of the field
- **c** repeatedly practising hitting a ball that rebounds from an uneven surface
- **d** repeatedly practicing serving a tennis ball to different opponents

6 A 20-minute practice activity involving repetitively dribbling a soccer ball around three markers, five metres apart, can be classified as a combination of what types of practice?
- **a** part, blocked and constant
- **b** whole, blocked and constant
- **c** part, random and constant
- **d** whole, blocked and varied

7 A drill makes a complex task easier for the novice learner by:
- **a** incorporating unpredictability into the environment.
- **b** separating the physical action from the environment in which it is performed.
- **c** increasing the number of components to think about.
- **d** allowing them to make their own decisions to solve problems.

8 You watch a video and discover that you take off 30 centimetres behind the take-off board when jumping. This is an example of:
- **a** knowledge of results.
- **b** knowledge of performance.
- **c** intrinsic feedback.
- **d** explicit instruction.

9 Which of the below statements is *incorrect*? Representative practice:
- **a** includes the key elements present in the performance environment.
- **b** provides the opportunity to practise technique together with perception and decision-making.
- **c** presents you with many problems to solve.
- **d** separates your actions from your perceptions.

10 Which of the below instructions has an external focus?
- **a** Throw the frisbee flat like a pizza, making sure that the toppings don't fall off.
- **b** Keep your head down when hitting the ball.
- **c** Drive your lead leg over the hurdle.
- **d** Bend your knee to 90 degrees.

Section B: Short-response questions (150–250 words)

1 It's the responsibility of a coach to design and implement practice conditions that lead to successful transfer of skills from practice to the performance environment. Suggest the most important principles of practice design that coaches should follow to best allow this transfer. Justify your choices.

2 Suggest the most important principles of feedback and instruction that all coaches and physical education teachers should follow to best support learning. Justify your choices.

Section C: Extended response to stimulus (400 words)

A typical goalkeeping practice task involves the coach repeatedly throwing the ball at a goalkeeper from close range.

1 Evaluate this practice task in terms of its effectiveness in preparing a goalkeeper for the performance environment. Respond under the following headings:
- Representativeness (the presence of key elements of the performance environment)
- Variability of practice
- Mental effort required (the problem-solving/decision-making)
- Perception–action coupling (the linking between what you do and what you see)
- Predictability of practice
- Intensity (amount of challenge)

2 Make three specific recommendations to improve the practice task based on what you have learnt in this chapter.

Figure 3.15 England's goalkeeper Robert Green saves balls thrown by the coach during a training session.

4 ASSESSING FORCE AND MOTION

Figure 4.1
When the bat connects, the force causes a change in motion.

There are many objects around you, some in motion and some not. The objects that aren't moving can be brought into motion by applying force: a push or a pull. A force can start movement, stop movement or cause changes in movement. Motion can also be of many different types, such as linear, curvilinear or angular.

You will learn about force and motion in this chapter. Don't be put off by the specialist terms used to explain these concepts. They seem difficult but they're no harder to learn than the technical terms associated with a sport.

KEY QUESTIONS

4.1 What are the laws of motion?

4.2 What is the relationship between force, mass and acceleration?

4.3 What forces cause a body to rotate?

4.4 How does an action cause a reaction?

4.5 What factors determine the outcome of a collision between two objects?

4.6 What factors affect an object's stability?

YOUR CHAPTER PLAN

4.1 The Newtonian laws of motion

British scientist Sir Isaac Newton (1642–1727) probably made a greater contribution to physics than anyone in the history of humanity. The unit of force, the newton (N), is named after him.

Newton discovered many of the fundamental relationships in mechanics that form a foundation for the analysis of human movement and physical activity. These relationships are summarised in the Newtonian laws of motion:

- the First Law of Inertia
- the Second Law of Acceleration
- the Third Law of Action and Reaction.

These laws help to explain how, when you apply force to an object, that force determines the movement of the object and how you can make such movement more efficient.

You might be familiar with these terms and concepts from your science classes, but what are they doing in physical education? All of these rules of physics relate to motion, and that means human bodies in motion as well. Understanding the laws of motion can help you develop new skills, detect errors in performance, improve safety, assist in preventing injury and design better equipment. Athletes who understand these scientific principles have a reference point from which to begin asking questions about their skills.

Figure 4.2 Olympic medallist Cam 'The Professor' McEvoy says his understanding of physics helped him to improve his performance.

4.1 Check your understanding

1 What three laws of physics are useful for analysing sports and physical activities?
2 Explain how understanding Newton's laws can help athletes.
3 Identify the units used to measure force.

4.2 Linear forces

No movement can start without a **force**. When a runner wants to leave the blocks, they must exert a force against the blocks. When a footballer wants to push an opponent out of the way, they must exert a force against the opponent. When an archer wants to shoot an arrow, they exert a force to pull back the bowstring.

Force can be defined as a pushing/pulling or hitting/throwing action that is applied to an object to start movement, stop movement or cause changes in movement. Some forces that you will have experienced are gravity, friction, buoyancy, air resistance and lift.

force
an action that is applied to an object to start, stop or cause changes in movement

Newton's Second Law

Newton's Second Law of Acceleration deals with the application of force. It states that:

> *Any change in motion is directly proportional to the applied force and is made in the line of the force.*

Newton's Second Law of Acceleration
any change in motion is directly proportional to the applied force and is made in the line of the force

This means that when a force is applied to an object, the speed with which the object moves is related to the force, and the object will move in line with the direction of the force.

This law is expressed by the following formula:

$$F = ma$$

where F = force (measured in newtons), m = mass and a = acceleration.

Mass is the amount of matter in an object, measured in kilograms (kg). Why not just call it 'weight'? That's because weight depends on gravity, which isn't constant. If you were playing sport in space, you would be weightless – but your body would still have mass. The greater an object's mass, the harder it is to speed it up or slow it down.

mass
a physical body's resistance to acceleration when a net force is applied

Acceleration is the rate at which an object changes its velocity (speed). When you're in a car and hit the accelerator, the car speeds up. When you hit the brake, you also change speed, but in the opposite direction, so you slow down. Acceleration is measured in metres per second-squared, or m/s^2.

acceleration
the rate at which an object changes its velocity

Newton's Second Law is easily applied to sports. When a batter in softball applies a hitting force to a ball, the ball will immediately move off the bat. The amount of force created by the bat is equal to the force taken up by the ball. Because the ball is now in motion, its force can be described in terms of its mass and acceleration away from the bat.

The mass of a softball stays the same during a game, so if the batter doubles the force of a hit by doubling the swing speed, the acceleration of the ball off the bat will also double.

Figure 4.3 Damien Birkenhead at the Rio 2016 Olympic Games, about to apply maximum force to the shot.

If a shot putter applies the same force to the shot at each attempt, but experiments with shots of varying mass, the situation will change. Let's say the shot putter first selects a 6-kilogram shot and then a 3-kilogram shot. As the mass of the second shot is half that of the first, and the same force is applied, the acceleration of the second shot would be double that of the first. This is the *inverse* (reverse) relationship in Newton's Second Law.

Designed for force

Understanding the principles of acceleration makes it possible to improve the design of sporting equipment, particularly vehicles. The lighter a vehicle, the less force is required to make it accelerate; this means it will reach a greater speed than a heavier vehicle receiving the same amount of force.

In the America's Cup yacht race, the 2017 final between Oracle Team USA and Team New Zealand featured two multi-hulled yachts. The major problem facing the design teams of such yachts is the need to make the boat strong and stiff, yet keep the mass as light as possible to enhance its acceleration and speed. The winner, Team New Zealand, was designed using unique materials. The hull, bulkheads and skins were made from hundreds of layers of composite carbon structure with a honeycomb core, while the frame was made from carbon fibre and Kevlar.

Formula 1 racing cars are also made of high-tech materials. The Red Bull car, driven by Daniel Ricciardo, has a carbon-fibre chassis and aluminium honeycomb composite structure. The car has to have a regulated minimum mass of 702 kilograms with driver, water and oil. To save weight, the gearbox is also made of carbon–titanium casing, and the engine has low-mass components made from ceramics. In addition, Ricciardo was instructed to lose at least 5 kilograms in weight for the 2017 season.

Human bodies aren't designed, but different body shapes and qualities can make them more efficient in some applications of force. Australian diver Melissa Wu, who is only 152 centimetres tall, regularly dives from the 10-metre diving platform. Her size and proportions give her many advantages in competition. A light frame gives her a high power-to-weight ratio, increasing her acceleration off the board; this gives her greater height and time in the air. Her shorter stature and limbs enable faster rotations in the air, and her shoulders take a smaller area when she enters the water, enabling a cleaner entry. Melissa used these advantages to great effect when she won gold for Australia at the 2018 Commonwealth Games.

Figure 4.4 Australian diver Melissa Wu

Check your understanding 4.2

1. Describe Newton's Second Law of Acceleration.
2. Explain the formula for Newton's Second Law of Acceleration.
3. Define mass.

Apply and analyse linear force

LEARNING EXPERIENCE

Use the formula for Newton's Second Law of Acceleration to answer these questions.

1. A soccer player kicks a soccer ball weighing 0.5 kilograms with an acceleration of 60 m/s^2. What is the force of the kick?
2. A high jumper applies a force of 1000 N to the ground, which produces an acceleration of 15 m/s^2. What is the mass of the high jumper?
3. A golfer applies a force of 1000 N to a golf ball of mass 0.05 kilograms. What is the acceleration of the ball off the clubhead?
4. A softball pitcher increases the force of a pitch from 800 to 1000 N. Given that the softball weighs 0.14 kg, what is the acceleration of the ball for each pitch?

Newton's Second Law of Acceleration

INTEGRATING MOVEMENT

Category: Striking and fielding
Physical activity: Cricket, softball

Purpose

This activity involves observing the relation between force, mass and acceleration.

Preparation

Time: one lesson
Location: open space near a wall
Equipment: balls of varying mass, measuring tape or wheel; recording tables

Setup

1. Form groups of three.
2. Assign one student to throw (Student A), one to measure (Student B) and one to record (Student C).

Performance

1. Student A: throw a cricket ball or softball from three positions:
   a. sitting with your back against a wall, with your throwing arm held flat against the wall
   b. standing with your feet together and facing the throw direction
   c. standing side-on with your feet apart.
2. Throw the ball as far as you can for each of the positions described above, using maximum force and aiming for maximum angle of projection.
3. Student B: measure the distance thrown for each position.
4. Repeat the task using balls of varying mass such as a sponge ball, a small shot and a tennis ball.

Data recording

DE 1

Student C: record the distance thrown for each position, and for each ball of varying mass. Record the data in a table; you can download one from your online resources.

Tasks

DE 3

1. Analyse the primary data in the following ways:
   a. Organise and sort the data by mass of ball thrown.
   b. Classify the data by position used to throw.
   c. Categorise the data by distance thrown.
2. Describe the relationships evident from the primary data between force, mass and acceleration. DE 4
3. Propose and generate a strategy, using Newton's Second Law of Acceleration, to enable a performer to achieve maximum distance with a throw. Justify your strategy using primary and secondary data.

http://mea.digital/qpe12_4

4.3 Angular forces

An object's **centre of gravity** is the point at which weight is evenly dispersed all around it. A human's centre of gravity changes as they take on different positions, but for many other objects it's a fixed location When a force is applied to an object through its centre of gravity, the object will move in a straight line (or 'translate' in physics terms).

This type of force is known as a **concentric force**. The term indicates that all parts of the object to which the force is applied will move in the same direction, without rotation. For example, a rugby player tackled through their centre of gravity will be pushed backwards in a straight line, without their body rotating.

To rotate an object, so that it takes up angular motion, a force needs to be applied to the object away from, or to one side of, its centre of gravity. This is known as an **eccentric force**, and it causes a body to both rotate and translate around a **pivot point**.

For example, when a rugby player tackles an opponent around the thighs, below the opponent's centre of gravity, the motion at the opponent's leg is arrested and their thighs become the pivot point for rotation. The opponent's body will then rotate and fall forwards around this pivot point. The closer the tackle to the opponent's feet, the greater the rotation and the faster they will fall. This is why low tackles are dangerous!

centre of gravity
the point on a body at which Earth's gravitational pull is concentrated

concentric force
a force applied through the centre of gravity of an object

eccentric force
a force applied to one side of the centre of gravity, causing the object to rotate

pivot point
the point in space around which an object rotates

Figure 4.5
A low tackle around Israel Folau's thighs ensures that he rotates forward and is brought to ground.

Moment of force

moment of force the force applied to an object multiplied by the moment arm

Angular force can be calculated just as linear force can, but the formula is different. To calculate the turning force that causes rotation, we need to calculate the **moment of force**, represented by T.

$$T = Fd$$

where T = moment of force, F = force and d = moment arm (turning arm)

To make sense of this, consider a high diver. If the diver lets their body simply rotate off the diving board (without any leg drive), then for as long as they're in contact with the board, their feet act as the pivot point (see Figure 4.6). Gravity is the only force that produces rotation, and the gravity line (the direction of the gravity force) acts through the diver's centre of gravity.

moment arm the shortest distance from the line of force application to the axis of rotation

The moment of force of the diver is the gravity force multiplied by the shortest distance from the gravity line to the pivot point, the feet. This distance is known as the **moment arm**. As the force of gravity is constant, the longer the moment arm, the greater the rotation of the diver.

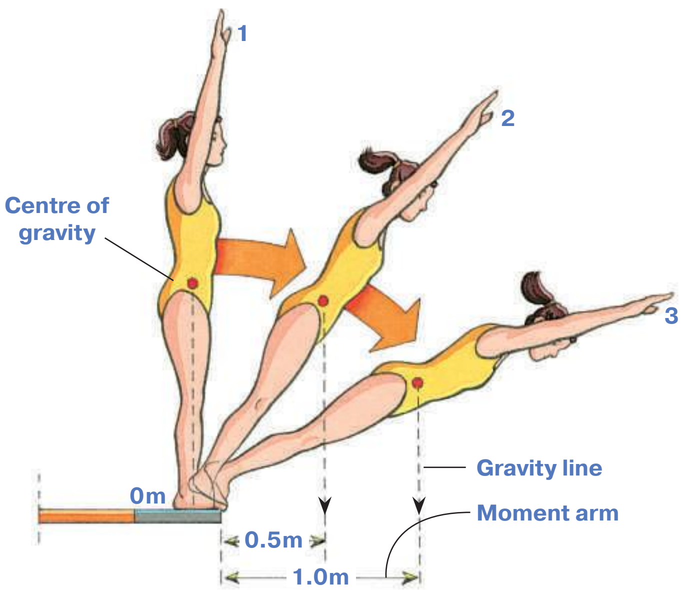


Figure 4.6 A diver letting their body rotate forward off the board with no leg drive

Given that the gravity force for the diver in Figure 4.6 is 500 N, then the moment of force for the diver in position 2 would be 250 Newton metres (Nm), and 500 Nm in position 3.

In position 2:
$$\begin{aligned} T &= Fd \\ &= 500\ \text{N} \times 0.5\ \text{m} \\ &= 250\ \text{Nm} \end{aligned}$$

In position 3:
$$\begin{aligned} T &= Fd \\ &= 500\ \text{N} \times 1.0\ \text{m} \\ &= 500\ \text{Nm} \end{aligned}$$

Check your understanding 4.3

1. Summarise what Newton's Second Law of Acceleration tells us about the role of an applied force in any change in motion.
2. What is the inverse relationship in Newton's Second Law?
3. Explain what an angular force is and how it can be calculated.

Evaluate and justify
moment of force

LEARNING EXPERIENCE

For each position (1–6) of the gymnast in Figure 4.7:

1. Mark the centre of gravity of the gymnast with a dot.
2. Draw a line vertically through the dot to represent the line of the gravity force (gravity line).
3. Draw a line horizontally from the gravity line to the vertical dotted line in the diagram. This horizontal line is the turning or moment arm.
4. To calculate the moment of force:
   - **a** Measure the length of the moment arm in millimetres. This raw figure can be used simply as a practice exercise in using the formula, or you can scale it up to a real figure. (Use a scale of 10 mm to 1 m.)
   - **b** Assume the gymnast has a gravity force of 700 N (this will be the same for all positions).
   - **c** The moment of force of the gymnast can now be calculated for each position: Moment of force = force (gravity) × moment arm.
5. In which position was the moment of force greatest? Justify your decision using evidence from the primary data.
6. Is this moment of force acting to accelerate or decelerate the gymnast? Reflect on this primary data and justify your response.

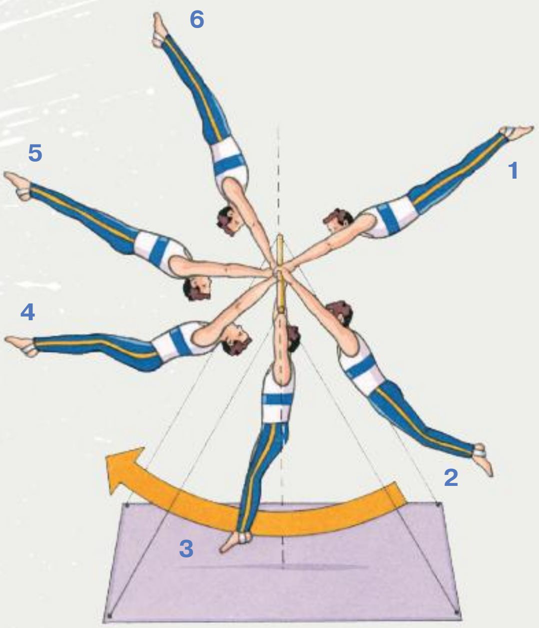


Figure 4.7 A gymnast performing a giant circle on the horizontal bar

4.4 Action and reaction in linear motion

Newton's Third Law of Action and Reaction
for every action there is an equal and opposite reaction force

Newton's Third Law of Action and Reaction states that:

> *For every action force or momentum, there is an equal and opposite reaction force or momentum. The forces that two bodies exert on one another are:*
> - *opposite in direction*
> - *equal in magnitude.*

You probably have a general understanding of this law through your own experiences. For example, heading a soccer ball that's wet and heavy can hurt your head. That's because the ball not only receives a force from your head, but your head also receives a force back from the ball (see Figure 4.8). The force is opposite in direction and equal in magnitude.

momentum
the force of a body in motion

This may be better understood by considering the resultant **momentum** (mass × velocity) of both bodies an instant after the collision. The momentum of both bodies (the ball and your head) is the same, but the smaller mass of the ball results in a high velocity off the head. Your greater mass means a significantly smaller velocity in the opposite direction, such that it may be absorbed by your body and hardly noticed (except for your sore head).

This action–reaction effect can occur without the objects actually coming into direct contact with each other. In the freestyle stroke in swimming, the action force of the hand causes a reaction force in the body, moving the body past the place where the hand applied the force. The reaction of the body equals the force applied by the hand.

The situation is similar for a canoeist performing the draw stroke (see Figure 4.9). An action force is applied by the paddle as it's drawn towards the canoe; the canoe reacts by moving in the opposite direction towards the paddle. The reaction force of the canoe equals the force applied by the paddle.

Figure 4.8 Alex Morgan of the USA wins a header; notice how the ball has been deformed or pushed out of shape.

When projecting a heavy object, such as a medicine ball or the shot in a shot put, the hand exerts a linear action force on the object and the object reacts with a linear force of equal magnitude back onto the hand. The effect of the object's reaction on the thrower's body is quite small because of the much greater mass of the body, but it will still cancel out some of the forward force being generated. This is why a thrower should plant their feet firmly on the ground to stabilise themselves; this adds the great mass of the ground to that of the body, helping to overcome the effect of the reaction force.

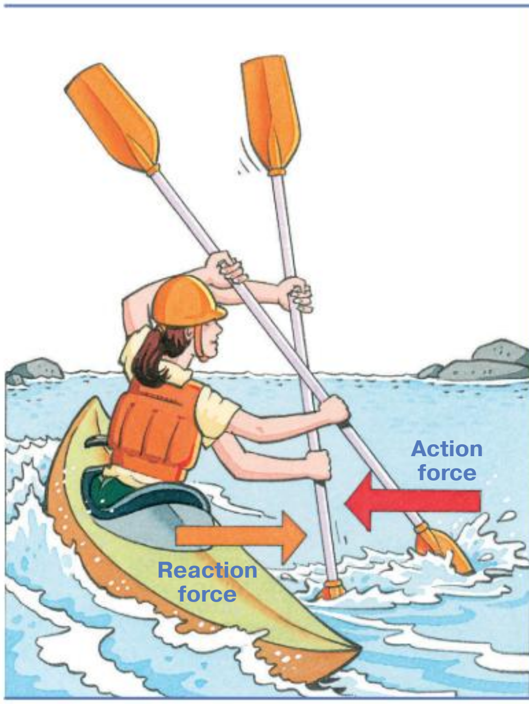


Figure 4.9 Action and reaction in the draw stroke in canoeing.

Apply and analyse
action and reaction in linear motion

LEARNING EXPERIENCE

Figure 4.10 shows a cue ball in snooker sliding (i.e. no rotation) into a stationary object ball. This is an example of linear action and reaction.

1. For the cue ball, draw an arrow to show the direction of the action force. For the object ball, draw an arrow to show the direction of the reaction force. Let the length of each arrow represent the magnitude of the action and reaction forces.
2. If the action force for the cue ball is 80 N, what would be the reaction force of the object ball?
3. Describe precisely the behaviour of the cue ball and the object ball before, during and after the collision.
4. If the object ball receives a force of 90 N and it has a mass of 0.2 kg, what would be its acceleration away from the cue ball?

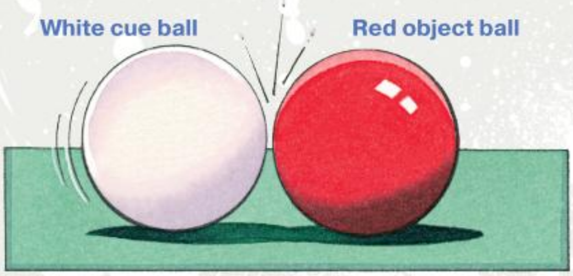


Figure 4.10 A cue ball hitting a stationary object ball in snooker

Action and reaction in angular motion

When considering angular motion in physical education, the two objects involved in action and reaction are almost always body parts. This is because almost every sport skill requires rotational movements of body parts around a joint to create **angular momentum**.

angular momentum the rotational equivalent of momentum (mass × velocity)

Before analysing any angular action–reaction effect, it's important to identify three things:

- the body part initiating the action
- the body part responding to the action
- the hinge around which both body parts rotate.

For example, when a soccer player jumps to head a ball, the upper body initiates the action, the lower body responds to the action, and the hips act as a hinge (see Figure 4.11). Because the player initiates the action by deliberately forcing the upper body at the ball, this is known as the 'action force'. The response of the lower body is called the 'reaction force'.

Direction and magnitude

When one body segment hinges around another, action and reaction occur in the same direction or pathway. When experts talk about rotational action and reaction, they always talk about the direction of the forces as clockwise or anticlockwise.

If an action force is exerted in a clockwise direction by the upper body, such as in the soccer heading action in Figure 4.11, the reaction force in the lower body will act in an anticlockwise direction. If an action force is exerted in an anticlockwise direction by the upper body – for example, when marking the ball in Australian football – the reaction force in the lower body will act in a clockwise direction (see Figure 4.12). The reaction of the lower body will be equal in magnitude to the action of the upper body, and will occur in the same vertical pathway.

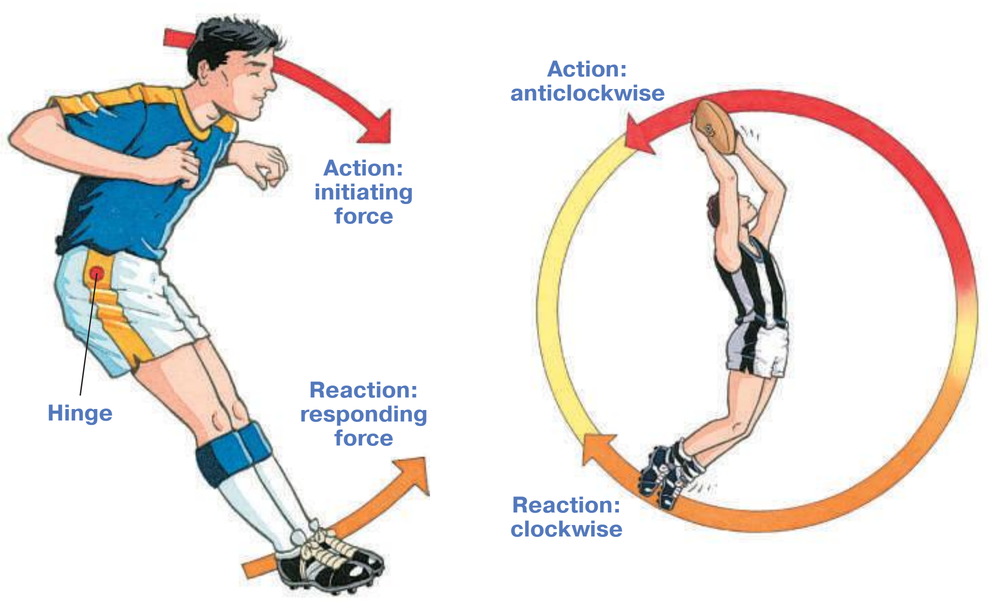


Figure 4.11 Action in the upper body and reaction in the lower body when heading a soccer ball

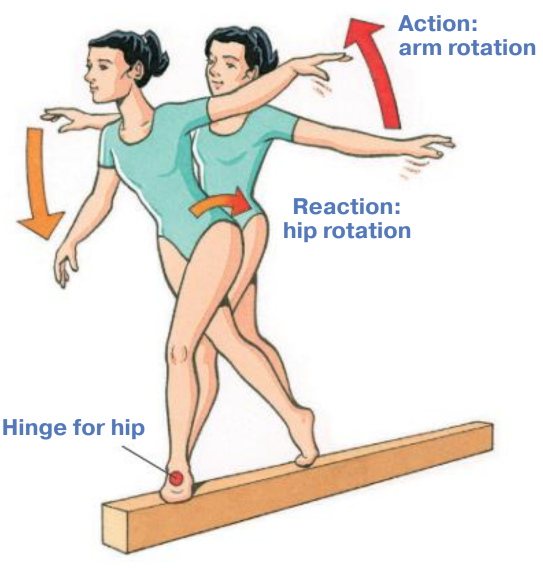
Figure 4.12 Action in the upper body and reaction in the lower body in a mark in Australian rules football

Look back at Figure 4.8 (p.94) and see how Alex Morgan uses only her left leg to react to the upper body, not both legs. Because she's using only half her leg mass, her left leg generates twice the velocity to keep the reactive force or momentum the same.

Balance effects

You can use the action-reaction effect to regain your balance. For example, if the arms of a gymnast walking on the beam initiate an action force by rotating anticlockwise, their hips will react in a clockwise direction (see Figure 4.13). This reaction will rotate the hips up and over the beam again.

In race walking, the arms counterbalance the legs (see Figure 4.14). The leg in recovery has a slight outward, then inward rotation. The reaction to this is an outward-then-inward rotation of the opposite arm. This serves to balance the walker and to make it easier to move in a straight line. You can see an extreme example of this action and reaction in speed ice skating, where the arms show exaggerated movement in reaction to a very wide, exaggerated push from the legs.



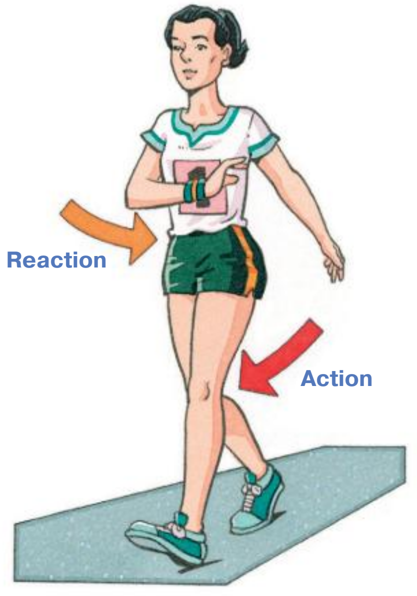


Figure 4.13 Action by the arms and reaction by the hips in a gymnast balancing on the beam

Figure 4.14 Action in the recovery leg and reaction in the opposite arm of a race walker

Check your understanding 4.4

1 Clarify how Newton's Third Law of Action and Reaction explains equal and opposite forces.
2 Describe the inverse relationship in Newton's Third Law.
3 Identify which factors in angular action and reaction must be identified before undertaking movement analysis.

Apply and analyse
action and reaction in angular motion

LEARNING EXPERIENCE

The long jumper in Figure 4.15 is performing a one-and-a-half-hitch kick. This is an example of angular action and reaction. The hitch kick is designed to overcome the forward rotation of the body generated at take-off and place the jumper (in particular, their legs) in the most desirable position for landing. The hitch kick technique is based primarily on the action and reaction principle.

1. The hitch kick is initiated in position **d** with a strong backward drive of the foot and leg. The arrow shows the direction of the action force of the foot and leg as it drives backward. Use an arrow to show the direction of the reaction force of the upper body in response to this action force.
2. If the jumper moved their arms in a circle, what would be the direction of the circle in relation to the direction of the action force of the foot and leg?
3. What is the purpose of the hitch kick and thereby the action and reaction forces in producing a longer jump? Consider the position of the feet and legs on landing.

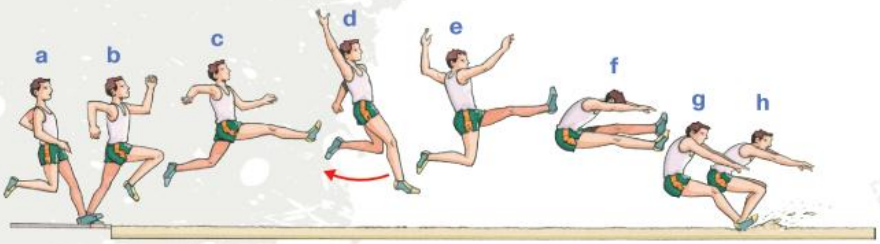


Figure 4.15 A long jumper performing a one-and-a-half-hitch kick

Evaluate and justify
action and reaction (Newton's Third Law)

LEARNING EXPERIENCE

Sepak takraw, sometimes called 'kick volleyball', is a popular sport in Southeast Asia. The basic rules and scoring are similar to volleyball, except that players use their feet, knees, chest and head to play the ball.

The game is played between two teams, each with three players: the left inside, right inside and back. The court is about the same size as a badminton court (6 m × 14 m) and the net is 1.52 metres high. Traditionally balls were hand-woven from bamboo or rattan, but most modern ones are synthetic.

Figure 4.16 shows a sepak takraw game in action. Consider the image carefully as you answer the following questions.

1 Answer these questions about the player in blue:
   - **a** Name the body part that is initiating the action force in kicking the ball. Based on what you see, what is the main body part that is responding to the action force?
   - **b** Identify the hinge around which both body parts rotate.
   - **c** Is this an application of Newton's Third Law in linear or angular motion?
   - **d** What is the role of the left arm?
   - **e** Determine the direction of the action force and reaction force. Justify your answer in terms of Newton's Third Law.
   - **f** Compare the magnitude of the action force and reaction force. How can you explain the fact that one limb will travel faster or further than the other? Justify by substituting momentum for force in Newton's Third Law.
   - **g** How would the application of Newton's Third Law enhance the accuracy of the kicking leg and foot?

2 Answer the following questions about the player in red:
   - **a** The player is trying to block the ball as it comes over the net. Which leg is likely to initiate the action–reaction effect?
   - **b** Name the main body part that will respond to the action force.
   - **c** Describe the positioning of the player's arms. How will they assist in delivering a reaction force?
   - **d** Discuss how the action–reaction effect serves to keep the player's body in balance while in mid-air. Will the action–reaction effect cause his body to rotate in mid-air?

3 For both the blue and red players, the head plays an important role in the accuracy and control of the total body movement. Describe the head positioning for both players in relation to ball positioning and body movements.

Figure 4.16
Sepak takraw being played at the 2014 Asian Games in Incheon, South Korea

4.5 Impact forces

Many popular sports are based on collisions between a ball (or similar object, such as a hockey puck) and a striking implement, such as a racquet or bat.

You've already considered how force is generated when a ball hits an implement. The velocity with which the ball leaves a striking implement is determined by these factors:

- the elasticity of the ball and the implement
- the materials from which the ball or implement is made
- the closeness of the ball to the centre of percussion or 'sweet spot'
- the effective mass of the player's body or body segments.

Elasticity

A material's elasticity is how quickly and how well it regains its original shape after being stretched or compressed. A high elasticity material, such as rubber, regains it quickly and easily; a low elasticity material, such as wood, regains it slowly and poorly, or indeed not at all.

When a ball collides with a surface it becomes compressed and then, due to its elasticity, expands back into its original shape and rebounds. If the ball had a **perfectly elastic collision** with the floor, and no energy would be lost during this compression and expansion, and it would rebound to its original height. (No such ball has yet been made, although a super ball can rebound to almost its original height.)

perfectly elastic collision
a collision in which no energy is lost

If, on the other hand, the ball were made of putty, it would have a plastic or **perfectly inelastic collision** with the floor and would not rebound at all (see Figure 4.17). All the ball's energy of motion (called 'kinetic energy') would be lost.

perfectly inelastic collision
a collision in which all energy is lost

All balls and bats used in sport fall somewhere between these two extremes of elasticity.

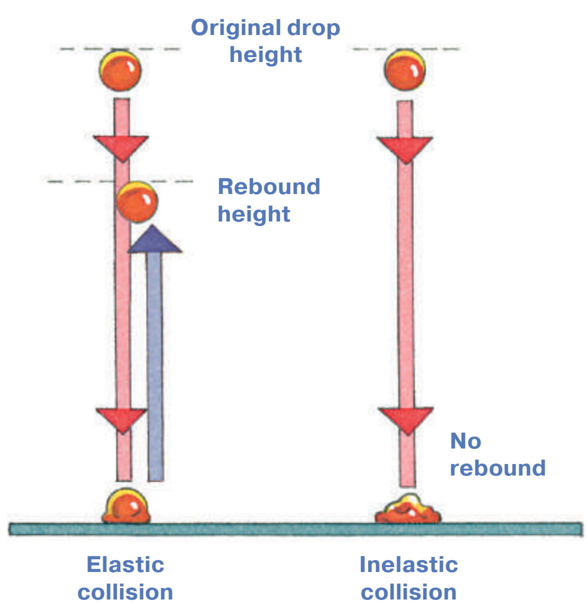


Figure 4.17 The difference between an elastic collision and an inelastic collision

Coefficient of restitution

In everyday terms, the elasticity of a ball is measured by its bounciness, and a bat by its springiness. Technically, the elasticity of a ball or implement is known as its **coefficient of restitution** (***e***):

coefficient of restitution
measure of an item's elasticity

$$e = \sqrt{\frac{\text{height of rebound}}{\text{height of drop}}}$$

Table 4.1 shows the coefficients of restitution of different kinds of balls dropped the same distance onto a rigid wooden floor.

Type of ball	Coefficient of restitution *e* (height of drop 1 m)
Super ball	0.90
Table tennis ball	0.80
Soccer ball	0.75
Golf ball	0.60
Squash ball	0.50
Field hockey ball	0.30

Table 4.1 Coefficients of restitution

As no ball or bat is perfectly elastic, some energy will be lost at impact. When a squash ball is hit against the front wall, the impact literally squashes and violently distorts the ball. The ball compresses and then reasserts its original shape, and in the process some small amount of elastic energy is lost. Some is converted to heat energy, as you'll know if you've ever felt a squash ball during a game. The heat increases the pressure inside the ball and makes it play faster than when it's cold, but even when the ball's hot, it won't be perfectly elastic.

The coefficient of restitution increases:

- when a ball heats up
- when a ball hits a springy surface.

The coefficient of restitution decreases:

- when a ball cools down
- when a ball gets older
- when a ball hits a surface at extremely high velocity.

Materials

The materials from which a ball or implement is made affect its bounciness or springiness. For maximum bounciness or springiness, the important issue is the ability of the ball or implement to restore itself rapidly to its original shape. For this to occur, a ball must be made from highly elastic materials, such as a golf ball with a titanium core, or it must have a high internal air pressure, such as a tennis ball.

This is another area where design technology can change sports. The 'Telstar 18' soccer ball was used in the 2018 World Cup in Russia. This ball has only six panels, bonded seamlessly for perfect roundness and consistent flight. It is light and made of very elastic materials, and so has a high coefficient of restitution.

Restoration of shape

The measure of a field hockey stick's springiness is not how far the shaft can be bent, but the ability of the shaft to rebound and return to the straight position before the ball has left the stick. In fact, the shaft should not bend much at all!

A golf ball has an impact time of only 0.001 seconds. In this time, the ball compresses, expands and pushes back (restoring its original shape) to force itself off the clubhead. You can't make any swing adjustments at impact —you do not have enough time!

If the ball is still in the process of restoring itself after the collision is over, then some of the energy required to force it off the clubhead will be lost. To stop this happening, golf balls are made from high-compression materials, such as titanium. These distort less on impact and restore rapidly to their original shape.

Figure 4.18 A golf ball compresses at the moment of impact with the club.

Apply and analyse
coefficient of restitution

LEARNING EXPERIENCE

For this activity you will need to work with a partner, and you will need a basketball.

Part 1: varying surfaces

One member of the pair is the dropper, and the other is the recorder.

1. The dropper drops the basketball from a height of 1 metre onto 4–5 different surfaces, such as wood, concrete, grass and dirt, or artificial grass.
2. The recorder notes the height to which the ball bounces. This can be done using digital capture, which may give a more accurate result than working by eye.

Together, work out the coefficient of restitution for each surface and record the values.

Type of surface	Height bounced	Coefficient of restitution

Part 2: varying heights

Swap roles in your pair.

1. The dropper drops the basketball from increasing heights onto a consistent surface.
2. The recorder notes the height to which the ball bounces each time. Again, you can use digital capture if desired.

Work out the coefficient of restitution for each height and record the values.

Distance basketball dropped (m)	Height bounced	Coefficient of restitution
1.00		
1.25		
1.50		
2.00		

Tasks

1. Describe the effect of different surfaces on the basketball's coefficient of restitution in Part 1.
2. Explain why the basketball's elasticity is compromised (changed) by the surface it lands on.
3. Describe the effect on the coefficient of restitution of increasing the drop height in Part 2.
4. Explain your Part 2 result in terms of the elasticity of the basketball on impact with the floor.
5. Suggest what lessons should be learnt from your findings for the game of basketball.
6. In striking sports such as golf, what effect might forcing the stroke (hitting the ball too hard) have on the distance travelled by the ball?

Centre of percussion

When a player swings an implement, the linear velocity at any point on the bat will increase as the distance from the handle to the head increases. Think of swinging your arm in a big circle. Your elbow travels in a smaller circle than your hand; in order for your hand to keep up with your elbow, it has to move faster

In theory then, the highest linear velocity of the bat would be at the very end or head of the bat, and this would seem to be the appropriate point at which to hit the ball. But you probably know from experience that a ball hit right at the end of a bat will jar your hands. You also likely know that there's a spot just before the end of a bat where the impact seems to be free of any jarring effect, and the ball seems to fly off the bat. This spot is known as the centre of percussion or 'sweet spot'.

When the ball is hit at the centre of percussion, the sensation is smooth and full, and is often referred to as hitting the ball off the 'meat' of the bat. You can investigate this for yourself by hanging a baseball bat from a piece of string and hitting it at various points on the barrel (see Figure 4.19). Any jarring or vibrating movements in the handle, which would ordinarily be absorbed by your hands, will now be easily seen.

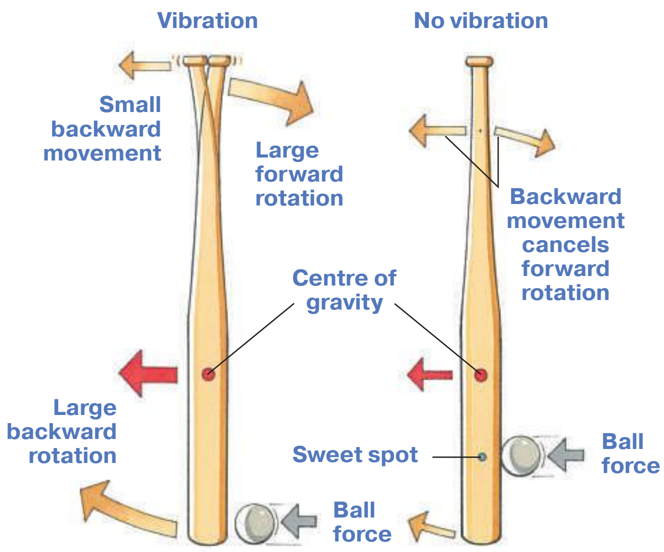


Figure 4.19 A suspended baseball bat struck at the centre of percussion or 'sweet spot' (right) and almost at the end of the bat (left)

When the bat is struck through the centre of percussion, there is no vibration or jarring effect. In this case, the contact spot is close to the centre of gravity, causing the bat to take up a small rotation and move backwards in a straight line. The small backward rotation at the end of the bat produces a less severe forward rotation at the handle. When the forward rotation of the handle cancels the backward linear movement of the handle, no vibration is experienced at the handle.

Hitting the ball at the centre of percussion produces the 'sweetest' hit, both in terms of force and accuracy, and eliminates the vibration or sting players feel when they hit the ball at a wrong spot on the bat.

However, although the centre of percussion produces the sweetest sensation, the ball is normally hit slightly further towards the head of the implement, where the bat is travelling faster. A small vibration can be tolerated if it produces a faster swing velocity. When little swing is evident, such as in a forward defensive shot in cricket, the best result is still obtained by contacting the ball at the sweet spot.

Jumbo tennis racquets are designed to increase the size of the sweet spot, a large area in the middle and towards the throat of the racquet. However, the sweet spot is only of practical value when the tennis ball is moving *towards* the racquet (Figure 4.20). When a tennis player serves, the ball isn't moving from in-court towards the racquet, so the sweet spot is irrelevant. It's now better to hit the ball at the top of the racquet (the 'dead spot') where the racquet is moving with a higher velocity at the end of a longer lever, and momentum is simply transferred from the racquet to the ball (see Figure 4.21).

Figure 4.20 Roger Federer hits a backhand volley on the 'sweet spot' of the racquet.

Figure 4.21 Eugenie Bouchard hits the ball on the 'dead spot' at the top end of the racquet while serving.

Engage and understand
centre of percussion

LEARNING EXPERIENCE

This activity should be conducted in small groups. Your group will need two softball bats, string and coloured sticky tape.

Balance one bat horizontally on your finger to find the approximate location of the centre of gravity. Place a piece of coloured tape around the bat at this point.

Next, attach a loop of string to the top of the bat handle. One member of the group should put their fingers through the loop of string and suspend the bat so that it can swing. (Alternatively, you could hang the bat from a hook.)

As a group, complete the following tasks:

1 Take the other softball bat and hit the hanging bat directly through the centre of gravity. Note what happens.
2 Hit the bat at the end of the barrel. Note what happens.
3 Hit the bat high up on the handle. Note what happens.
4 Now hit the softball bat at different points, gradually working your way up from the end of the barrel. Note what happens in different positions.

Now answer the following questions:

1 What did your groups observe in relation to vibration the first three times you hit the bat (on the centre of gravity, at the end of the barrel and high up on the handle)?
2 How did you know when you hit the bat through the centre of percussion?
3 Why is it important to hit the ball through the sweet spot on the bat?

Effective mass

If two footballers running at the same velocity collide with each other, the player with the greater mass will overcome and knock over the player with the smaller mass. The situation is different if the defender has stopped running, propped and 'dug in'. Using the additional mass of the ground makes the smaller player's bracing action more effective. The effective mass encountered by the attacking player is therefore the defending player's mass plus that of the ground.

Effective mass comes into play during any collision. When a soccer player uses a straight approach to the ball, and kicks with the instep, the instep striking mass may be 3.9 kilograms. If the player kicks with their toe instead, their striking mass may drop to 2.4 kilograms. The ball's velocity will drop as well, by approximately one third, making the shot less powerful.

The concept of effective mass can also be applied to the number of body parts contributing to the impact. A tennis player performing a backhand volley can hit the ball much harder if the arm and shoulder are braced before impact. The braced arm and shoulder, plus the racquet, create a more effective striking mass than if the arm and shoulder were more relaxed.

Similarly, in a roundhouse kick in taekwondo, it's important for athletes not only to develop high foot speed but also to brace their leg and ankle just before impact with the opponent's head. If they don't brace their leg and ankle, and the opponent braces their neck muscles, then the kicker could instead injure their foot.

4.5 Check your understanding

1 What is the coefficient of restitution of a ball or implement?
2 Describe what is meant by the 'sweet spot' of an implement.
3 Clarify why 'effective mass' results in a more effective striking action.

4.6 Balancing forces

You've seen that several different forces come into play when two objects collide. But of course, not every sport involves collision – at least, not on purpose. Many sports and physical activities involve movement and balance instead, like dance or gymnastics. These activities are affected by different factors, which apply to both human bodies and any other object in play:

- the position of the body's centre of gravity
- the body's base of support
- the height of the centre of gravity
- the mass of the body.

Position of the centre of gravity

parabola
curved pathway travelled by an object where the angle of take-off is identical to the angle of landing

As discussed on page 91, the centre of gravity of a body is the point at which the entire weight of a body is concentrated, and around which its weight is evenly distributed. It's important to know the position of a body's centre of gravity so that its position can be tracked when the body changes shape or position. When a dancer moves at different angles to the floor, their centre of gravity is also displaced in these directions (see Figure 4.22).

At the same time, changes to the body's shape can cause the centre of gravity to change position. For example, in position A, the centre of gravity is outside the body mass, whereas in position B it is within the body mass.

When a dancer projects their body into the air, the path or direction of the centre of gravity cannot be changed unless an external force is applied (see Figure 4.23). The path will be a symmetrical curve or **parabola**, with the angle at take-off being almost identical to the angle at landing.

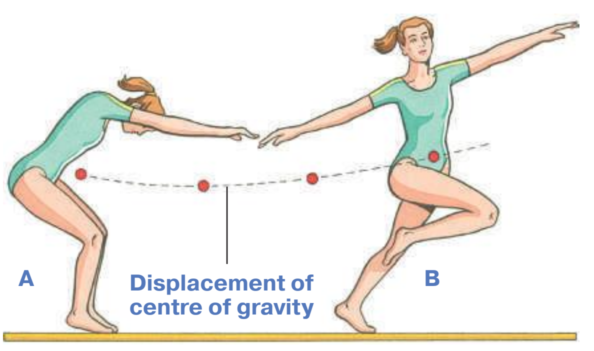


Figure 4.22 How the centre of gravity changes position as a dancer moves on the floor.

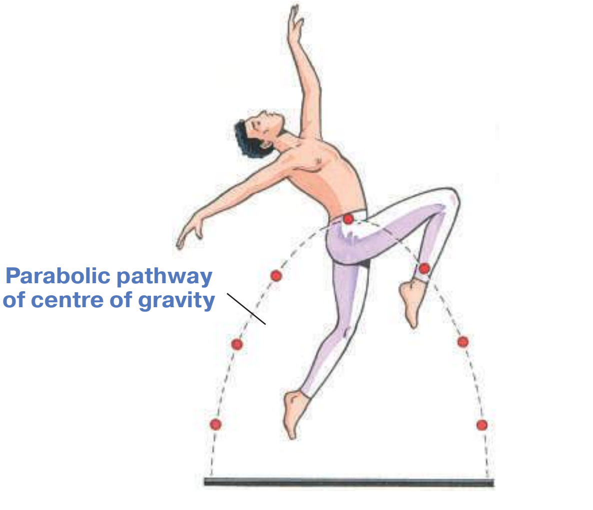


Figure 4.23 How the centre of gravity changes position as a dancer leaps into the air.

The base of support

Every object has a base of support – the area beneath the object that makes contact with the supporting surface. A person standing on the floor uses their feet as their base of support; a cricket ball resting on a table has a very small base of support, the spot where it makes contact.

To identify where body weight is located in relation to the base of support, you need to imagine a gravity line dropping from the centre of gravity to the base of support (see Figure 4.24). If this gravity line intersects the middle of the base, the centre of gravity is centrally located and the balance should be secure. Any movement of the gravity line towards the edge of the base tends to make the balance more insecure.

The distance between the gravity line and the limit of the base is called the *effective* base of support. This is because it's the actual or effective distance the body weight has to move before balance is lost. The effective base of support changes if external forces are applied to the body (see Figure 4.25). Two factors have to be considered:

- the direction of the force
- the pivot point over which the body rotates.

The pivot point may be a discrete point or a line joining two separate points. In Figure 4.26, the pivot point in A and C is the side of the foot, while in B it's a line joining the heels of both feet. The body becomes unbalanced by rotating or hinging over these pivot points. The pivot point changes according to the direction of the force.

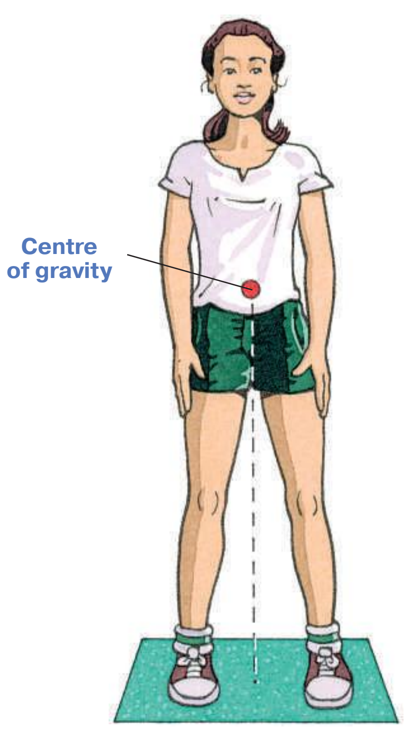


Figure 4.24 The gravity line and the base of support

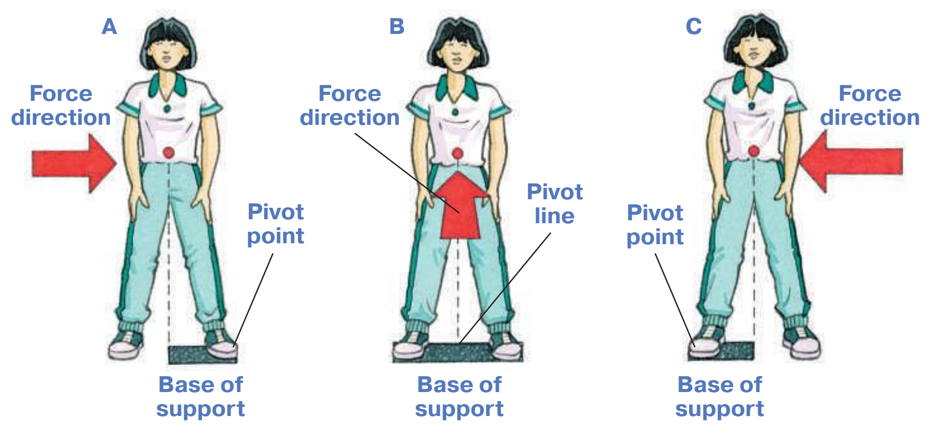


Figure 4.25 Changes in the effective base caused by external forces

When a rugby fullback wants to stop a slow oncoming forward, and perhaps even push the forward back in the opposite direction, the fullback needs to take up a very stable set position (see Figure 4.26). The player enlarges their effective base by moving their body weight forward towards the front foot. This makes the effective base the distance from the gravity line (just inside the front foot) to the pivot point (the back foot). This is a very strong resistive base, and the forward would have to move the fullback's body weight a long way before the fullback can be pushed off balance.

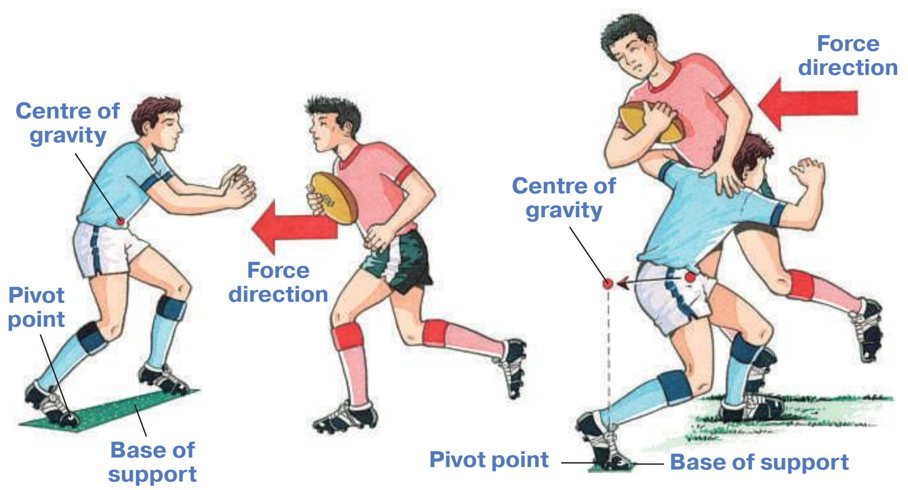


Figure 4.26 A rugby fullback tackling a slow oncoming forward

A solid base like this would be inappropriate for the fullback in some cases, as a head-on collision with an oncoming player would involve such force that both players could be badly hurt. To avoid this, the fullback should move their body weight just before the instant of collision, in the direction in which the oncoming forward is travelling. The tackle should be made at thigh level and slightly to the side, so that the fullback falls backwards with the forward. This will still result in stopping and bringing the forward to the ground. In this case, the fullback is effectively decreasing their effective base and rotating over the pivot point, the back foot.

Height of the centre of gravity

The height of the centre of gravity also determines the security (steadiness) of the balance:

- the lower the centre of gravity, the greater distance the gravity line has to move before reaching the limit of the base, and the more secure the balance.
- the higher the centre of gravity, the less distance the gravity line has to move before reaching the limit of the base, and the less secure the balance.

The relationship between height and security can be explained in terms of the angle through which the body has to rotate before it becomes unbalanced.

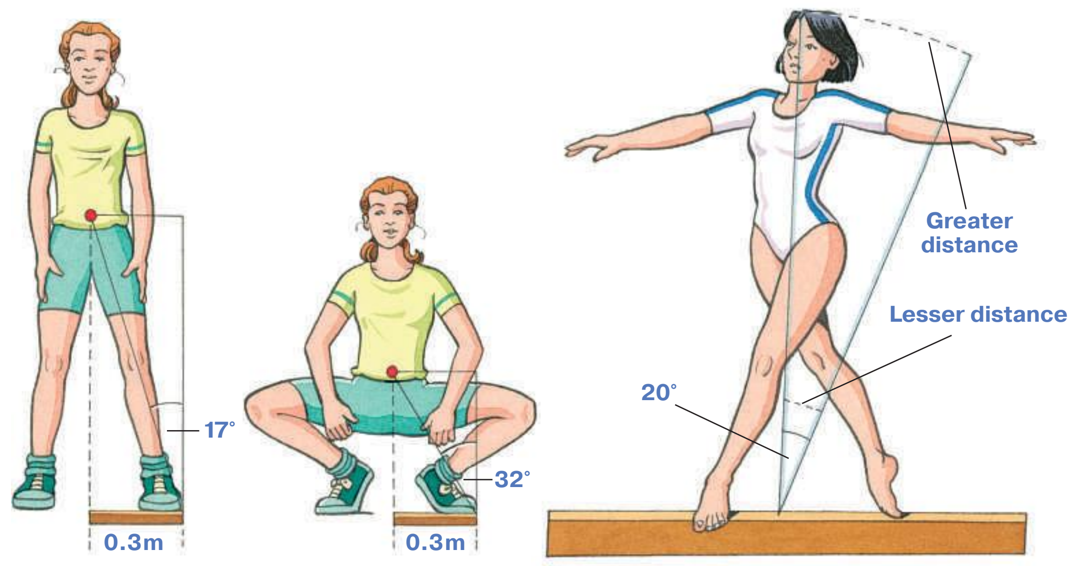


Figure 4.27 The relationship between security of balance and the height of the centre of gravity

Figure 4.28 This gymnast senses the overbalance and makes an early correction.

The effective base of support for both bodies in Figure 4.27 is the same. When the individual squats, their centre of gravity is lower and has to rotate through a greater angle than when in the standing position to reach the point at which balance is lost. It's the angle through which the body rotates that's important, not the linear distance that the centre of gravity moves.

While a high centre of gravity means a less secure balance, this is usually more than offset by an athlete's ability to sense problems and make corrections. For example, consider the gymnast in Figure 4.28, who's starting to overbalance. By the time her whole body has moved through an angle of 20°, the free-moving end of her body (the head) has moved a much greater linear distance than any other body part. The relatively greater movement of her head permits the gymnast to sense the unbalancing movement almost immediately and make a correction at the earliest moment.

There are a number of sports in which raising the centre of gravity can be useful, because a higher position helps the athlete adjust their position quickly. For example, a tennis player waiting to receive a serve can raise their centre of gravity by bringing their feet closer together. This creates an unbalancing effect, allowing them to quickly move sideways to intercept the ball.

In other team sports, and especially combative sports, a low centre of gravity is better, since balance adjustments aren't as important as resisting the force of an opponent. A sumo wrestler is almost designed to be an immovable object; his short, muscular legs provide power and lower his centre of gravity. To maintain this low centre of gravity, body bulk from the waist up, including the shoulders, has a higher proportion of fat, which is lighter than muscle.

When the centre of gravity is below the base of support, an athlete cannot be unbalanced. For example, a gymnast displaced out of a vertical hanging position will swing like a pendulum before settling back into the original vertical hanging position (see Figure 4.29). The centre of gravity comes to rest when it finds its lowest point.

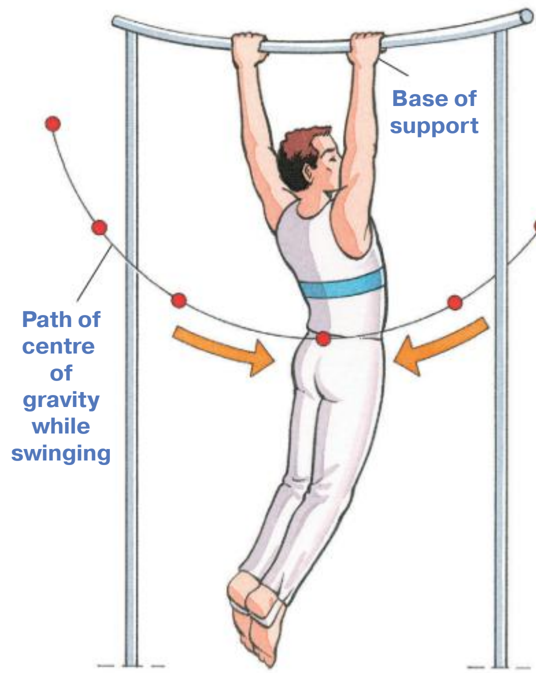


Figure 4.29 This gymnast's centre of gravity is below the base of support, where the hands are on the bar.

Mass of the body

Until now you've only considerd the directional qualities of the gravity line or other external forces. However, the performer's weight will also determine the security of the balance. In general, the greater the weight pressing vertically downwards, the more difficult it is to unbalance the body.

You can see this demonstrated in high-wire walking. With the use of a long pole weighted at the ends, the walker increases their overall mass, which lowers the overall centre of gravity and increases the rotational inertia.

Check your understanding 4.6

1 Identify what constitutes the centre of gravity of an object.
2 What factors contribute to the effective balance or stability of an object?
3 Demonstrate how changing the height of the centre of gravity affects the security of balance.

Apply and analyse
the effect of height variables on balance

LEARNING EXPERIENCE

For this activity you'll need a partner and the following equipment:

- softball bat
- ruler
- practice beam (or a straight line on court boundary)
- pendulum
- beanbag.

1 Balance a softball bat with the head of the barrel on your finger, keeping your eyes fixed on the handle. Next, balance a ruler on your finger, keeping your eyes fixed on the top. Which object was easier to balance and why?

2 Balance the softball bat again, but this time with your finger on the handle end.

   a What's the approximate location of the centre of gravity for both positions of the softball bat?

   b Is the second way of balancing the bat easier than the first? If so, why?

3 Walk along a practice beam. Stop halfway along the beam and close your eyes. Is your balance affected? If so, why?

4 Continue walking slowly along the beam, keeping your eyes focused on a pendulum being swung by your partner, standing at the other end of the beam. (After this, change roles and swing the pendulum while your partner walks along the beam.) Did the swing of the pendulum affect your balance? If so, why?

5 Walk slowly along the beam, focusing your eyes on a beanbag placed at the other end of the beam. Does the placement of the beanbag affect your balance? If so, why?

Figure 4.30
A high centre of gravity means a less secure balance.

Chapter review

[4.1] Sir Isaac Newton was a 17th-century philosopher who discovered many of the fundamental relationships in mechanics. These relationships, known as the Newtonian laws of motion, apply to all moving objects, including the bodies of athletes.

[4.2] Newton's Second Law of Acceleration states that any change in motion is directly proportional to the applied force and is made in the line of the force. It is expressed by the formula $F = ma$. The inverse relationship of the law means that doubling an object's mass halves its acceleration, and vice versa.

[4.3] Angular forces are eccentric in nature and can be calculated by using the moment of force formula, $T = fd$.

[4.4] Newton's Third Law of Action and Reaction states that for every action force or momentum, there is an equal and opposite reaction force or momentum. The inverse relationship of the law means that doubling an object's mass halves its velocity (speed), and vice versa.

[4.5] Many sports involve collisions between balls (or similar objects) and striking implements (which can include body parts). The impact forces in those collisions are affected by the items' elasticity, their effective mass and the materials they're made from, as well as the closeness of impact to the implement's centre of percussion.

[4.6] An object or player's balance depends on the size of the base of support and the height of the centre of gravity. The centre of gravity is the point at which the entire body's weight is concentrated and around which its weight is evenly distributed.

Review questions

Section A: Multiple-choice questions

1 When a sliding cue ball in snooker comes into contact with a stationary object ball, which of the following statements would be true?

a The cue ball will exert a reaction force against the object ball.
b The object ball will exert an action force against the cue ball.
c The object ball will exert a reaction force against the cue ball.
d None of the above.

2 In order to analyse a skill using the principle of action-reaction in angular motion, which of the following components must be identified?

a the body parts that initiate the action
b the body parts that respond to the action
c the hinge around which both body parts rotate
d all of the above

3 Which of the following statements is *not* true?

a The impact between a baseball bat and ball is over before any shot correction can be made.
b A totally inelastic ball will not rebound off a surface.
c A totally elastic ball will bounce back up to its original drop height.
d A collision between a golf club and golf ball may last up to one one-thousandth of a second.

4 In which of the following situations would the coefficient of restitution of a golf ball *not* increase?

a when it heats up
b when it impacts with a springy surface
c when it impacts with a club travelling at very high speed
d when it has a titanium core

5 The dead spot of a tennis racket is:

a a spot that is only useful when playing ground strokes to an incoming ball
b a spot in the middle of the strings
c a spot low down and towards the throat of the racket
d a spot at the top of the strings that is only useful when serving the ball

6 Newton's Second Law explains:

a inertia.
b action and reaction.
c moment of force.
d acceleration.

7 Moment of force is concerned with:

a linear motion.
b angular motion.
c curvilinear motion.
d parabolic motion.

8 A concentric force is applied:
- **a** through the centre of gravity of an object.
- **b** through any point on an object.
- **c** at the end of an object.
- **d** through the mid-point of an object.

9 When a gymnast leaps into the air, the curved pathway of their movement is described as:
- **a** straight.
- **b** angular.
- **c** parabolic.
- **d** curvilinear.

10 Which of the following contributes to an effective balance?
- **a** small base of support
- **b** low centre of mass
- **c** small effective base of support
- **d** decreased body mass.

Section B: Short-response questions (150–250 words)

1 The long jumper in Figure 4.31 is executing a one-and-a-half-hitch kick.
- **a** Identify and explain the direction of the linear action-reaction effect at position **a**.
- **b** Determine and comment about the direction of the rotational action-reaction effect at position **d**.
- **c** Develop two strategies the long jumper could use to improve the action-reaction effect at position **d** in the hitch kick.

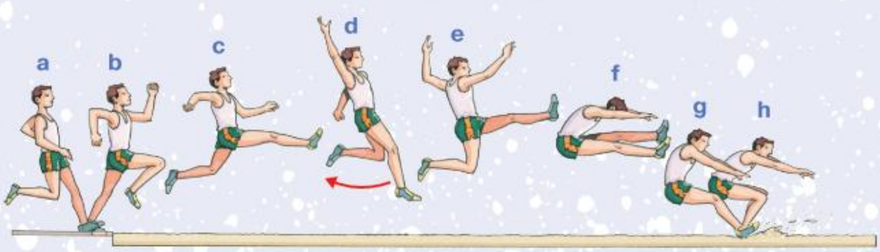


Figure 4.31 A long jumper executing a one-and-a-half-hitch kick

2 Figure 4.32 shows two contrasting positions in the step-out phase of a front walkover.

- **a** For each position (**a** and **b**), draw an X to distinguish the approximate position of the gymnast's centre of gravity.
- **b** For each position (**a** and **b**), draw the gravity or weight line of the gymnast.
- **c** For each position (**a** and **b**), determine the effective base of support of the gymnast. Discuss evidence used to support your decision.
- **d** Which position, **a** or **b**, represents the more correct technique? Explain why.

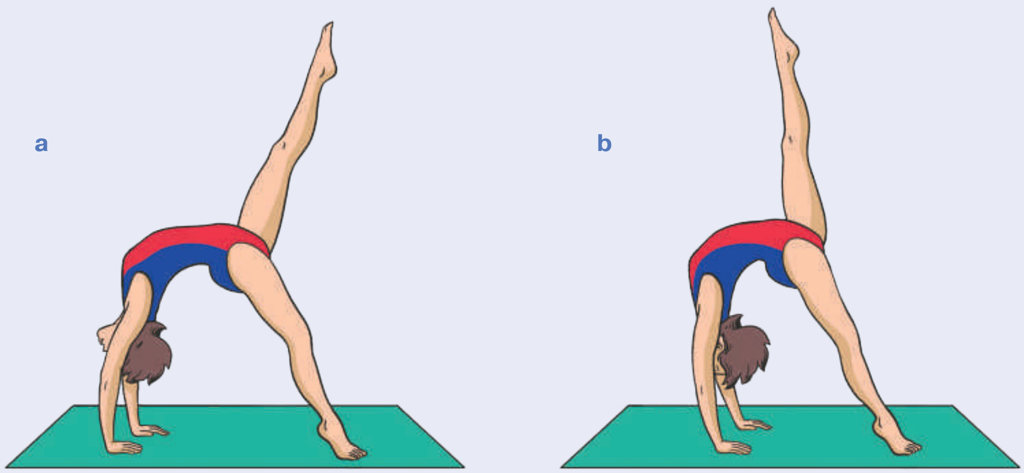


Figure 4.32 Two constrasting positions in the step-out phase of a front walkover

Section C: Extended response (400 words)

Jump vertically as high as you can so that you return to land on the take-off spot. At the height of your jump, flex forcibly at the hips as if you're heading a soccer ball.

1 Synthesise and evaluate the resulting trunk and leg actions of your body from take-off to landing.

2 Using Newton's Third Law justify why, after generating angular body forces in the air, you will return to land on the same spot.

5 APPRAISING FUNCTIONAL ANATOMY

Figure 5.1
Ancient Indigenous Australians understood many core concepts of anatomy.

The human body is capable of an amazing variety of movements. Every time you're active, your muscles and bones contribute to your movement. The skeletal system provides the body with a framework of rigid links to enable movement. Your muscles are the engine of the musculoskeletal system. As your muscles contract and then relax, they move bones and joints that provide leverage to allow a change in your body position.

In this chapter, you'll learn how the structure and function of muscles and bones contribute to movement in different physical activities.

KEY QUESTIONS

5.1 What role does the skeletal system have in movement?

5.2 What role does the muscular system have in movement?

5.3 How can these systems be manipulated to enhance movement?

YOUR CHAPTER PLAN

5.1 The skeletal system

5.2 The muscular system

5.3 Muscles in motion

Chapter review

5.1 The skeletal system

musculoskeletal relating to the muscles and skeleton

The human skeleton and the muscles of the body work together to form the **musculoskeletal** system, which assists the body to perform movements that you can observe during physical activity. It's important that you can understand and describe these movements using correct terminology.

The axial and appendicular skeletons

axial relating to the head, neck and trunk

appendicular relating to the limbs

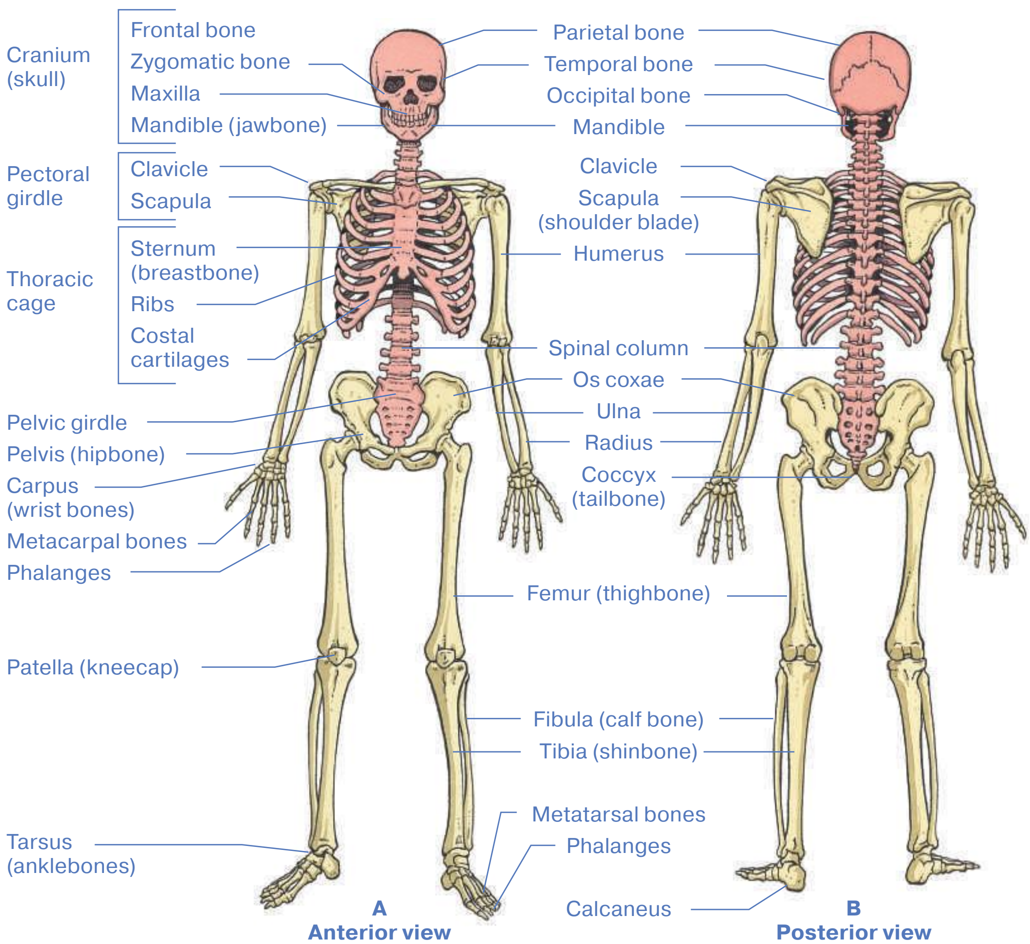
joint a point of articulation where two bones or segments join to allow movement

The human skeleton, which is made up of the **axial** and **appendicular** skeletons, consists of over 200 individual bones, the **joints** where bones meet, and the cartilage and ligaments within various joint structures.

The axial skeleton consists of the bones of the skull, vertebrae and ribs. It's capable of only minimal movement, as this part of the human skeleton provides a central structure (shaded in pink in Figure 5.2).

The appendicular skeleton is comprised of the major bones that are directly involved in developing movement. These include each of the bones of the limbs, along with the pelvis and shoulder girdle, including the scapula and clavicle. It can be considered as an arrangement of rigid links, connected by different joints, that enable specific movements in a variety of physical activities.

Figure 5.2 The human skeleton



The anatomical position

The anatomical position is a reference position that's used as a starting point to allow people to precisely describe various movements and positions of the body. This position is used to develop consistency about the way movement and actions are described in physical activity. Researchers have also developed standard movement terminology to help develop a common communication and understanding in describing movement.

To place yourself in the anatomical position, stand tall and straight with your head and feet pointing directly forwards, your eyes looking straight ahead. Your lower limbs should be close together, with your feet parallel with each other. Rest your arms down by the sides of your body, with the palms of your hands facing forwards. This is a slightly different position to their natural placement when you stand relaxed, where your palms would normally face your body. This palms-forward position aligns the joints of the elbow, wrist and hand and orients these joints with the rest of the body so that movements can be described from that reference position.

It's important to note that when describing movements, especially of the upper body, the naming of the rotations of joints stays the same as in the anatomical position. When you begin to analyse and interpret complex movements of the upper or lower limbs, picture the limb at the reference point of the anatomical position, then isolate the specific joint movement to identify the **axis of rotation** as well as the direction of movement.

axis of rotation
a pivot line about which rotation occurs

transverse plane
divides the body into upper and lower halves

inferior
situated below; away from the head

superior
situated above; toward the head

sagittal plane
divides the body into left and right halves

coronal plane
divides the body into front and back halves

anterior
situated to the front; in front of

posterior
situated to the rear; behind

Anatomical terminology

When you refer to the various movements of the body, or the locations of anatomical structures, it helps to use specific terminology.

Planes are used to describe movements:

- The **transverse plane** is a horizontal plane that runs across the body. It divides the body into two parts: **inferior** and **superior**.
- The **sagittal plane** divides the body into left and right segments.
- The **coronal plane** divides the body into **anterior** and **posterior** segments.

Figure 5.3
The anatomical position

proximal
toward the attached end of a limb or the origin of the structure

distal
away from the attached end of a limb or the origin of the structure

extremity
a limb and/or the end part of a limb

medial
towards the midline of the body, on the inner side

lateral
away from the midline of the body, towards the outer side

Similarly, specific terms are used to describe the location of various parts of the body in relation to the whole body:

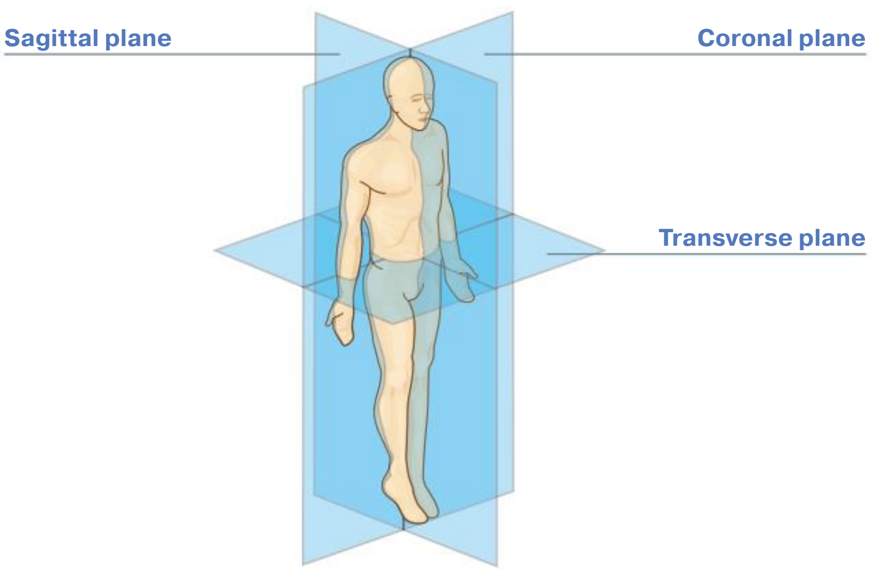
- The precise location of a point on the axial or appendicular skeleton is indicated as either **proximal** or **distal**. A point that is more proximal lies closer to the axial skeleton than one that is more distal on an **extremity**. For example, the elbow is proximal to the wrist.
- Superior and inferior describe points that are above and below each other. For example, the shoulder is superior to the wrist.
- Whether a point is on the front or back of the body is described with the terms anterior and posterior, such as the anterior and posterior cruciate ligaments of the knee.

Finally, a third set of terms establish on which side of a segment a specific point is located:

- A **medial** point is closer to the midline of the body.
- A **lateral** point is further away from the midline.

For example, the medial ligament of the knee is located on the inside of the knee, closer to the midline. The lateral ligament is the ligament on the outside of the knee, further away from the midline.

Figure 5.4 Planes of the human body



5.1 Check your understanding

1 Describe the differences between the axial and appendicular skeletons.
2 Explain why the anatomical position is used as a reference point to describe different movements.
3 Sketch a basic diagram of the anatomical position. Identify the various body positions with symbols or shading on your diagram.

5.2 The muscular system

The skeletal muscles of the body are the dynamic mechanisms that drive the combined musculoskeletal system. The bones of the skeleton and its joints provide the shape and structure of the body, but without the forces generated by the various muscle groups to support the joints, the skeletal framework would fall apart and collapse.

Figure 5.5 The musculo-skeletal system drives dynamic action.

Types of muscle tissue

skeletal muscle muscle tissue involved in movement

Skeletal muscle has the capacity to generate movement, across joints, by shortening or lengthening to produce tension. In the human body, there are three different types of muscle tissue:

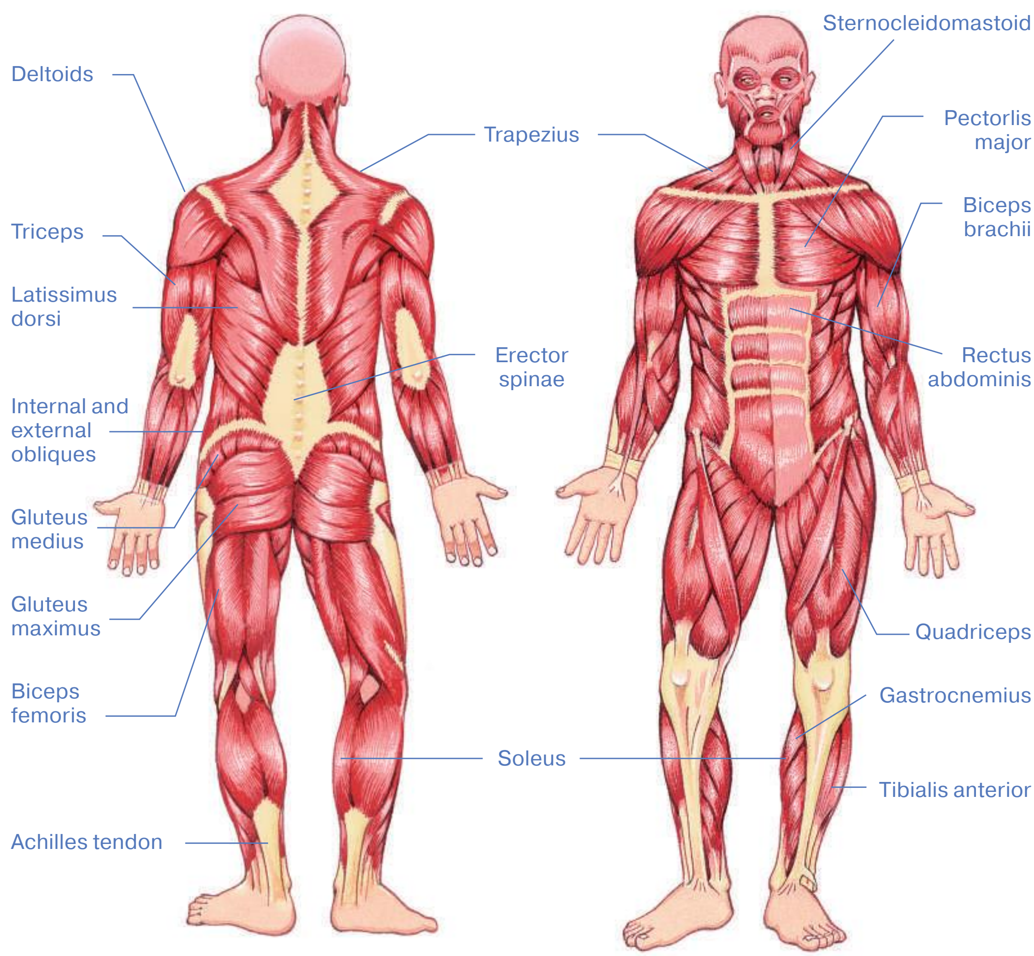
- smooth muscle
- cardiac muscle
- skeletal muscle.

All these types of muscle tissue can contract and create tension.

Smooth muscle is found in the walls of veins and arteries, and in organs such as the stomach and intestines. Cardiac muscle is found in the walls of the heart, and appears different from smooth muscle and skeletal muscle under a microscope. Both cardiac and smooth muscle tissue are known as involuntary muscles, as you have no conscious control over these muscle tissues.

When researchers study movement and physical activity, the muscle tissue they are most interested in is skeletal muscle. These muscles largely undergo voluntary contraction. The functions of each of the skeletal muscles are described in Figure 5.6.

Figure 5.6
Major skeletal muscles associated with movement



Muscles, joints and movement

In the human body, joints provide the pivot points between bones to enable movements. As muscles contract and generate force, they act on bony surfaces and joints to cause the body to move.

There are several different types of joints within the human body, which can allow various ranges of movements. The type of joint associated with most movement is a **synovial joint**, which allows an extensive range of critical movements.

synovial joint
a freely moveable joint

A common language and terminology allows us to describe these movements precisely, as shown in Table 5.1. Remember: when you describe these movements, refer to the anatomical position as the starting point of your description.

Table 5.1 Description of movements of the human body

Movement term	Description
Flexion	Bending to decrease the angle between two bones
Extension	Increasing the angle between two bones
Abduction	Movement of the bone away from the midline
Adduction	Movement of the bone toward the midline
Pronation	Movement of the bones of the forearm to place the palm of the hand facing downwards
Supination	Movement of the bones of the forearm to place the palm of the hand facing upwards
Rotation	Movement of a bone around a central axis
Circumduction	Movement of a bone to describe a circle as it moves around
Dorsiflexion	Movement of bones to raise the toes and foot to the anterior face of the lower leg
Plantar flexion	Movement of bones to point the toes
Eversion	Movement of bones so that the sole of the foot moves outward at the ankle
Inversion	Movement of bones so that the sole of the foot moves inward at the ankle

Check your understanding 5.2

1. Describe the role of skeletal muscle in movement.
2. Identify the different types of movement required in your selected physical activity. Describe these movements, using correct terminology.
3. Create a labelled diagram to indicate the movements in your selected physical activity.

CASE STUDY

Quantitative motion analysis in biomechanics

Quantitative motion analysis involves recording movement by tracking markers attached to the body. Biomechanists use quantitative motion analysis as a tool in human movement research. Kinematic and, when combined with use of force measurement, kinetic variables can be calculated from the output of the motion capture system. These systems enable the position of the markers, and hence the body segments to which they are attached, to be located accurately in three-dimensional space. Typically, the systems can do this to within 1 mm, so are very accurate. The systems work at a high frequency, taking between 60 and 240 samples every second, with the newest systems able to record up to 500 samples per second.

The space in which data are collected is known as the capture volume; it needs to be large enough to encompass the whole of the movement of interest, but not so long that large parts of the volume are unused. Six or more cameras will be used to cover a capture volume, although some multi-person motion captures in large volumes may use 24 or even 32 cameras. Generally, cameras are spaced equally around a volume to ensure maximum coverage and accuracy in marker position reconstruction.

Markers are placed on the participant at known anatomical landmarks that relate to the underlying skeletal structure. Typically 25 to 30 lightweight markers of between 10 mm and 25 mm in diameter are attached to the body at various locations. The most accurate way of tracking skeletal motion would be to use pins to attach markers directly to the bone, but this is obviously impractical for routine motion analysis, although it is used in some research studies. To reconstruct the position and orientation of a 48 Gait analysis segment in three-dimensional space, at least three markers are required on every segment that is being tracked. Careful marker placement is very important, as it will directly affect the validity of the final results of the motion analysis. The results of an on-line motion analysis session carried out by a sports biomechanist are presented in an anatomically meaningful way (see planes and axes of movement) so that they can be understood by physiotherapists, coaches, and other personnel working with an athlete.

On-line motion analysis has the advantage of being able to provide accurate three-dimensional data quickly and easily with minimal processing time by the biomechanist. It is far less labour intensive than video analysis and the most advanced systems can produce graphical output of joint angles in real time, as the data are being collected. This real-time feedback has great potential in the development of rehabilitation strategies after injury and is actively being developed as an advanced clinical tool by biomechanics researchers. The main disadvantage of on-line motion capture is that it cannot be used in the field or in competition because it requires the application of markers to the performer's body and the cameras are unable to track markers outdoors. It is, however, a powerful tool for laboratory-based analysis.

Source: Milner, C.E. (2008) *Functional Anatomy for Sport and Exercise*

QUESTIONS

1. Describe quantitative motion analysis.
2. Investigate methods of marking body segments to enable motion analysis that you could use when capturing digital evidence for your folio.
3. Design an appropriate capture volume to capture your performance.
4. Experiment and test different methods of marking body segments for digital capture.

5.3 Muscles in motion

In general, muscles are comprised of two 'ends' that are attached to bones by a **tendon**. These attachments are generally located on either side of a joint. If a muscle contracts or pulls, an equal force will be applied to each attachment, causing the bones to move. Generally, as a muscle shortens, the **insertion**, the location where the muscle is attached to a moveable bone, moves towards the **origin**, which is a fixed and relatively immobile bony structure.

In anatomical terms, the origin of the muscle is generally situated at the proximal end of the attachment, while the insertion is located at the distal end of the attachment of the muscle to the bone. In biomechanical terms, the origin of the muscle attaches to bone that moves less compared to the attachment end of the bone where the muscle inserts and produces greater movement.

tendon
cord of dense, fibrous tissue that attaches muscle to bone

insertion
the moveable attachment of a muscle

origin
the attachment of a muscle that remains relatively fixed during muscular contraction

Apply and analyse
modelling joint and muscle movement

LEARNING EXPERIENCE

Work in pairs to create a model of a joint.

1. Drill or make a small hole at the end of two rulers.
2. Attach the rulers together with a small nut and bolt to create a simple hinge with two separate arms.
3. Attach a thin piece of elastic at the top of one ruler to the bottom of the other ruler, using adhesive tape or putty, across the joint formed by the nut and bolt.
4. Have your partner hold the rulers in a straight line so that the joint is stable. Shorten the elastic by lifting it. Observe what happens to the movement of the two rulers.
   - **a** Identify the 'origin' of the elastic. Observe the movement at this point.
   - **b** Identify the 'insertion' of the elastic. Observe the movement at this point.
   - **c** Compare the movements using correct anatomical terms.
5. Predict how the movement you observed could be reversed. In other words, how might the elastic be attached to straighten the rulers to their original position?

Muscles working together

The arrangement of skeletal muscles allows them to work together or oppose each other to produce smooth, coordinated and precise movements. Whatever one muscle or specific muscle group can 'do', there's another muscle or specific muscle group that can 'undo' the movement.

This process is known as **reciprocal inhibition**, and is controlled by the nervous system. Muscles located on one side of the joint relax to accommodate muscle contraction on the other side of the joint, producing movement. Each of these muscles can take on different roles according to the specific movement required.

reciprocal inhibition
process in which muscles located on one side of a joint relax to accommodate muscle contraction on the other side

Figure 5.7 Hurdlers demonstrate smooth, coordinated and precise movements

agonist
the prime mover, providing major force to lead a muscle action

antagonist
muscles that work in opposition to the agonist to reverse a movement

The muscle in any movement that provides the major force is known as the prime mover or **agonist**; it leads the specific movement. For example, the biceps brachii muscle is the agonist when bending your elbow to lift a barbell in a bicep curl.

Antagonist muscles work in opposition to the agonist to reverse a movement. Generally, these muscles are located on the opposite surface of the bone that is subject to movement.

When a movement occurs, antagonists are often stretched or relaxed as the agonist progressively contracts. These muscles can also help to regulate and control the action of the agonist, and make movement more efficient and effective. A muscle that creates a movement of a joint in one specific direction is generally resisted by a muscle that can reverse the movement in the opposite direction.

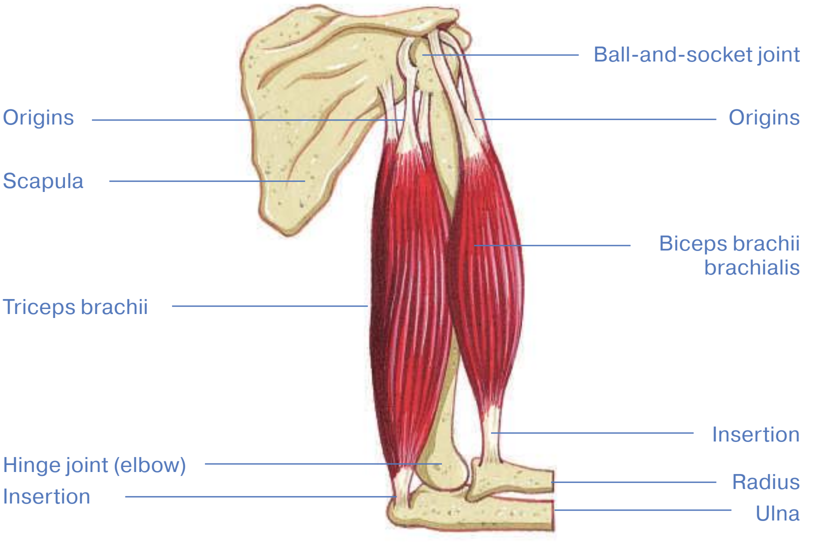


Figure 5.8 Muscle relationships working across the elbow joint

Other muscles involved in movement help to stabilise joints, working with the agonist and antagonist. They are known as **fixators**. As these muscles increase tension, they work to stabilise the joint and assist in controlling the action of muscles involved in the movement.

fixator
muscles involved in movement that assist to stabilise joints

Types of muscle contraction

When a skeletal muscle 'works' in a physical activity, the muscle generally contracts, developing tension and force, to act on a joint and cause movement. Most of these movements are known as **isotonic** contractions. This means that the same rate of contraction is applied to the movement, given a specific load and angle of the joint achieved. In other words, the resistance to the movement is constant, but the speed of the movement is varied.

isotonic
constant muscle contraction at a given joint angle and load

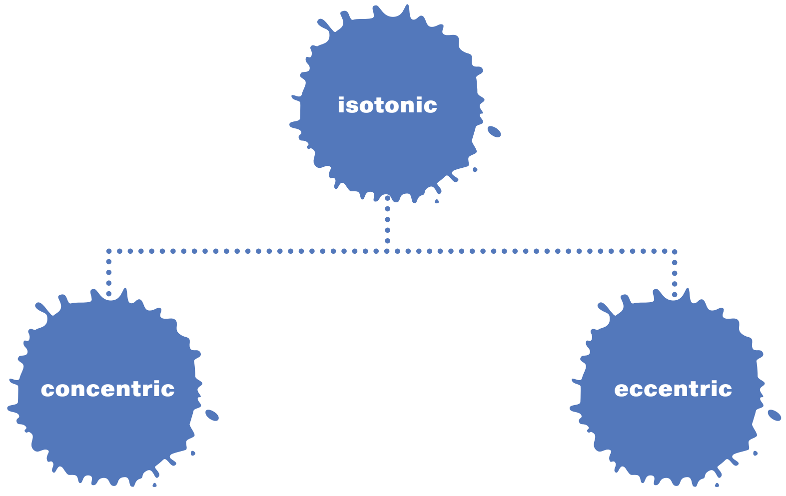


Figure 5.9 Isotonic contractions can be eccentric or concentric, while resistance remains constant through the activity.

A dumbbell curl, bench press, leg press or calf raise are all isotonic movements. The resistances used in these exercises are constant, as the weight being lifted and lowered doesn't change throughout the exercise. However, the speed of the movement does change throughout the **range of movement**.

Several other types of muscle contraction can be identified during movement and physical activity. For example, as you lift and lower a weight using your arms, different types of contraction occur:

- As the weight is lifted, a **concentric contraction** takes place, shortening the muscle and developing tension.
- As the weight is lowered, the muscle is lengthening while it is working. This type of contraction is known as **eccentric contraction**.

A useful guide to observe and identify a contraction is that when a muscle is active, and its attachments are drawn together, it is acting concentrically. If the attachments are drawn further apart, then the muscle is performing eccentric contraction.

range of movement
the extent of movement able to be demonstrated in a joint

concentric contraction
a muscle contracting under load and shortening to produce tension

eccentric contraction
a muscle contracting under load and lengthening to produce tension

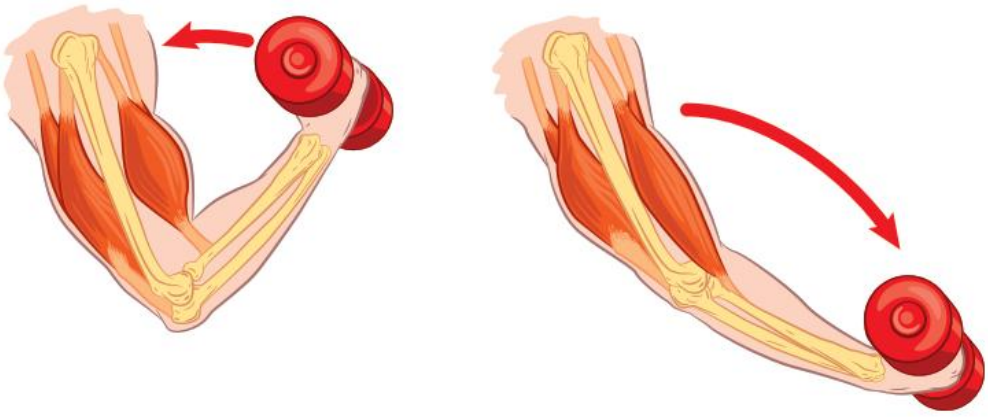


Figure 5.10 Concentric and eccentric muscle contractions develop tension and force.

Muscle strength

The force a muscle is capable of producing depends on different factors. The number of muscle fibres, the length of the muscle and its area in cross-section can all influence force production.

Skeletal muscle is composed of many muscle fibres, as well as smaller strands called **myofibrils**. The arrangement of these components affects the behaviour of the muscle:

myofibril long contractile thread found in skeletal muscle cells

- When fibres and myofibrils are arranged and attached end to end, this is known as connection in series.
- Fibres and myofibrils can also be arranged side by side; this is known as fibres in parallel.

Increasing the number of fibres that are side by side, or parallel to each other, increases the amount of force a muscle can generate.

When an athlete undergoes strength training, the number of fibres in their muscle tissue do not increase, and the muscle fibres do not lengthen. What does happen is that the individual fibres thicken. This increases the cross-sectional area of that muscle, which increases the amount of tension or force that can be developed with that muscle.

5.3 Check your understanding

1 Describe:
   a the role of a tendon
   b the differences in movement of the bone attachments of the origin and insertion
   c the concept of reciprocal inhibition.
2 Identify the agonist and antagonist as the elbow bends in a bicep curl during resistance training.
3 Visually describe concentric and eccentric muscular contractions using a graphic organiser, model or diagram.

Anatomical concepts in movement

INTEGRATING MOVEMENT

Category: All
Physical activity: All

Purpose

1. This activity involves using anatomical concepts when observing performances of specialised movement sequences.
2. This activity focuses on the physical activity your teacher has selected for this topic.
3. The primary data collected in this activity could be used to support your folio task. DE 1

Preparation

Time: two lessons (one for capture, one for analysis)
Location: depends on activity
Equipment: depends on activity, digital capture device

Setup

1. With a partner, select a specialised movement sequence from the activity that requires improvement to optimise performance.
2. Create a table to identify the critical anatomical and joint movements required when performing the sequence. You may want to break the sequence up into distinct subroutines or phases.
3. Analyse the critical anatomical and joint movements in your table, using secondary data.
4. Determine which camera angle will provide the optimum location to gather data – for example, elevated, from the side, front on, from directly above, from behind.

Performance

Perform the selected specialised movement sequence, alternating with your partner.

Data recording

1. Each of you should digitally capture each other's performance of the specialised movement sequence. DE 6
2. After the performance, you and your partner should review the recorded data and capture again, if required. DE 1

Tasks

Evaluate which anatomical concepts are most important to performance in the specialised movement sequence. Justify your response, using primary and secondary data. DE 3 DE 4

http://mea.digital/qpe12_5

Chapter review

[5.1] The skeleton is divided into two major segments. The axial skeleton consists of the bones of the skull, vertebrae, and ribs. The appendicular skeleton consists of the bones of the limbs, with the pelvis as well as the shoulder girdle, including the scapula and clavicle.

[5.1] Specific anatomical language is used to describe movement and position. Movement occurs in one of three planes: transverse (upper/lower), sagittal (left/right) or coronal (front back). The location of a point on a limb may be proximal (close) or distal (far); superior (above) or inferior (below); and anterior (at the front) or posterior (at the back). Medial points are closer to the midline; lateral points are further away.

[5.2] Skeletal muscle has the capacity to generate movement, across joints, by shortening or lengthening to produce tension. There are several different types of joints; the type associated with most movement is a synovial joint, which allows an extensive range of critical movements.

[5.3] The development of force by muscle is related to its cross-sectional area. When a muscle works, the origin of the muscle remains relatively fixed, whilst the insertion of the muscle creates movement. There are two types of muscle contraction during movement: concentric and eccentric.

[5.3] Reciprocal inhibition is controlled by the nervous system. Muscles located on one side of the joint relax to accommodate muscle contraction on the other side of the joint, to produce movement.

Review questions

Section A: Multiple-choice questions

1 Anatomical terms that refer to the back of the human body in the anatomical position include:
- **a** medial.
- **b** anterior.
- **c** posterior.
- **d** inversion.

2 Consider the femur and tibia in the thigh and lower leg. In anatomical language, which term best describes the femur and its relationship with the tibia?
- **a** inferior
- **b** ventral
- **c** superior
- **d** lateral

3 Movement towards the midline of the body is known as:
- **a** flexion.
- **b** eversion.
- **c** adduction.
- **d** abduction.

4 The axial skeleton contains:
- **a** just the skull and the spine.
- **b** the skull, spine and rib cage.
- **c** the shoulders, arms, elbows and hands.
- **d** the limbs joined by the pelvis and shoulders.

5 Flexion of the trunk is:
- **a** bending forward.
- **b** bending backward.
- **c** bending your head back.
- **d** raising your upper leg forward.

6 When analysing the movement of a goal shooter (GS) rebounding in netball, what evidence of joint movements in the legs would you observe?
- **a** flexion of the hip, flexion of the knee, extension of the ankle
- **b** flexion of the hip, flexion of the knee, plantar flexion of the ankle
- **c** extension of the hip, extension of the knee, extension of the ankle
- **d** extension of the hip, extension of the knee, plantar flexion of the ankle.

7 When a muscle contracts under load and shortens to produce tension, the type of muscle contraction is known as:
- **a** isotonic.
- **b** isometric.
- **c** isokinetic.
- **d** concentric.

8 Reciprocal inhibition relates to the role of:
- **a** muscle abduction.
- **b** muscle adduction.
- **c** agonist and antagonist.
- **d** every type of muscular contraction by all muscle tissue.

9 Isotonic muscle contractions:
- **a** show constant tension at a given joint angle and load.
- **b** show variable tension at a given joint angle and load.
- **c** shorten the muscle fibres and increase internal tension.
- **d** lengthen the muscle fibres, but increase internal tension of the muscle.

10 In a windmill softball pitch, the movement evident at the pitcher's shoulder joint is described as:
- **a** abduction.
- **b** dorsiflexion.
- **c** circumduction.
- **d** shoulder extension.

Section B: Short-response questions (150–250 words)

1 An underhand throw requires movement of the arm forward and the release of the ball towards the target. Identify and describe, using the correct anatomical terms, the movement that is occurring at the following body segments during the movement of the arm forward and the release of the ball from the hand:
- **a** wrist and hand
- **b** elbow joint
- **c** shoulder joint
- **d** Justify your reasoning for your responses in each of a, b and c.

2 Choose a specialised movement sequence from the sport or activity you're currently studying.
- **a** Identify the critical anatomical and joint movements of the sequence.
- **b** Identify which functional anatomy concepts are most important to optimal performance in this sequence.

Section C: Extended response (400 words)

Evaluate the significance of functional anatomy concepts for optimising performance in the physical activity you're studying. Why is an understanding of anatomy and anatomical concepts required to identify technical characteristics of performance? Justify your response, using primary and secondary data.

6 EXPLORING MOMENTUM

Figure 6.1
Olympic softballer Stacey Porter is a whirl of motion as she throws to homeplate.

Momentum is one of the most important concepts in biomechanics. It’s used frequently in sport biomechanics to describe and explain collisions, as well as the generation of velocity in throwing and striking actions. The term is also used in everyday language. For example, sports commentators might remark on the increased ‘momentum’ a team generated to get up and win the game.

In this chapter, you’ll learn about the properties of momentum, how to calculate it and how it affects movement in sport. You may find a calculator useful for determining momentum and completing formulas.

KEY QUESTIONS

6.1 Why is momentum so important in physical activity?

6.2 How can we achieve the highest velocity of a thrown object?

6.3 How can we increase the accuracy of strikes and throws?

6.4 Does the inertia of an object help or hinder performance?

6.5 How does angular momentum differ from linear momentum?

YOUR CHAPTER PLAN

6.1 Linear momentum

linear momentum the product of mass and velocity of an object travelling in a straight line

An object moving in a straight line has both mass (weight) and velocity (speed). The product of those factors is the object's **linear momentum**, expressed by the following formula:

$$M = mv$$

where M = momentum, m = mass and v = velocity.

(The term 'momentum' when used by itself in the rest of this chapter refers to linear momentum.)

Momentum is a measure of how much power and motion a moving object has. The greater an object's mass, the greater its momentum will be. A shot used in shotput, for instance, is very heavy. The heavier the shot (or, in technical terms, the greater its mass), the greater its momentum will be, given a constant release velocity. Think of a shot of a given mass, thrown at different velocities. The faster the shot travels, the greater its momentum.

Momentum can be increased or decreased by increasing or decreasing mass or velocity. For example, in a game of tenpin bowls, one player may have a heavier ball than another. If both bowls are released at the same velocity, the heavier bowl will have the greater momentum at impact. It will therefore scatter the pins more dramatically.

In a game of rugby union, a player of a given mass can change momentum by changing velocity. Different players, however, have varying masses. Heavier players will have greater momentum at the same velocity than lighter players. On the other hand, a small, fast-moving player can have the same momentum as a slow, massive player.

Consider the athletes in Figure 6.2.

The momentum of Athlete 1 is:

$$\begin{aligned} M &= mv \\ &= 75\text{kg} \times 2\text{m/s} \\ &= 150\text{kgm/s} \end{aligned}$$

The momentum of Athlete 2 is:

$$\begin{aligned} M &= mv \\ &= 50\text{kg} \times 3\text{m/s} \\ &= 150\text{kgm/s} \end{aligned}$$

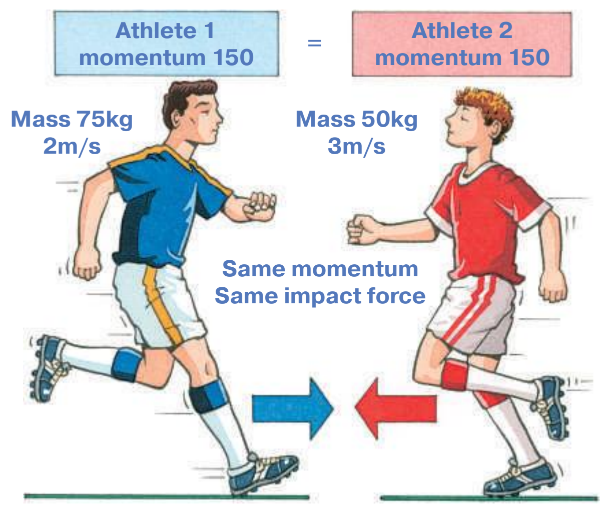


Figure 6.2 The momentums of two athletes with different masses travelling at different velocities.

Conservation of linear momentum

When an object is moving, it has momentum. As long as no external force is applied to increase or decrease the velocity of the object, its momentum is said to be conserved (saved).

Newton's cradle demonstrates this concept (Figure 6.3). The red ball on the left swings into the first silver ball. The red ball stops, instantly transferring its momentum through the three silver balls and into the red ball on the right. The red ball on the right swings up to the same level as the starting ball. Momentum has been transferred and conserved.

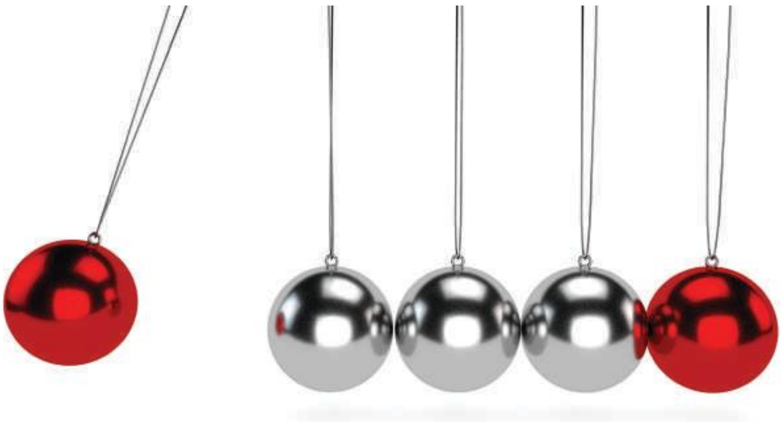


Figure 6.3 Newton's cradle demonstrates transfer and conservation of momentum.

True **conservation of momentum** occurs only in theory, because there are always other forces acting on a moving object. At the very least, a moving object is slowed down by the force of air resistance. But when a shotput athlete puts the shot, the effects of air resistance may be negligible. The heavy mass of the shot, relative to its surface area, enables it to easily push the air aside. In a put of just over 18 metres, approximately 5 centimetres is lost because of the slowing effect of air resistance. We could say that the momentum of the shot is almost totally conserved.

conservation of momentum the preservation of energy or momentum in a moving body or in a collision between two objects

In a collision between two players, or between a player and an object, conservation of momentum also applies. For example, a rugby union player with a large body mass and running at high velocity has a high momentum. In a collision with a stationary defender, the momentum of the attacker doesn't just disappear. Instead, some momentum is transferred to the defender and some retained by the attacker. The defender will probably be thrown backwards, and the attacker will continue to travel forwards, but with a decreased velocity. Whatever happens, the total momentum before the collision will equal the total momentum after the collision.

The momentum built up by a runner is, in reality, mainly not conserved. It's reduced by air resistance, and by the friction between the runner's feet and the ground (see Figure 6.4). If the aim is to keep momentum constant, a runner has to continue applying force with their legs to make up for the loss of momentum due to air resistance and friction.

Figure 6.4 The momentum of a runner is continuously reduced by air resistance and friction.

Impulse

impulse
change in momentum that occurs when force is applied over a given time

Impulse is the change of momentum that occurs when a force is applied to an object, such as when a bat hits a ball, or a diver hits the surface of the water. For example, when a field hockey player pushes a dead ball, the ball's momentum will change from zero to a given momentum before it leaves the stick. The change of momentum that occurs while the ball is in contact with the stick is known as the 'impulse', and is calculated using the following formula:

$$I = Ft$$

where I = impulse, F = force and t = time.

Impulse occurs in any pushing, striking or throwing skill in which a player changes the momentum of an object. The momentum of the object can therefore be changed by varying the force applied or the length of time it is applied or both. For example, by keeping the ball in contact with the stick for the longest possible time, the hockey player can apply force for a longer time and maximise the ball's impulse.

When a tennis racquet hits a tennis ball, the collision is over in an instant. For the racquet to impart maximum force and a large change of momentum to the ball, the tension of the strings must be such that they are fully restored to their original position at the moment the ball leaves the racquet. The ball must also be fully restored to its original shape at the moment it leaves the strings. This time period between the racquet hitting the ball and the ball leaving the strings must be just right, or optimal, to apply the maximum impulse.

Impulse in design: the clap skate

The concept of impulse underlies the development of hinged 'clap' skates, which have replaced fixed blade skates in long-track speed skating (Figure 6.5).

At the end of the push-off, the back of a fixed blade skate would lift off the ice as the heel lifts. The clap skate has a spring hinge between the blade and the boot, so that when the foot lifts, the blade stays in contact with the ice fractionally longer and force can be applied for a longer time. This maximises the impulse given to the skater.

When the blade finally leaves the ice, it snaps up underneath the boot, making the noise that gave it the name 'clap' skate.

Figure 6.5 A speed skater on clap skates

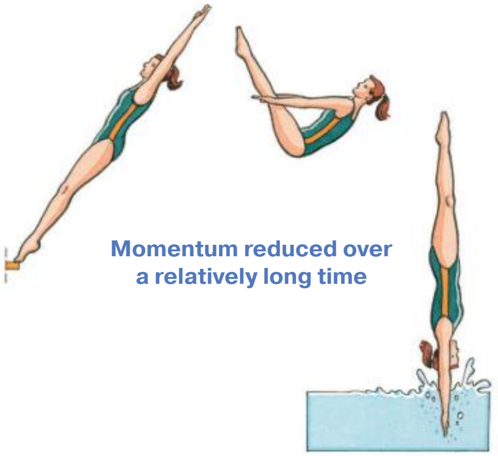
Impulse in action: diving and boxing

Consider a diver who's performing a back dive with somersault from the 3-metre board (Figure 6.6). On impact with the water, the diver experiences an impulse that will eventually bring the momentum back to zero. It's therefore important to use a splash-less entry technique, such as the 'rip entry'. Such an entry creates a hole in the water so that momentum can be dissipated gradually. The yielding nature of the water ensures that the diver doesn't experience an unpleasant amount of force on impact with the water.

A boxer who receives a blow to the head (Figure 6.7) may experience the same impulse as the diver. In this case, though, the time the blow takes much less time and the amount of force applied in that time has a more dramatic effect on the recipient. If the boxer doesn't have time to sway away from the stinging jab, the total force is received in a very short period of time, resulting in an almost instantaneous change of momentum. In this case, an injury may be sustained.

Figure 6.6 A diver hitting the water experiences an impulse over a relatively long period of time.

Figure 6.7 A boxer receiving a blow to the head experiences an impulse over a very short period of time.



6.1 Check your understanding

1. Define momentum and how it can be transferred and conserved.
2. What is an impulsive force?
3. Summarise the interplay between force and time variables.

Apply and analyse linear momentum

LEARNING EXPERIENCE

Momentum

1. Drop a shot and a softball from a height of 1 metre into a tray of sand or onto a soft surface. What was the order in which they hit the sand?
2. Now drop a shot and a squash ball from a height of 1 metre into the tray of sand or soft surface:
   a. What was the order in which they hit the sand?
   b. Was the velocity (speed) of each object the same?
   c. Which object had the greatest momentum and created the greatest collision effect?
   d. What was the property of each object that contributed to the greater collision effect?
3. Consider two shots with the same mass. If one is dropped from a greater height, which factor will contribute to the greater momentum of this shot at impact?

Momentum transfer and conservation

1 Figure 6.8 shows a rugby union fullback defending the ball and colliding head on with a rampaging forward:
   - **a** What is the momentum of each player just before the collision?
   - **b** What would be the total momentum in the collision?
   - **c** What would be the likely outcome of the collision?
   - **d** Ignoring ground or foot forces, would the total momentum in the collision be conserved?

Figure 6.8
A rugby forward and fullback about to collide

2 A soccer player kicks a ball of mass 0.5 kilograms with a leg/foot velocity of 5 m/s and effective leg and foot mass of 2 kilograms. Assume that no energy is lost during impact:
   - **a** What is the momentum of the foot just before impact with the ball?
   - **b** What is the momentum of the ball just after impact?
   - **c** What is the velocity of the ball just after impact?
   - **d** Using the formula for momentum (mass × velocity) describe two means by which the player could increase the velocity of the ball.
   - **e** Has the total momentum in the collision been conserved?

6.2 Summing momentum

As you've seen, momentum can be used to an athlete's advantage in collision or impact situations, or when developing velocity in particular body parts.

When an athlete needs just a small amount of momentum to accomplish a task, the number of body parts moved should be kept to a minimum. For example, the small amount of momentum required for putting in golf is supplied by more than just moving the arms and hands.

But in activities such as the javelin throw, or throwing a cricket ball from the outfield, maximum momentum is required. The whole body needs to contribute, with the momentum of different parts of the body summed (added together) to achieve the highest possible velocity.

Stabilisation

It's not enough to just generate momentum – that movement has to be transferred effectively into the appropriate action.

Consider a javelin run-up. The momentum generated by the run has to be transferred effectively into a throwing action at the moment the javelin thrower props in the final stride. The leading leg is set in position and stabilised so that it doesn't move further until after the release of the javelin (Figure 6.9).

Figure 6.9 Kathryn Mitchell of Australia competes in the Rio 2016 Olympic Games; notice her stabilised straight leg.

stabilisation the setting of the base of support as a foundation for the summing of momentum

This **stabilisation** is essential, not only to avoid fouling the throw line, but to enable the transfer of energy from the run-up into the athlete's body. Once in this stabilised position, the body has a solid pivot around which maximum momentum can be generated by all available body parts.

Stabilisation is a necessary element in all throwing and striking skills. As well as maximising the momentum of the object being thrown or struck, stabilisation holds the different parts of the body accurately in position. For example, a tennis player wishing to minimise leg movements and optimise accuracy in a backhand slice will stabilise in the flexed leg position. This also provides a basic height setting for the skill, as the flexed leg in this case permits a flatter return.

You can remember the sequence of stabilisation using the Step-Stop-Stabilise mnemonic (Figure 6.10).

Figure 6.10 The Step-Stop-Stabilise sequence

Contributory body parts

After the body is stabilised, the total momentum in a throwing or hitting action is the sum (total) of the individual momentums of different body parts. Generating high momentum is of critical importance in developing maximum ball or implement velocity.

To generate maximum momentum in an object being thrown or hit, as many body parts as possible must be used. For example, in a softball pitch the body parts contribute to the action in the following sequence: hips, spine, shoulders, upper arm, forearm and wrist. In a golf power swing, bending the lead arm in the downswing will add an additional segment and potentially produce greater momentum, but this may be at the expense of accuracy.

Optimum stretch

As each body part is brought into play in a throwing or hitting action, the muscles involved must be stretched to optimal length. For example, when the trunk rotates to the front in a softball pitching action, the muscle attached to the humerus (the pectoralis major) is stretched. Positions of **optimum** stretch allow the pitcher to contract the muscles with maximum force.

optimum
the best or most favourable amount

Sequence of body parts

To generate maximum momentum, the smaller body parts that are capable of moving fast (such as the arms and hands) must be used last in the sequence. But the larger, slower parts that move earlier in the sequence (such as the hips) play an important role in generating large amounts of momentum. The smaller parts feed off this momentum later in the sequence to produce fast, dynamic movements.

Optimum contribution of body parts

It's important that each body part makes its optimum contribution at exactly the right time, before the next body part begins to move. For example, in a softball pitch or overarm throw, the hips must rotate as far as possible to the front before the next part – the trunk – begins its rotation to the front.

Range of motion

To achieve maximum velocity of the object being thrown or hit, the body parts must track over the greatest possible range of movement. For example, the more body parts that contribute to a tennis backhand, the greater the range of motion of the last segment – the lower arm and racquet (see Figure 6.11). The greater the range of motion of the lower arm and racquet, the higher the velocity of the racquet head when it connects with the ball.

Figure 6.11 To achieve maximum velocity in a tennis backhand, Roger Federer uses the greatest possible range of movement for his lower arm and racquet.

6.2 Check your understanding

1. In summing momentum, what role does stabilisation play in setting the base of support?
2. After setting the base of support, what factors contribute to the final release or take-off velocity?
3. Describe the optimal sequence of body part movement for generating and transferring momentum in a pitching motion.

Apply and analyse
summing momentum

LEARNING EXPERIENCE

1 Select a skill with sequential actions such as throwing, striking or kicking. Observe or film a partner performing the skill.
2 Determine the phase of setting the base using the sequence Step-Stop-Stabilise. Identify the body parts involved and describe the action of the parts.
3 After the base is set, momentum is summed in order to deliver the highest velocity at impact or release. Name the body parts that generate this momentum in the correct sequence, large to small.

Summing momentum

INTEGRATING MOVEMENT

Category: All
Physical activity: Various

Purpose

1 This activity involves measuring the effects of summing body momentum.
2 This activity involves five separate activities, which need to be performed in order.

Preparation

Time: one lesson
Location: gymnasium or similar environment
Equipment: tennis balls or beanbags; measuring tape or wheel; recording tables

Setup

1 Get into groups of four.
2 Allocate members to four roles: throwing, measuring, recording and retrieving.

Activity 1 Performance

1 The thrower takes up a long sitting position (legs flat in front) against a wall, keeping their shoulders and hips tight against the wall.
2 The thrower's task is to throw a tennis ball or a beanbag with maximum effort and over the greatest possible distance. Keep the angle of release as consistent as possible, using a hoop or other height marker.
3 The measurer measures the distance of the throw.
4 The recorder records the distance of each throw.
5 The retriever retrieves the balls.

Activity 2 Performance

1. The thrower moves one metre away from the wall, but remains in a long sitting position.
2. This time, the thrower rotates their shoulders and arm back as far as possible to make the throw, but keeps their body upright, not leaning back. They throw the ball using their shoulders and arm only.
3. The measurer, recorder and retriever repeat their tasks.

Activity 3 Performance

1. The thrower moves two metres away from the wall and stands square to the direction of the throw.
2. The thrower rotates their hips and shoulders as far back as possible to make the throw. Their feet must remain in contact with the ground and must not twist around. They throw their ball using the hips, shoulders and arm only.
3. The measurer, recorder and retriever repeat their tasks.

Activity 4 Performance

1. The thrower stands two metres away from the wall, side-on to the direction of the throw, with the feet shoulder-width apart and the back knee straight.
2. To make the throw, the throwers rotate their trunk as far back as is comfortable. They throw the ball using their hips, shoulders and arm, but makes sure that their body weight has been transferred forward before the arms begin to move. Both feet should remain in contact with the floor throughout the throw.
3. The measurer, recorder and retriever repeat their tasks.

Activity 5 Performance

1. The thrower repeats Activity 4, but now takes a step forward and throws the ball. Their back foot should be free to move or slide forward during the throw.
2. The measurer, recorder and retriever repeat their tasks.

Data recording

DE 1

1. The recorder captures all data for this activity as described.
2. All data should be shared with the group once the performance is completed.

Tasks

DE 3

1. Analyse the primary data for each of the five different performances and describe any trends that are evident.
2. Classify the data according to the number of body segments used in each performance.
3. Discuss the relationship between the momentum achieved in each throw and the number of body parts used.
4. Propose an optimum sequence of body parts through a movement that will generate the greatest momentum. DE 4
5. Predict why the side-on position permits greater force production. Justify your response, using primary and secondary data.

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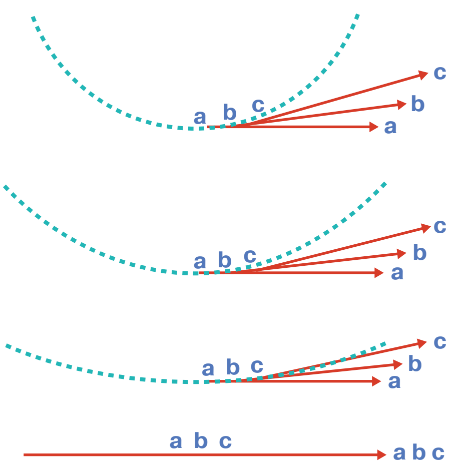
6.3 Accuracy

When hitting or throwing any object, maximising momentum and velocity must always be balanced by the need for accuracy. In general, accuracy can be broken down into two components: height accuracy and sideways accuracy. Both must be achieved to ensure maximum target accuracy.

Height accuracy

Height accuracy in a throw or hit can be achieved if release or impact is made at any point on a straight or direct line to the target (see Figure 6.12). If the hand in a throwing action can be made to move in a straight line towards the target, then it doesn't matter where the ball is released on that line – the ball will fly to the target at the correct height.

In a hockey drive, where body parts and the hockey stick rotate around an axis to generate momentum, height accuracy is more difficult to achieve than in a throw (see Figure 6.13). Nevertheless, the player can still achieve height accuracy if the ball is hit at one precise point at the middle or bottom of the swing arc. Contact at this point sends the ball off on the correct horizontal pathway along the ground.



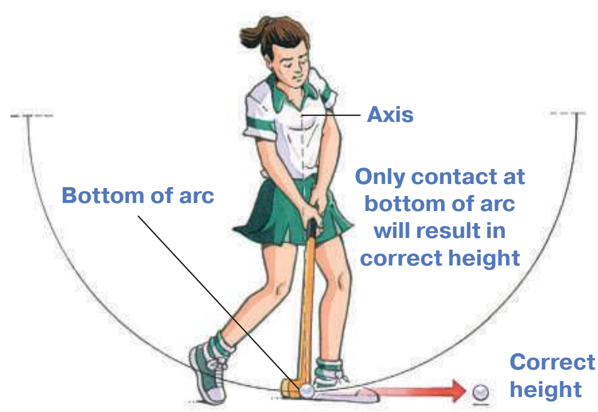


Figure 6.12 The relationship between point of impact of a hit, or release of a throw, and the ball reaching the target at the correct height

Figure 6.13 Achieving height accuracy in a hockey drive

The need to hit the ball at a precise point at the bottom of the swing arc leaves little margin for error. The player can obtain better results if the stick travels in a flatter horizontal pathway just before and through impact, such as by flattening the arc of the swing. The stick will contact the ball at many points on the flattened section of the 'arc' and still achieve optimum height accuracy.

Sideways accuracy

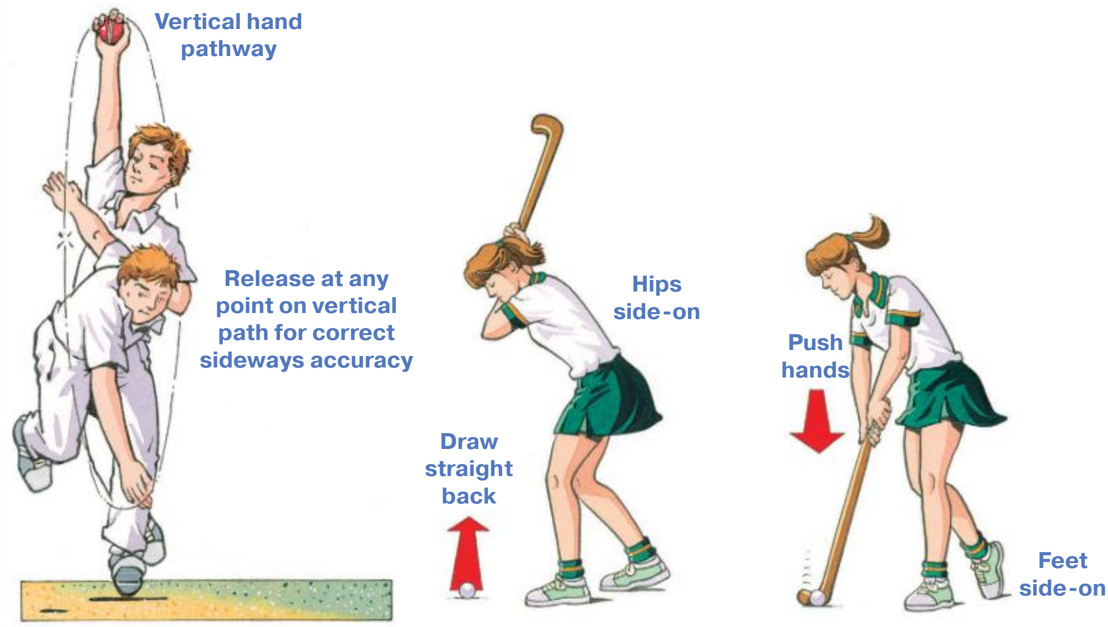
Sideways accuracy can be achieved if the arc of the swing is kept in vertical alignment with the target. This can be achieved easily in the cricket bowl (see Figure 6.14).

In other skills, such as the hockey drive (see Figure 6.15), the rotational movements of the body make sideways accuracy much more difficult to achieve. However, it can be achieved in these situations:

- the ball is hit at one precise point at the middle or bottom of the swing arc, when the stick is travelling in the correct direction
- the player keeps the stick in its optimal alignment just before and during impact, to minimise any movement inside or outside the line of the swing
- the face of the stick is square relative to the target so that the ball is hit through the desired line.

Figure 6.14 Achieving sideways accuracy when bowling a cricket ball

Figure 6.15 Achieving sideways accuracy in a hockey drive



6.3 Check your understanding

1 Explain how flattening the arc of the swing contributes to overall target accuracy.
2 Describe the factors that contribute to sideways accuracy in a throwing or bowling action.
3 What do you need to achieve to ensure the greatest height accuracy when throwing or striking?

6.4 Newton's Law of Inertia

In Chapter 4 you considered Isaac Newton's Second and Third laws of motion. Now it's time to consider his First Law, the Law of **Inertia**, which states that:

> *A body will continue in its state of rest or uniform motion unless acted upon by an applied force.*

inertia
the degree of difficulty in getting an object to move or stop

Inertia refers to the degree of difficulty in getting a stationary object to move, or a moving object to stop. It's related to an object's mass. The heavier the object, the more difficult it is to get that object to move, or to stop it when it's moving. On the other hand, the lighter the object, the easier it is to get that object to move, or to stop it when it is moving.

Inertia affects many aspects of sport. For example, when a soccer ball becomes wet, its additional mass gives it higher inertia. This will make it more difficult for players to:

- start the ball moving when it's stationary
- slow the ball down or speed it up when it's already moving
- stop the ball when it's moving.

In futsal (indoor soccer), where the game is played in a confined area, players use a smaller, lighter ball with lower inertia than a normal soccer ball. This makes it easier for players to change the motion of the ball.

Rotational inertia

A body's inertia is its resistance to change of motion and is directly related to its mass. If the motion is rotational (turning around an axis), not only the object's mass has to be considered, but also the distance of the mass from the axis of rotation. Examples of rotational motion are swinging around a gymnastics bar, swinging a golf club and the hammer throw (see Figure 6.16).

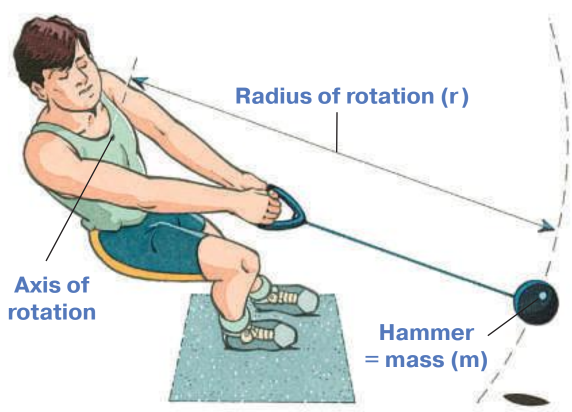


Figure 6.16 The rotational inertia of the hammer is determined by its mass and its radius of rotation.

rotational inertia a body's resistance to change due to its mass and its radius of rotation

The **rotational inertia** of an object is determined by its mass and its radius of rotation. It can be calculated using the following formula:

$$I = mr^2$$

where I = inertia, m = mass and r = radius of rotation.

Mass

The larger the mass of an object, the greater its resistance to rotational movement, and the greater its persistence once it does start moving. For example, a heavy cricket bat will have higher rotational inertia and be more difficult to swing than a light cricket bat, but once it starts moving it will be more difficult to stop.

Radius of rotation

The further the mass of an object is distributed away from the axis of rotation, the greater its resistance to rotational movement, and the greater its persistence once it does start moving. For example, the axis of rotation of a cricket bat is where the hands grip the bat. The further the mass of the bat is distributed away from the hands, the harder the bat will be to swing. If the bat is weighted more at the end than near the handle, it will be more difficult to swing than a bat of the same mass that is not weighted at the end. If a player 'chokes the grip' by dropping their hands further down the handle, this brings the mass closer to the axis of rotation and makes the bat easier to swing.

Figure 6.17 demonstrates a perfect 'low rotational inertia' twist of the human body. Former Australian gymnast Lauren Mitchell is fully extended with her head slightly back. Notice her clasped hands and elbows held in, together with overlapping big toes to ensure a tight body position around the long axis of her body. Body mass in this instance is not as important as its distribution around the long axis. Gymnasts, divers and acrobats may therefore be assisted by having smaller body frames but maintaining a high power-to-weight ratio.

Figure 6.17 Lauren Mitchell performs a 'low rotational inertia' twist.

Changing rotational inertia

As mass is difficult to adjust, changes in the rotational inertia of an object are usually made by adjusting the radius of rotation. In most sports, you can make radius adjustments whenever you wish during the performance of a skill. For example, a spinning ice skater can increase the radius of rotation by extending their arms (see Figure 6.18), and a cricket batsman can reduce the radius of rotation by moving their hands down the grip.

Mass changes can be made only by using objects of different mass (such as a heavier softball bat) or, in the case of parts of the body, by changing muscle bulk over an extended time.

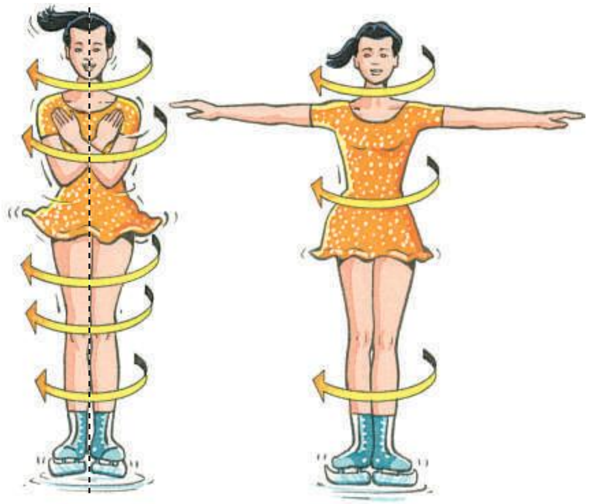


Figure 6.18 A skater spinning with arms outstretched has a higher rotational inertia than when spinning with their arms clasped across their chest.

High rotational inertia

A body with high rotational inertia has the following characteristics, although not all of these may have a practical application within one specific sports skill:

- it's resistant to changes in rotational motion (a rotating hammer thrower)
- it's steadier (a skater spinning with arms extended)
- it's hard to accelerate and decelerate (a golf club at the beginning of the backswing)
- it's slow-moving (a layout somersault compared to a tuck somersault)
- it's hard to stop (a swinging softball bat just before impact with the ball).

Figure 6.19 Taylor Worth competing at the Rio Olympics; the weighted rods on his bow are stabilisers that reduce tremor.

Increasing rotational inertia affects many aspects of sport. In archery (see Figure 6.19 on the previous page), weighted rods or stabilisers on the bow increase the rotational inertia of the bow by taking the mass further away from the axis point at the shoulders. The total mass is also greater, increasing the rotational inertia and dampening any rotational motion in the bow. This reduces tremor and steadies the bow.

A golf club's mass is concentrated approximately in the middle of the clubhead. When the club is extended just before impact, it has high rotational inertia and resists changes in motion. Its momentum will be maintained and it's unlikely to deviate from its chosen pathway, which makes for a more forceful and accurate shot.

Low rotational inertia

A body with low rotational inertia has the following characteristics, although not all of these may have a practical application within one specific sports skill:

- it's responsive to change in rotational motion (a runner's flexed recovery leg)
- it's less steady (a gymnast pirouetting on the Olympic beam)
- it's easy to accelerate and decelerate (a child's cricket bat, compared to a full-size bat)
- it's fast-moving (an ice-skater spinning in a tuck position)
- it's easy to stop (a spinning golf ball with greater mass in the core than on the softer cover).

Many sports skills use decreasing rotational inertia to advantage. In almost every case, rotational inertia is decreased by drawing the mass closer to the axis of rotation.

For example, an ice-skater moving into a spin quickly brings their limbs as close as possible to the long axis of rotation, which in this case is a line drawn through their body from head to toe (see Figure 6.18). The result of this decrease in rotational inertia will be a much faster spin rate and a greater number of rotations.

In a more complex example, a bowler in cricket quickly snaps their non-bowling arm into their chest, reducing the length of the arm and shoulder lever, and thus the radius of rotation (see Figure 6.20). This results in faster shoulder rotation, so the bowling arm has a higher rotational velocity.

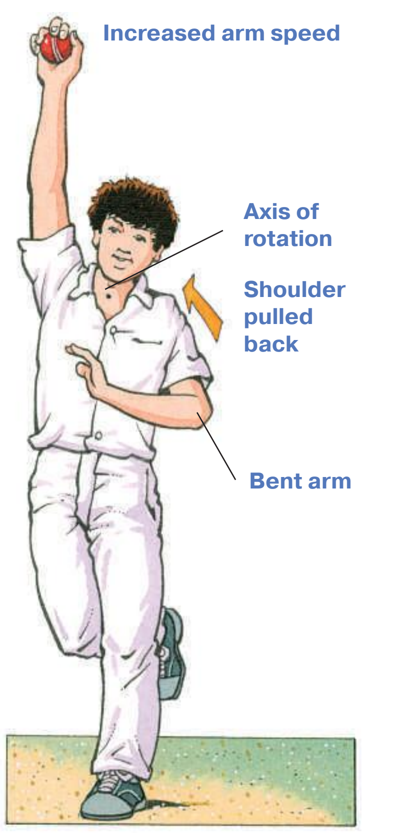


Figure 6.20 A bowler bends their non-bowling arm into their chest to increase the rotational velocity of their bowling arm.

Squared effect

In the formula for rotational inertia ($I = mr^2$), the radius of rotation is squared. This means that changes to the radius result in more dramatic velocity changes than changes to mass.

For example, when a baseball pitcher throws the ball from the infield over a relatively short distance, their throwing arm is flexed. Using easy numbers, if the length of the arm is reduced by half, then the rotational velocity of the arm will increase four times (see Figure 6.21). In situations where velocity is crucial, this technique is very important.

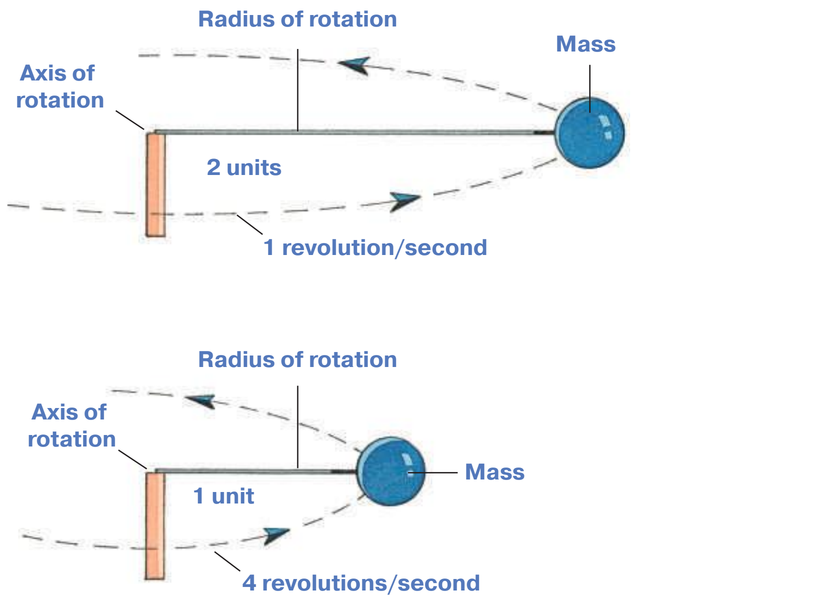


Figure 6.21 Reducing the radius of rotation from 2 units to 1 unit decreases rotational inertia by a factor of 4 and increases velocity by a factor of 4.

Levers

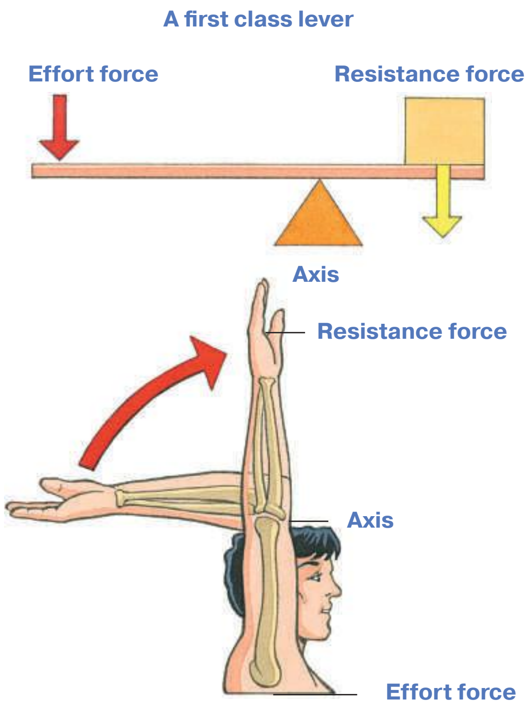
A **lever** is a rigid rod that rotates about a fixed point or axis. Levers are used to move loads and produce rotation of a body segment. A lever is acted on by two forces: an effort force and a resistance force. There are two lever arms: the effort arm and the resistance arm.

lever
a rigid rod or body segment that rotates around an axis

There are three types of levers:

- first-class levers, in which the axis is located between the effort force and the resistance force (Figure 6.22)
- second-class levers, in which the resistance force is located between the effort force and the axis (Figure 6.23)
- third-class levers, in which the effort force is located between the resistance force and the axis (Figure 6.24).

Third-class levers have a long resistance arm that improves the lever's speed of movement. They are the most common type of lever used in sport, because the levers used in sport are musculoskeletal. The muscle provides the effort force, and the relevant joint is often the axis. The muscle attachments are closer to the joint axis than the resistance force.



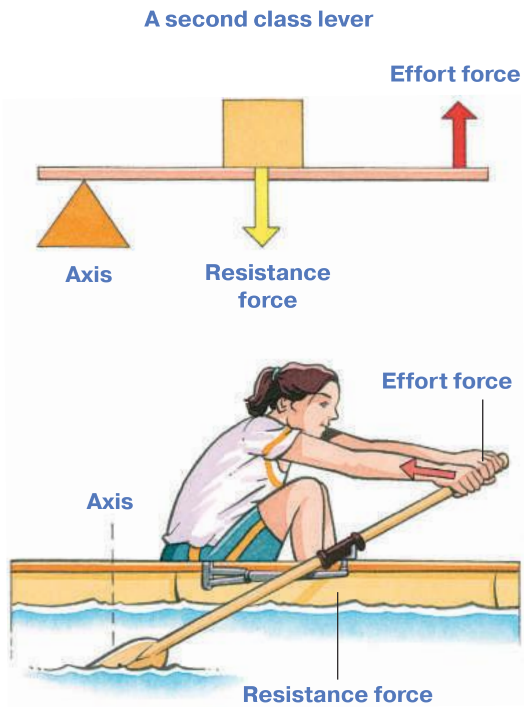


Figure 6.22 The arm acts as a first-class lever in a basketball lay-up.

Figure 6.23 In rowing, the oar is a second-class lever.

The longer the resistance arm, the greater the velocity of the lever, as long as the increased weight of the lever is manageable. An athlete gains an advantage because of the increased range of motion, especially if the weight of the lever is relatively light. For example, an aluminium softball bat can be longer than a wooden bat, but still retain its lightness because it's hollow. Its length and smaller mass allow the batter to get the bat to the ball more quickly.

Inertial velocity and leverage

There are differences between the high velocities generated from decreasing an object's rotational inertia and the high velocities generated at the end of a longer lever.

For example, the lever in a golf swing consists of the upper body, the arms and the club. At the beginning of the downswing, the lever is shortened by flexing the wrists. The whole lever now has a high rotational velocity due to its decreased rotational inertia (see Figure 6.25), but the head of the club may not be travelling at high velocity. The lever becomes longer as it unhinges and straightens just before impact with the ball. This longer lever produces progressively higher velocities at the end of the lever as the whole lever straightens, even though the increased rotational inertia may not alter the swing velocity of the whole lever unit.

In the golf swing shown in Figure 6.25, the addition of the club lever (between points B and C) to the arm lever (between points A and B) doubles the total length of the lever. This means that the clubhead travels double the distance travelled by the hands in the same time, effectively doubling its velocity. In an efficient swing, the wrists open just before impact, whipping the clubhead through an even greater distance and causing further velocity increases.

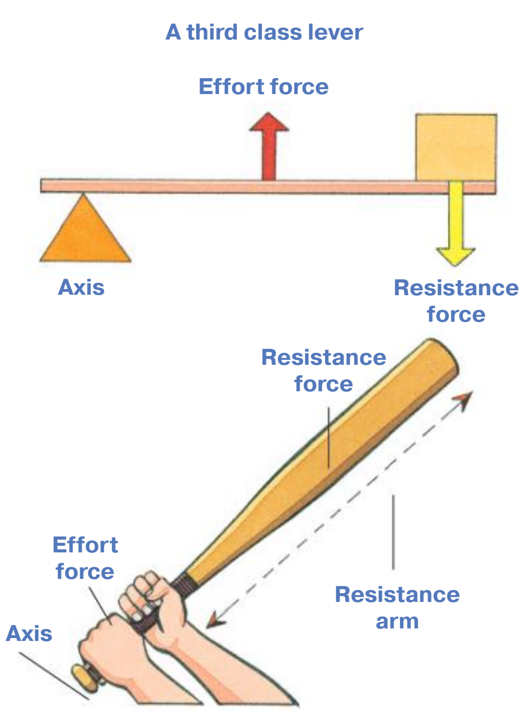


Figure 6.24 The baseball bat is used as a third-class lever.

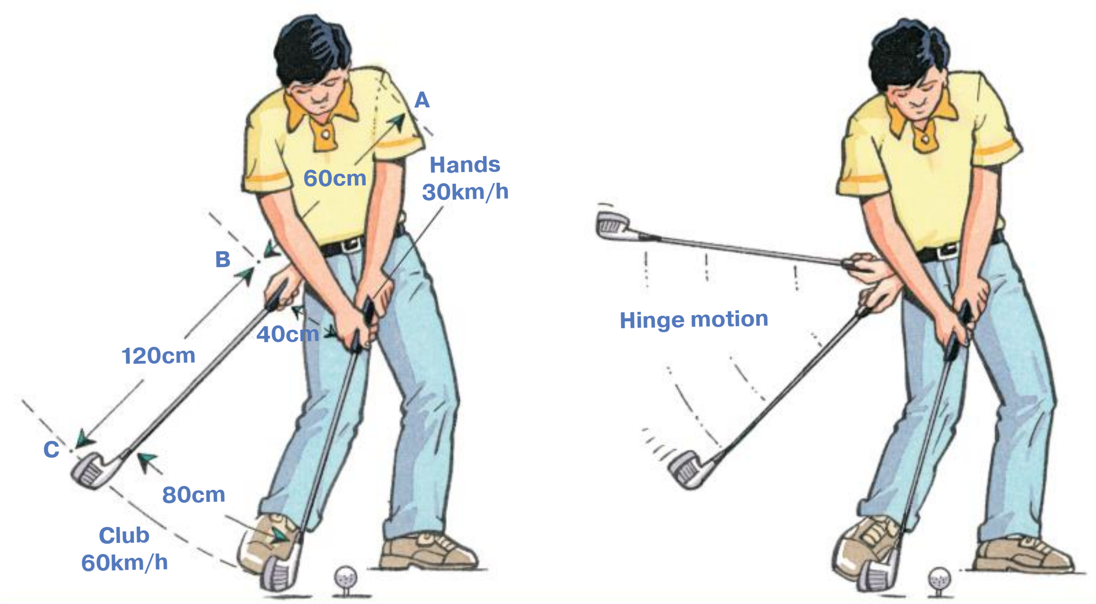


Figure 6.25 Inertia, velocity and leverage in a golf swing

Check your understanding 6.4

1. Explain how Newton's Law of Inertia affects the motion of an object.
2. What variables determine the rotational inertia of an object?
3. Describe how to use levers such as body segments to change the rotational inertia of an object.

Apply and analyse
changing rotational inertia

LEARNING EXPERIENCE

This activity should be performed in a space with a hard floor.

1. Get into groups of three; each group needs a swivel chair.
2. Divide the group into three roles: sitter, spinner and recorder.
3. The sitter sits in the chair in the following positions:
   - **a** arms folded; legs drawn into the base of the chair
   - **b** legs drawn into the base; arms abducted (spread) and extended to the side
   - **c** arms folded; legs extended
   - **d** arms abducted and extended to the side; legs extended.
4. For each position, the spinner pushes hard on the back of the chair so that it rotates. (It may be worth a trial push to make sure you don't push too hard and overturn the chair.)
5. For each position, the recorder counts and records the number of turns (revolutions) the chair makes after being pushed.

After spinning in all four positions, share the data with the group and answer the following questions:

1. Which position accounted for the most number of turns?
2. What position accounted for the least number of turns?
3. Was there the same difference between all four positions?
4. Suggest which position would account for the slowest rotation or least number of turns: arms extended or legs extended. Justify your reasoning.
5. Describe the rotational inertia as high, low or medium for each position, and explain your reasoning.

6.5 Angular momentum

Linear momentum, as the name implies, is a quality of an object moving in a straight line. A rotating object also has momentum, but not linear momentum, because it's not moving in a line. Instead it has angular momentum (also called rotational momentum), which is a measure of the momentum of its rotation. Angular momentum is based not on the object's mass but on its rotational inertia, which reflects both mass and the radius of rotation.

Changes in an object's linear momentum are normally the result of changes in velocity, as its mass remains constant. However, changes in angular momentum (also called rotational momentum) may occur not only due to changes in angular velocity, but also due to changes in the distribution of mass around an axis point, which changes its rotational inertia. Angular momentum can be calculated by using the following formula:

$$L = I\,\omega$$

where L = angular momentum, I = rotational inertia and ω = angular velocity (ω is the Greek letter omega; you write it like a curvy 'w').

A diver performing a forward tuck somersault (see Figure 6.26) can't change the angular momentum of their body after take-off. This is because the force used for the dive is generated by pushing against the diving board; in mid-air, there's nothing to push against to create a force. While the body's angular momentum can't change, it's possible to change its rotational inertia, which will in turn change its angular velocity. The diver's rotational inertia increases when their whole body is extended, in a layout position in a somersault.

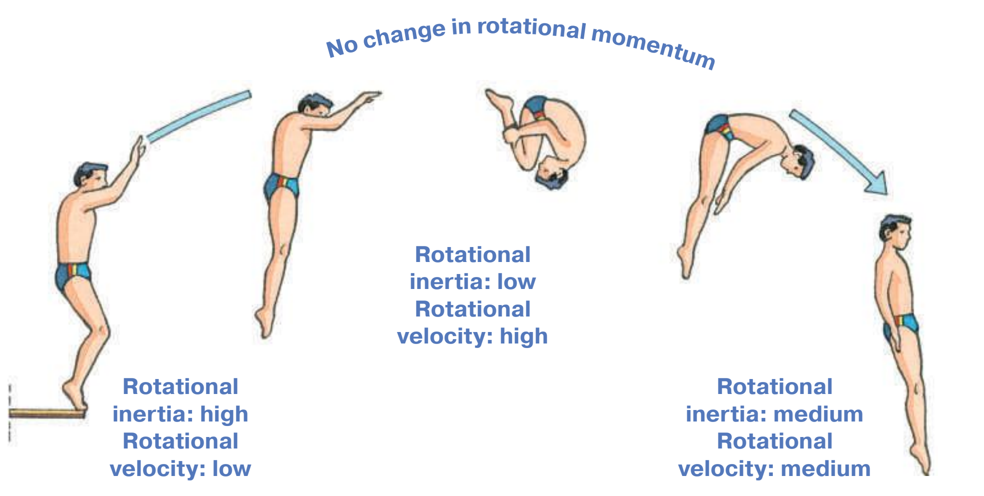


Figure 6.26 Rotational momentum during a forward tuck somersault dive

A gymnast performing a tsukahara vault (see Figure 6.27) must apply a large force at take-off to generate enough linear momentum to carry their body over the required distance before landing. A forward lean at take-off will also initiate an angular momentum that remains constant until the gymnast applies a further force on push-off from the horse:

- In position 2, during pre-flight, the extended body has a high rotational inertia around the centre of gravity and a low rotational velocity, with the angular momentum remaining constant.
- In position 3, the gymnast pushes off from the horse, increasing the angular momentum, which then remains constant during post-flight until landing.
- From position 4 to position 5, the rotational inertia decreases and the rotational velocity increases, with no change in the angular momentum.
- When the gymnast lands, all angular momentum is lost.

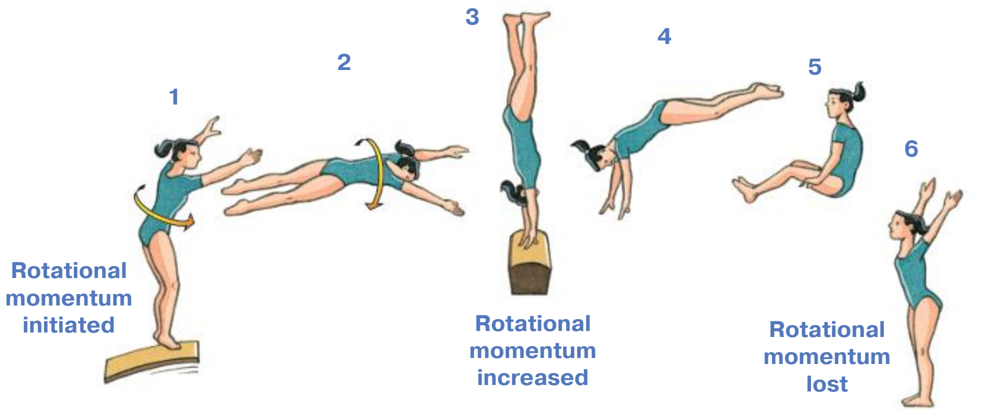


Figure 6.27 Rotational momentum during a tsukahara vault

Conservation of angular momentum

Like linear momentum, angular momentum is conserved until a force, such as contact with the floor, is applied to change it. In real-world movements, a small amount of angular momentum is lost because of air resistance, but the remainder is conserved.

In the example of the tsukahara vault, angular momentum is initiated at take-off and conserved in pre-flight. During the push-off from the horse, angular momentum increases, and that new level of angular momentum is conserved in post-flight. During landing, all angular momentum is lost. Remember that in post-flight there may be changes to rotational inertia and angular velocity, but angular momentum will be conserved.

6.5 Check your understanding

1. Describe the factors that account for changes in angular momentum.
2. Under what conditions can angular momentum be conserved?
3. Explain how to calculate angular momentum.

Engage and understand
creating and conserving angular momentum

LEARNING EXPERIENCE

In this activity, you will demonstrate both angular momentum and its conservation.

Equipment

- a hollow cylinder or cone (such as a Styrofoam cup)
- a piece of string with small weights (such as several washers) tied to the end

Attach the weights securely to the string. Do not swing the weighted string near any other people.

Task 1

1. Thread the weighted string through the cylinder.
2. Hold the cylinder with one hand and use the other hand to hold the non-weighted end of the string.
3. Start the weight rotating. You have now generated energy or angular momentum.
4. Pull down on the string, away from the cylinder, to draw the weight towards the cylinder, shortening the rotating length of string.

Questions

1. When you pull on the string, you shorten the length of the string and don't generate more energy. Has the angular momentum of the rotating weight changed? Explain why or why not.
2. Has the angular velocity of the weight changed? Why or why not?
3. Has the rotational inertia of the weight changed? Why or why not?
4. Describe the relationship between angular velocity and rotational inertia that keeps the angular momentum of an object the same.
5. Is this an example of conservation of angular momentum? Explain your response.

Task 2

1. Hold the string close to the cylinder, so that the weight is suspended on a long length of string.
2. Start the weight swinging from side to side in a wide arc (but not right round), like a pendulum.
3. Quickly pull down on the string, away from the cylinder, to draw the weight towards the cylinder.

Questions

1. Describe what happened to the speed of the weight when you pulled in the string.
2. Describe how have the rotational inertia and angular velocity have changed.
3. Has the angular momentum changed?
4. Has the angular momentum been conserved?

Chapter review

[6.1] Momentum is the product of mass and velocity, and implies a quantity of motion in a straight line. It is expressed by the formula $M = mv$. Momentum can be transferred from one body to another and conserved as long as no external force is applied. Impulse is the change of momentum that occurs due to the manipulation of force and time.

[6.2] Summing momentum involves having muscles on optimum stretch, sequencing body parts in the correct order and tracking them over the greatest range of motion. Stabilisation is essential in setting the base of support for a throw, strike or jump.

[6.3] Increasing momentum can impact accuracy, so movements need to take both factors into account. Flattening the arc of a swing creates a flatter horizontal pathway for an implement. Sideways accuracy is enhanced by keeping the arc of a swing in a vertical pathway.

[6.4] Newton's Law of Inertia states that a body will continue in its state of rest or uniform motion unless acted upon by an applied force. Inertial velocity can be changed by increasing or decreasing the length of a lever – a rigid rod that can be rotated around an axis and can be classified as first-, second- or third-class.

[6.4] Rotational inertia is the product of an object's mass and radius of rotation, expressed by the formula $I = mr\omega$. It is most commonly changed by altering the length of a lever, usually a body segment.

[6.5] Angular momentum is the product of rotational inertia and angular velocity and is expressed by the formula $L = I\omega$. It is conserved unless impinged upon by an external force.

Review questions

Section A: Multiple-choice questions

1 In the human body, the lever system that promotes speed and range of motion is primarily which class?
- **a** first
- **b** third
- **c** second
- **d** no specific class

2 Inertial speed refers to which of the following?
- **a** decreasing rotational inertia
- **b** increasing rotational inertia
- **c** slowing the rotation of body movements
- **d** increasing the length of the lever

3 When the length of a rotating lever is doubled (lengthened by a factor of 2), which of the following statements would be true?
- **a** Rotational inertia decreases by a factor of 4.
- **b** Rotational velocity increases by a factor of 2.
- **c** Rotational momentum increases by a factor of 4.
- **d** Rotational inertia increases by a factor of 4.

4 Which variable may be described as the 'quantity of motion'?
- **a** force
- **b** inertia
- **c** momentum
- **d** velocity

5 An object's linear momentum is conserved until:
- **a** an external force increases or decreases its rotational inertia.
- **b** its centre of mass changes.
- **c** an external force increases or decreases its velocity.
- **d** its radius of rotation changes.

6 In a hockey drive, sideways accuracy can be optimised by:
- **a** pushing the arms and hands towards the target.
- **b** taking a small stride.
- **c** breaking (hinging) at the wrists at the beginning of the backswing.
- **d** taking a larger stride.

7 An individual has a better chance of catching a ball without a mitt (glove) if they:
- **a** decrease the time over which the ball is caught.
- **b** increase the distance over which the ball is caught.
- **c** increase the time and distance over which the ball is caught.
- **d** do all of the above.

8 The most important *single* factor contributing to the distance and velocity of a throw is:

- **a** shoulder rotation.
- **b** wrist flexion.
- **c** elbow whip.
- **d** arm rotation about the shoulder.

9 Which of the following rules would NOT be applied if a footballer wished to kick a football over the maximum distance?

- **a** Use as many body parts as possible.
- **b** Place body segments on optimum stretch.
- **c** Each body segment should make an optimum contribution.
- **d** Use large mass parts last in the sequence.

10 In throwing, the stabilisation of the front leg:

- **a** sets the gross height for the throwing action.
- **b** promotes accuracy in the throw.
- **c** enables maximum force production.
- **d** does all of the above.

Section B: Short-response questions (150–200 words)

1 Figure 6.28 shows an overarm throwing action:

- **a** Identify the body part that provides both the stabilisation and gross height setting for the upper body.
- **b** List the body parts that directly contribute to the summing of momentum of the body.
- **c** Discuss how body segment momentums contribute to the maximum release velocity of the ball.

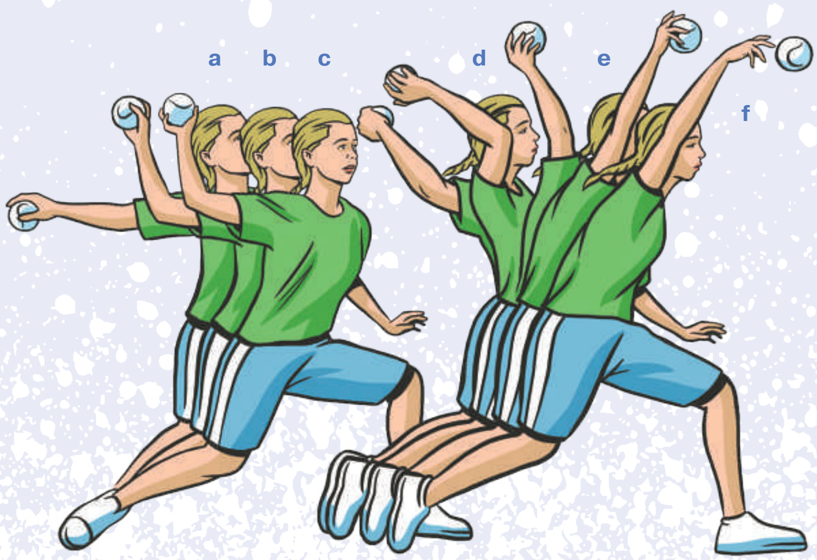


Figure 6.28
Overarm throwing action.

2 Figure 6.29 shows a fast bowler in cricket bowling the ball:

- **a** Which component of accuracy is the bowler trying to manipulate?
- **b** Describe two techniques the bowler could use to promote this accuracy.

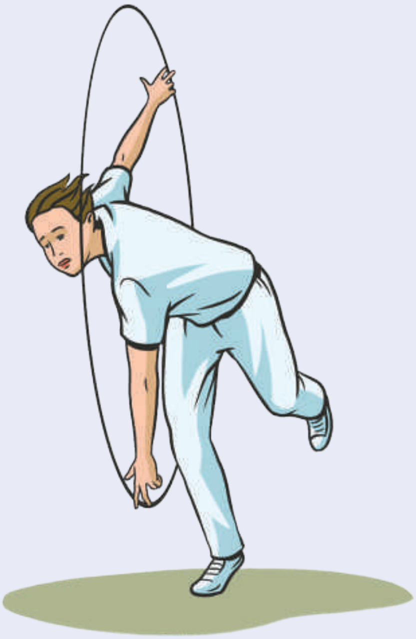


Figure 6.29
Fast bowler bowling

Section C: Extended response (400 words)

A bushwalker wishing to retain optimum balance while walking along a narrow bridge might prefer to walk tall, keeping the heavy pack high on their shoulders. How can this be reconciled with the knowledge that biomechanically, a high centre of gravity represents a more unstable balance position?

7 EXAMINING AIR AND WATER FORCES

Figure 7.1 Steven May stretches for the mark as air resistance causes the football to spin and swerve.

A projectile is an object propelled into the air or water by an external force. A projectile can be an object, such as a discus, football or arrow, or the human body performing aerobic gymnastic skills, such as jumping, swimming or doing a somersault.

In this chapter, you'll examine the forces that act upon projectiles, both to set them in motion and to slow or change their movements. As with the other chapters in this topic, there are several technical and mathematical concepts to take on board.

KEY QUESTIONS

7.1 What causes an object propelled into the air to follow a symmetrical parabolic pathway?

7.2 How can our understanding of aerodynamics be applied to balls in flight?

7.3 How is movement in water different to movement in air?

7.4 What forces reduce the velocity of projectiles?

7.5 How can a swimmer optimise propulsive forces over resistive forces?

YOUR CHAPTER PLAN

7.1 The flight of a projectile

Two naturally occurring forces act on a **projectile**: air resistance and gravity. Air resistance is important in sports like cycling, where air or wind exerts very large forces against the body. In football, javelin throwing and golf, air resistance affects the aerodynamic characteristics of the projectile in generating spin and swerve. Before considering those forces, though, you need to start by determining how the projectile would move without additional forces affecting it.

The flight path of a projectile is determined at the point of release (the point at which it takes flight) by three key factors:

- angle of release
- height of release
- speed of release.

The flight path of a projectile cannot be altered during flight. This means that the distance a projectile travels, and the time it spends in the air, can't be changed after take-off unless other external forces are applied.

projectile
an object propelled into the air or water by an external force

Angle of release

The angle of release of a projectile is the angle formed between its path and the ground. It determines two things:

- the time the object stays in the air
- the horizontal distance the object moves.

If a cricket ball is thrown vertically into the air (so with vertical force only), it will stay in the air for a considerable time. The ball won't move any horizontal distance, though, because no horizontal force has been applied. If the ball is thrown straight out, with horizontal force only, it will move a considerable horizontal distance but spend little time in the air.

Vertical force gives the ball time in the air, and horizontal force makes the ball travel a horizontal distance. An equal amount of both horizontal and vertical force gives an angle of release of 45°, which is the ideal angle to cover the maximum range.

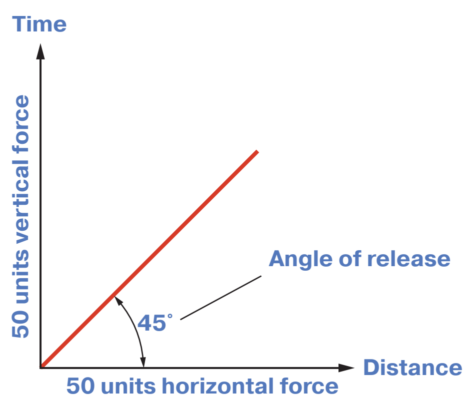


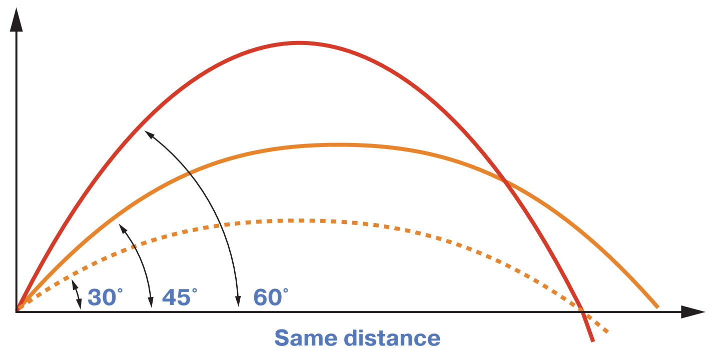
Figure 7.2
The relationship between the time a projectile spends in the air, the horizontal distance it travels and the ideal angle of release

In the absence of air resistance, a ball thrown into the air with both horizontal and vertical force will follow a symmetrical curved pathway called a parabola (see Figure 7.2), which you examined earlier in Chapter 4 (p.xx).

In a parabola, the angle at release or take-off is the same as the angle on landing. In reality, air resistance alters this pathway, particularly in the case of a lighter projectile with a larger surface area. For example, a volleyball is relatively light and will be affected by air resistance, so its flight path will fall short of a true parabola.

A projectile thrown or hit at an angle of release of 45° + *x*° or 45° − *x*° will cover exactly the same horizontal distance (see Figure 7.3). A ball projected into the air at an angle of 45° + 15° (a total of 60°) will travel the same horizontal distance as one projected into the air at an angle of 45° − 15° (a total of 30°). The ball projected at 60° will be in the air longer, but travel the same horizontal distance as the ball projected at 30°. This means that the loss in horizontal distance at 60° is equivalent to the loss of horizontal distance at 30°. This relationship applies for all angles of release that are equal displacements (alterations) above or below 45°.

Figure 7.3 Horizontal distance travelled by a projectile in relation to the angle of release



When a cricket ball is hit from ground level with the aim of travelling the maximum distance, the ideal angle of projection is 45°. In most other sports, there are other variables (such as the height of release and speed of release) to take into into account, resulting in an ideal release angle that's slightly less than 45°.

In the shotput, the optimum angle of release ranges from 39° to 42°. When the shot is projected at smaller angles, the distance it travels is decreased. Table 7.1 shows the increases in distance that the shot travels when released at different angles but at the same height (2.2m) and velocity (13.7m/s).

Table 7.1 Increases in horizontal distance a shot travels with increasing angle of release

Angle of release (°)	Distance (m)	Increase in distance (m)
36	21.1	–
39	21.4	0.3
42	21.5	0.1

Height of release

Many sports skills, such as the shotput, baseball hit and cricket throw, involve projecting a ball from a given height above ground level and it then landing at ground level. In most cases, the height of release varies between 1.8 m and 2.4 m above ground level, due to the height of the athlete and their stance.

If a cricket ball is thrown from a height of approximately 2.1 m above the ground, a release angle of 45° may not be optimal (Figure 7.4). Because of its release height, the ball will already have extra time in the air compared to a ball released at ground level. Therefore, the athlete should concentrate on releasing the ball at a lower angle and making it travel a greater horizontal distance.

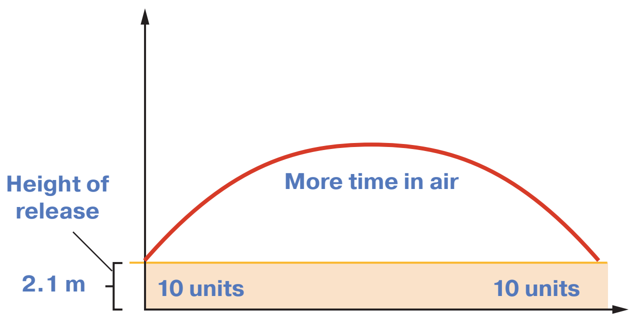


Figure 7.4 The relationship between height of release of a projectile and its time in the air

The following generalisations can be made about the relationship between height of release of a projectile, its angle of release and the horizontal distance it covers:

- the greater the height of release of a projectile, the greater the horizontal distance it will cover, as long as the force applied at release is the same.
- as the height of release of a projectile increases, its optimal angle of release decreases.

Table 7.2 shows actual increases in horizontal distance travelled by a projectile released at increasing heights. The angle of release is the same in all cases (42°), as is the speed of release (13.7m/s).

Height of release (m)	Distance (m)	Increase in distance (m)
2.1	21.3	–
2.3	21.5	0.2
2.4	21.6	0.1
2.6	21.7	0.1

Table 7.2 Increase in horizontal distance a projectile travels with increasing height of release

Speed of release

The higher the speed of release, the greater the distance a projectile will cover, assuming the angle and height of release remain the same. The speed of a projectile at release is far more important than the angle or height of release in maximising the distance travelled.

Table 7.3 shows the distance covered when a ball is released at different speeds. The angle of release is the same in all cases (42°), as is the height of release (2.2 m).

Table 7.3 Increase in horizontal distance a projectile travels with increasing height of release

Release speed (m/s)	Distance (m)	Increase in distance (m)
13.1	19.8	–
13.4	20.6	0.8
13.7	21.5	0.9
14.0	22.4	0.9

Other factors

Other factors can influence the angle and speed of release:

- In throwing and hitting movements, muscles (such as the chest muscles) operate more efficiently in a horizontal direction; this means it's better to use a smaller rather than larger angle of release.
- In long jump, the fast run-up reduces the angle of take-off to approximately 22°, as the horizontal forces cannot be converted into vertical forces in the limited time available.
- A very heavy object (such as a shot) will always be projected at an angle of less than 45°, due to difficulties in handling its weight in the arm push stage.

In summary, when throwing and hitting projectiles in sport, it is generally best to make the angle of release lower (smaller) rather than higher (larger).

7.1 Check your understanding

1. Describe the term projectile and explain the natural forces acting on it.
2. Identify each of the main factors affecting the flight path of a projectile.
3. Determine which additional factors may affect the flight path of a projectile.

CASE STUDY

Dani Stevens

In 2009, at the age of 21, Australian Dani Stevens became the youngest ever female world champion in discus throwing.

In 2017 at the IAAF World Championships, Stevens won the silver medal with a throw of 69.64 m, her personal best. The following year she went on to win the gold medal for discus at the 2018 Commonwealth Games.

You can observe the 'optimum stretch' of the anterior deltoid and pectoralis major muscles and the torque (twist) of the trunk in the summing of momentum in this photo of Stevens.

Stevens has remarked in the past about her successful throws that she 'didn't force it at all and it shows how important technique is'.

QUESTIONS

1. Stevens is 1.82 m tall. The average Australian woman is 1.61 m tall. What would an average-height woman need to do to throw as well as Stevens?
2. Suggest why Stevens feels that technique is important in achieving her throws.

Apply and analyse
angle, height and speed of projection

LEARNING EXPERIENCE

For this activity you will need to work outside in groups of three. Each group needs a hose connected to a water supply, a measuring tape or wheel, and a digital video camera or smartphone.

1 Allocate members to three roles: hose minding, measuring and recording.
2 The recorder gets into a position from which they can capture video without moving or re-aiming the camera.
3 The hose minder takes up the hose, makes sure that the water has a high pressure, then completes the following tasks:
   a Turn on the tap with one hand. With the hand that holds the hose at ground level, direct a stream of water to cover the greatest distance possible. Continue directing the stream while the measurer records the distance, then turn off the tap.
   b Repeat the performance, but this time with the hose nozzle at hip level. The aim is still to cover the greatest distance possible.
   c Repeat the performance, but this time with the hose nozzle at shoulder level. The aim is still to cover the greatest distance possible.
4 The recorder films all three performances on their digital capture device. The device needs to be perpendicular to the middle of the water stream.

Once all data is recorded, export and save all video. Print stills from the video and determine the approximate angle of the initial water flow by drawing on the printed copy. (Alternatively, use image analysis software to work out the angle.)

Share all data and results with the group, and use it to answer the following questions.

1 Describe the shape of the first arc of the water stream in biomechanical terms. What was the angle of projection?
2 What was the angle of projection of the second stream?
3 What was the angle of projection of the third stream?
4 Analyse the results and describe the relationship between height of projection and angle of projection.
5 Given the same height and angle of projection, describe what other variable would increase the distance covered by the water stream.
6 To cover the maximum distance possible, evaluate whether it would be better to use a lower or higher projection angle. Justify your response.

7.2 Movement in air

Air resistance

Resistance is exerted by any gas or fluid, such as air or water, on an object moving through it. When the object attempts to push its way through the fluid, it is opposed or resisted by the fluid. The resistance, or drag, slows down the movement of the object.

Although resistance can be a hindrance, it can also be a help to a sportsperson. For example, the air hitting against the front of a ball may slow it down, but the resistance of the air can enhance its spin or swerve.

Features of both the front and back of an object affect the amount of drag or resistance it encounters. The amount of resistance depends on the following characteristics:

- size
- shape
- smoothness
- speed.

For example, a gridiron football kicked end over end effectively becomes a relatively large object that meets with significant resistance (see Figure 7.5). But when the same football is kicked or thrown torpedo-style, its shape helps to reduce the amount of resistance it experiences.

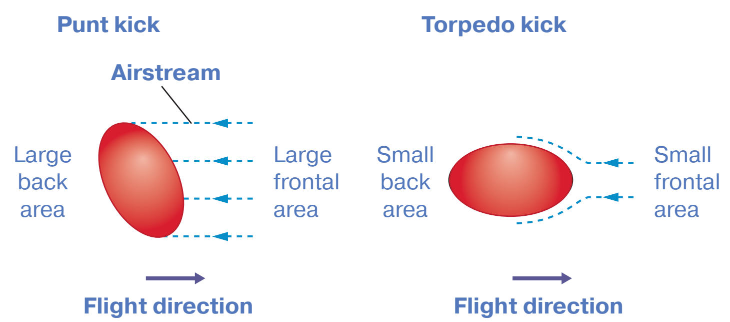


Figure 7.5 Air resistance encountered by a gridiron football travelling end over end, and torpedo-style

If a ball has a smooth surface, there will be less friction between the airstream and the ball's surface. The ball won't lose as much speed due to air resistance as a ball with a rougher surface.

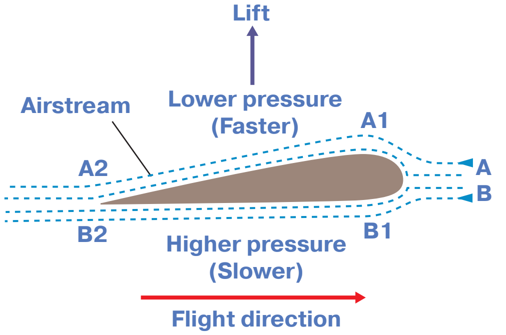
The Bernoulli principle

Differences in air pressure can affect the speed of a ball through the air and how it spins or swerves. These pressure differences were first discovered by 18th-century scientist Daniel Bernoulli, who found that where air flow velocity is fast, the air pressure is low, and where the air flow velocity is slow, the air pressure is high. This is known as the **Bernoulli principle**.

Bernoulli principle
air moving at low velocity under a wing generates a higher pressure than high-velocity air moving over the wing

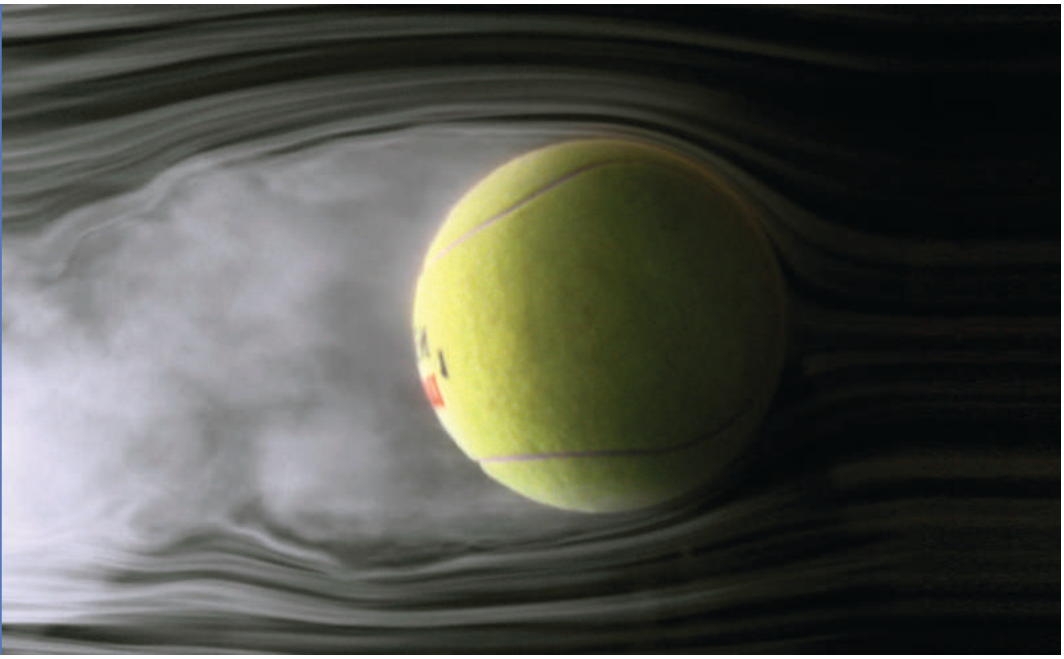
The Bernoulli principle can be illustrated using an aerofoil (cross-section of an aeroplane wing) as shown in Figure 7.6. As air flows past the aerofoil, it is diverted over the upper curved surface and has to travel further than the air flowing underneath the flatter surface below. As air molecule A moves from point A1 to A2 in the same time that air molecule B moves from point B1 to B2, molecule A must travel faster. In other words, the velocity of A is greater than that of B, and this creates a lower pressure above the aerofoil than underneath it. The resulting higher pressure under the aerofoil forces it upwards, giving the aeroplane lift.

Figure 7.6 The Bernoulli principle as applied to an aerofoil



When a round ball is kicked into the air, air is forced against the front of the ball, creating resistance (see Figure 7.7). The air then streams out and around the surface of the ball. When the air arrives at the back of the ball, the flow breaks up, forming swirls of turbulent, faster-moving air. In keeping with the Bernoulli principle, this turbulence creates a region of lower air pressure behind the ball. The higher pressure at the front of the ball then pushes against the ball, slowing it down even more.

Figure 7.7 A tennis ball with no spin in a wind tunnel, flying from left to right. Smooth stream lines of smoke pass up and around the ball, breaking up and creating turbulence as they reach the back.



Objects will always be forced to move from areas of high pressure to areas of low pressure. In general, turbulence behind a ball accounts for most of the drag it encounters.

An egg-shaped ball, such as an Australian rules football, can cut through the air more cleanly than a round ball – but only if it is moving with a pointed end in front and is not spinning. Air can flow with much less resistance over the nose of the ball. The tapered tail fills more space behind the ball, so there is less turbulence and less energy is lost by the ball.

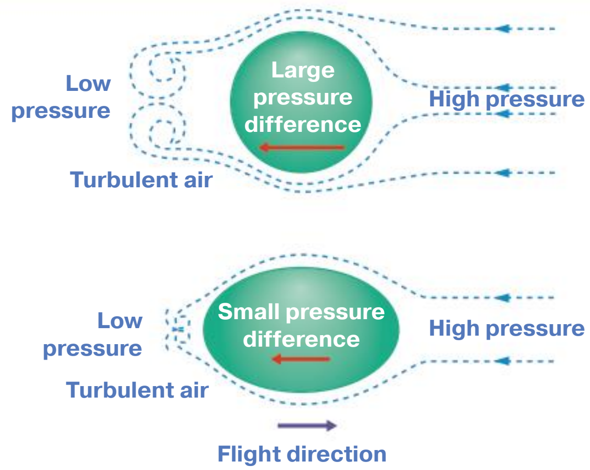


Figure 7.8 A fast-moving ball encounters greater air resistance and turbulence than a slower moving ball.

The faster a ball moves through the air, the more difficulty the airstream has clinging to the ball and the earlier it breaks up, producing a greater amount of turbulence at the rear of the ball. This increases the pressure difference from the front to the back of the ball (see Figure 7.8) and causes the ball to slow even more.

Spin and swerve

Objects will usually swerve or change direction during flight due to spinning or rotating. Spin isn't the only cause of swerving, though – in the case of a ball with stitching on it, the seams disturb the airflow. A tennis ball dips under the influence of topspin (see Figure 7.9), while a cricket ball 'seam swings'.

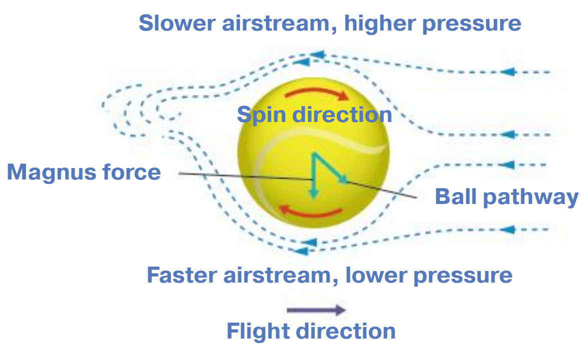


Figure 7.9 Side view of a tennis ball under the influence of heavy topspin

As the tennis ball spins, the airstream flowing over the top of the ball moves in the opposite direction to the spin of the ball. This tends to deflect or push the airstream off the surface of the ball very quickly. But the airstream flowing under the ball, and moving in the same direction as the ball spin, is attracted to the ball's surface; it travels much further and faster around the ball's surface.

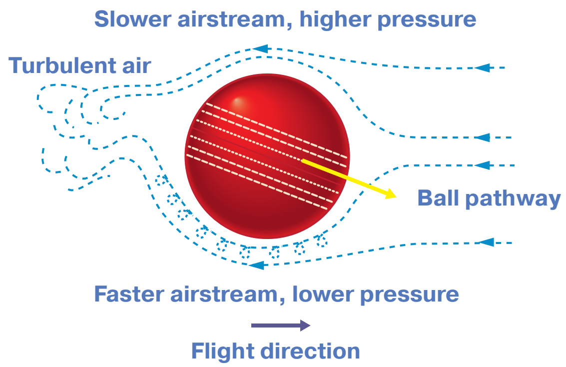
Because slow-flowing air has a higher pressure than faster-moving air, a ball with topspin is forced downwards by the higher pressure above the ball. This force is known as the **Magnus force**. A ball with underspin, on the other hand, is pushed upwards, while a ball with sidespin is pushed to the side.

Magnus force application of the Bernoulli principle causing a spinning ball to deviate in flight, or a ball with a seam to swerve in flight

A right-handed golfer hitting the ball with slice (fade) will impart some underspin and a lot of sidespin, so that the ball flies high and carries away to the right of the player. A draw (hook) shot with some topspin and a lot of sidespin will fly lower and carry away to the left of the player.

An object that isn't spinning can also swerve in flight. In the case of a cricket ball, the prominent stitched seam creates the conditions necessary for swerve to occur (see Figure 7.10).

Figure 7.10 A cricket ball can swerve in the air due to turbulence created by its seam.



When the air hits the front of a cricket ball, some of the airstream is diverted around the smooth side of the ball, and some around the seamed side. As the airstream meets the seam, it becomes turbulent and begins to swirl back onto the surface of the ball.

The swirling air is repeatedly forced back onto the ball's surface as the airstream continues its flow around the ball, enabling the airstream on this side to cling to the ball's surface over a greater distance than the airstream on the opposite side of the ball. This makes the airstream travel faster, and it develops a lower pressure.

On the opposite side of the ball, the pressure is relatively high, so the Magnus force pushes the ball towards the seam side. A cricket ball will therefore always swing in the direction the seam is pointing.

To create a reverse or 'Irish' swing, the ball is roughened on the smooth side that will be at the front, facing the direction of travel, when the ball is bowled. This makes the ball act as if the seam is on the opposite side of where it actually is, and so the ball swings in the opposite direction. The legal way of doing this is by polishing the opposite side, making the front rougher by comparison. In 2018, members of the Australian men's cricket team used sandpaper to tamper with the ball during a Test in South Africa; this was an illegal way of roughening the smooth side of the ball.

The amount of swerve can be increased in several ways:

- spinning a ball faster, such as imparting a heavier topspin to a tennis ball
- keeping the spin speed the same but using a larger ball – spinning a softball creates a greater swerve than spinning a cricket ball at the same speed
- reducing the linear speed of the ball so that the main force acting on the ball is a spin force – in baseball, a slow curve ball swerves more than a fast curve ball

Angle of approach and rebound

When a ball hits a surface, it rebounds. The angle at which it hits that surface is the angle of approach; the angle at which it rebounds is the angle of rebound. The kind of spin upon the ball affects its behaviour when it hits the surface, and thus affects the angle of rebound.

A ball with no spin approaching a surface (Figure 7.11) will be robbed of some of its energy as it hits and rubs across the surface. Friction will cause the underside of the ball to be pulled backwards and the top of the ball forwards, thus initiating some forward spin on the ball. This means that the angle of rebound will be less than the angle of approach.

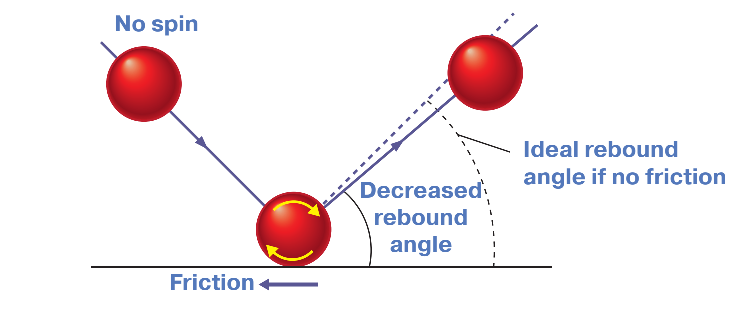


Figure 7.11 The angle of approach and rebound of a non-spinning ball

A ball with topspin approaching a surface (Figure 7.12) will rebound off that surface faster and lower than a ball with no spin. When the ball hits the surface, the dramatic backwards movement of the underside of the ball against the surface results in an opposite forwards force, which converts some of the ball's rotation into linear movement. The additional forwards force increases the linear speed of the ball and reduces the angle of rebound.

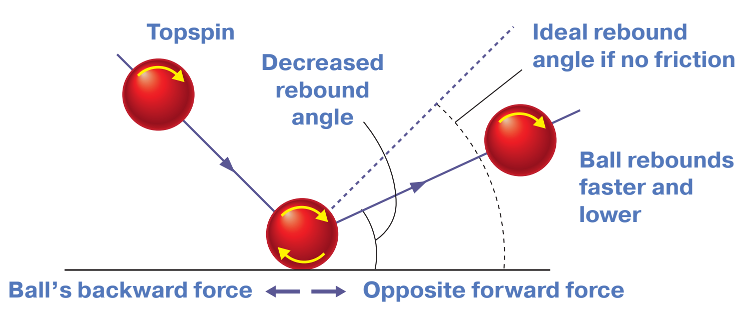
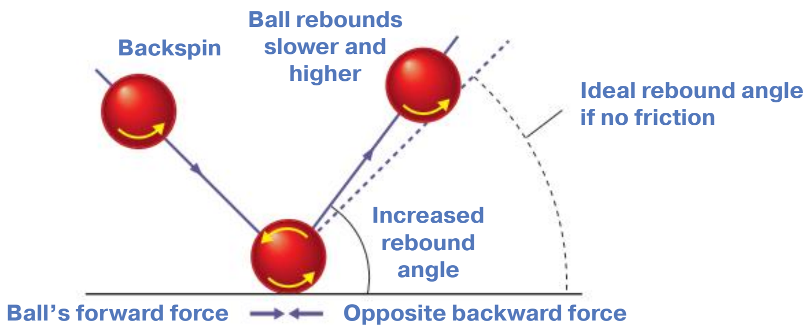


Figure 7.12 The angle of approach and rebound of a ball with topspin

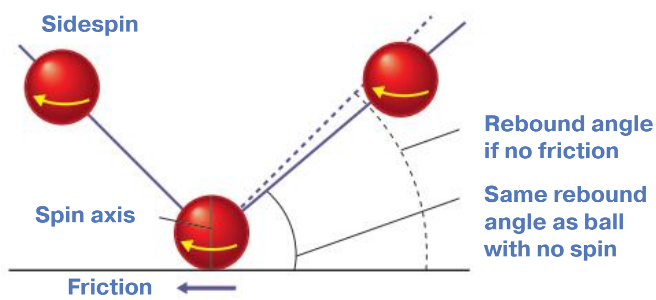
A ball with backspin (Figure 7.13) behaves in the opposite way to a ball with topspin. The ball will come off the surface slower and higher. The underside of the ball is moving forwards in relation to the surface, creating a forward force against the ground. This results in an opposite backwards force that makes the ball slow down and sit up, increasing the angle of rebound.

Figure 7.13 The angle of approach and rebound of a ball with backspin



A ball with sidespin will deviate to the side on the rebound, as long as it doesn't land on its long axis point (Figure 7.14). If the ball with sidespin does land on its axis point, no additional forces are created. The ball then behaves as if it has no spin and will not deviate to the side. This confuses many inexperienced players, particularly if the sidespin is combined with topspin or backspin.

Figure 7.14 The angle of approach and rebound of a ball with sidespin



7.2 Check your understanding

1 Describe the four characteristics of a body that determine its air resistance.
2 What is the Bernoulli principle and how does it affect the flight of a non-spinning ball?
3 Describe how a ball's spin affects the angle of rebound when it hits a wall.

Angle of approach and rebound

INTEGRATING MOVEMENT

Category: Net and court
Physical activity: Tennis

Purpose

This activity involves investigating the effect of different types of spin on a ball.

Preparation

Time: one lesson
Location: indoor tennis court or open space near a wall
Equipment: table tennis bat and ball; digital capture device

Setup

Work with a partner, who will record your performance.

Performance

1. Stand five metres from a suitable wall and hit the ball against the wall with:
   - no spin
   - topspin
   - backspin.
2. Observe the angle of rebound, the height of the rebound and the speed of the rebound.
3. Stand five metres apart and bounce the ball to your partner with:
   - no spin
   - topspin
   - backspin.
4. Observe the angle of rebound, the height of the rebound and the speed of the rebound.
5. Hold the ball with one hand on either side and apply sidespin to the ball so that it drops vertically to the ground. Observe how the ball behaves.

Data recording

DE 1 DE 6

Your partner should use digital capture to record the movement of the ball. This may require setting up a tripod for the set of bounces.

Questions

DE 3

1. Analyse and synthesise the primary data capture of the three performances. You will need to classify and compare:
   - **a** the angle of rebound as the ball left the wall
   - **b** the height of the rebound
   - **c** the speed of the rebound.
2. Determine the relationships between the angle of the rebound, the height of the rebound and the speed of the rebound. Explain reasoning for your decisions.
3. Evaluate the effect of spin axis on a rebounding ball. Justify your response.

DE 4

http://mea.digital/qpe12_7

7.3 Movement in water

In aquatic activities, such as swimming, rowing and canoeing, there are forces that must be dealt with that you don't normally encounter when moving on land. An appreciation of these forces helps you to develop a feel for the water, as well as an understanding of the dynamics of flotation and the movement of bodies in and through the water.

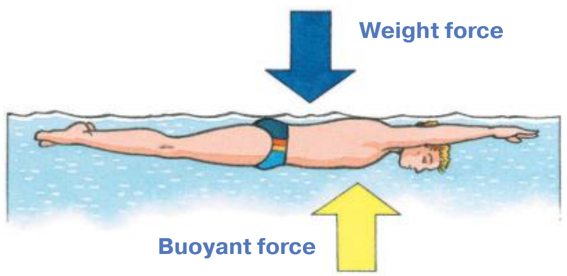
Buoyancy

buoyancy
the tendency of an object to float in water

buoyant force
an upward force against the underside of an object in water

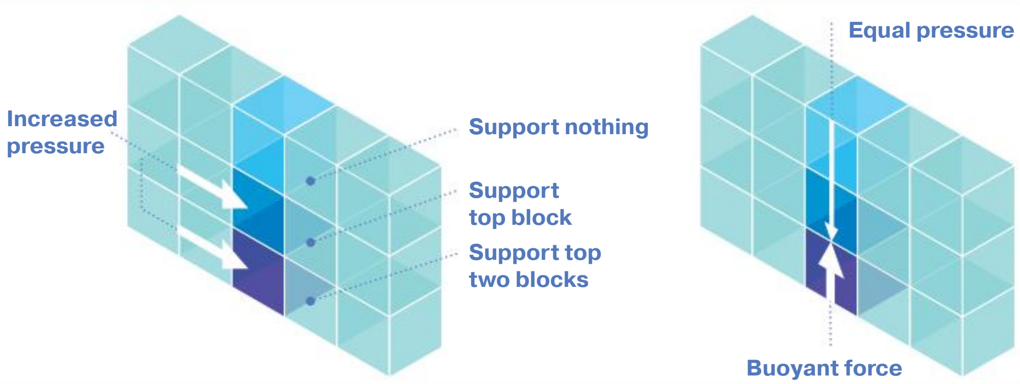
Buoyancy is the tendency of an object to float in water. This isn't just a physical property of the object; it's due to a **buoyant force**. This is an upward force exerted against the underside of a floating or submerged body, such as a swimmer. This upward force or pressure enables the swimmer to counter the gravity, or weight force, that's pushing the swimmer towards the bottom (see Figure 7.15). The buoyant force tries to push the swimmer towards the surface and into a potential floating position.

Figure 7.15 Counteracting forces: weight force and buoyant force



You can visualise this by imagining that the water in a swimming pool is divided into a series of vertical blocks (see Figure 7.16). The top block has no other block to support, so it has no weight pressing down on it. The block underneath has to support the pressure of the top block, the third block has to support the pressure of the top two blocks, and so on. This means that the pressure on any given block of water increases as you go deeper.

Figure 7.16 How water pressure increases with depth. The upwards pressure of the bottom block on the blocks above is the buoyant force.



Shouldn't the pressure of the top blocks of water squeeze out or compress the supporting blocks? No; water is practically incompressible, and also the water is contained within the bounds of the pool, with nowhere to move. This means that the supporting blocks respond to the pressure of the top blocks by exerting an upward pressure equal to that downward pressure. This upward pressure is known as the buoyant force.

Archimedes' principle

The buoyant force applies to any body within the water. However, the effect of that buoyant force depends on the physical characteristics of the body it's being applied to. A human being may float, but a lump of lead will definitely sink. Why the difference?

Archimedes' principle states that a body wholly or partly submerged in a fluid is buoyed up by a force equal to the weight of the displaced fluid. This principle was discovered by the ancient Greek scholar Archimedes, who stepped into his bath and noticed that the water level rose. He realised that the volume of water displaced must be equal to the volume of the body part he had submerged, and Archimedes' principle was one of the discoveries that came out of this insight.

Archimedes' principle
a body wholly or partly submerged in a fluid is buoyed up by a force equal to the weight of the displaced fluid

Figure 7.17 Statue of Archimedes in a bathtub, demonstrating the principle of buoyant force

Weight density and flotation

Another way of describing the buoyant effect is to compare the weight densities of the human body with water. (Weight density is the weight per unit volume of a body.) As it turns out, the weight of the human body is approximately the same as an equal volume of water, and if this ratio was 1:1 the body would float perfectly.

But the human body has tissues with many different weight densities: fat has a weight density of 0.8, muscle 1.0 and bone 1.8. So the human body has a weight density that varies slightly above and below 1, depending on the person.

When the weight density of the body is exactly 1 (i.e. the weight of the body is exactly that of an equal volume of water), the body will float perfectly, just lipping the surface of the water. Perfect floaters might be adults with large legs, underdeveloped muscles and quite a bit of fat tissue, or children who have a light frame and musculature.

A body with higher proportions of fat might have a weight density of 0.9, making the body only nine-tenths the weight of an equal volume of water. Because the water exerts an upwards buoyant force that is greater than the downwards weight force of the body, the body will be pushed up and out of the water. The body will stop its upwards movement and find its position of flotation when the weight of the body exactly matches the weight of an equal volume of water. So if the body is nine-tenths the weight of an equal volume of water, then nine-tenths of the body will locate itself in the water and one-tenth will be out of the water.

On the other hand, a body with a heavy frame and musculature could have a weight density of 1.1, making the body heavier than an equal volume of water and causing it to sink. In general, lean adults with heavy frames and light musculature will sink, as will massively built adults with heavy frames and heavy musculature.

In competitive swimming, positive buoyancy – your body being partly out of the water – reduces drag because a smaller cross-sectional area of your body is exposed to the direction of movement through the water. Researchers have found that buoyancy lift may account for up to 10 per cent of the variance in speed for competitors in a 400-metre swim.

Evaluate and justify
flotation of different body tissues

LEARNING EXPERIENCE

Place a piece of bone, a piece of meat and a piece of fat in water. Observe whether they float or sink.

Note: For any of the tissues that sank, or were heavier than the weight of the displaced water, you can assess which one was heavier by observing the speed of sinking.

1. Complete the following statements using the terms ‘float’ and ‘sink’:
   - **a** Bone tissue will …
   - **b** Muscle tissue will …
   - **c** Fat tissue will …
2. Describe any additional factors a swimmer could manipulate to lighten the body.
3. Explain which of the following body types would have the best flotation capability:
   - endomorph (fat)
   - ectomorph (lean)
   - mesomorph (muscular)
4. Evaluate whether an individual with good flotation capabilities will learn to swim more easily than someone without such capabilities.
5. Determine whether a competitive swimmer with good flotation qualities is more suited to a sprint or an endurance event. Explain your response.

Centre of weight and centre of buoyancy

The weight density of a body will basically determine whether or not it floats. Its position and angle of flotation will be determined by the relative location of its centre of weight (gravity) and centre of buoyancy (see Figure 7.18).

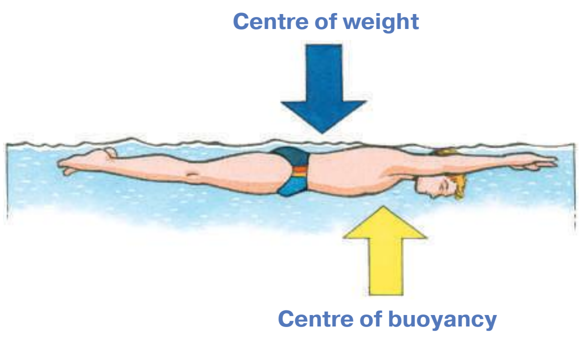


Figure 7.18 The centre of buoyancy is located around the sternum, in a higher position than the centre of weight.

The human body

In a symmetrical object of uniform density, both the centre of buoyancy and the centre of weight would be located at the same point. The human body, however, is an irregular object of varying weight density. Because of this, the centre of buoyancy is generally located in the bigger-volume chest cavity area around the sternum, and the centre of weight is located around the navel.

The location of the centre of buoyancy will vary according to an individual's body type, and can only be altered by a change in body shape or volume. But the location of the centre of weight can be altered both by changes in body type and, at any given time, by a change in the distribution of body parts around the centre of weight.

When the buoyant force and the weight force are in vertical alignment, the body will maintain a stable floating position in the water (see Figure 7.19). When the centre of weight is lower in the body than the centre of buoyancy, the downward weight force will rotate the lower body around the axis point – the centre of buoyancy – until both come into vertical alignment, and the body will then stabilise and float in that position.

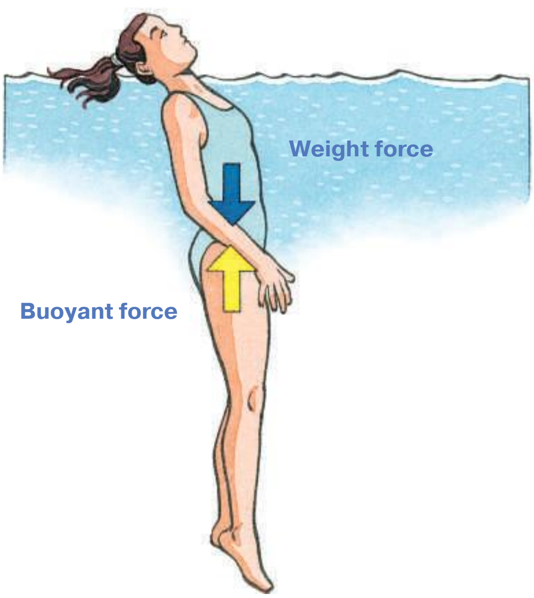


Figure 7.19 When the buoyant force and the weight force come into vertical alignment, the body will float in that position.

If you find it difficult to float in any given position, your centre of weight must be brought closer to your centre of buoyancy. This reduces the size of the moment arm between the line of the weight force and the line of the buoyant force, and lessens the potential of the legs to rotate. You can achieve this by redistributing your body parts: for example, bending your legs under your body or stretching your arms overhead (see Figure 7.20).

The most extreme redistribution of body parts is demonstrated in the tuck float, in which the centre of weight can easily be brought into vertical alignment with the centre of buoyancy (see Figure 7.21). The body will have no rotational tendency and will float, usually with the back just lipping the surface. Most people can float in this position, but only as a last resort, as it leaves the swimmer in a life-threatening face-down position in the water.

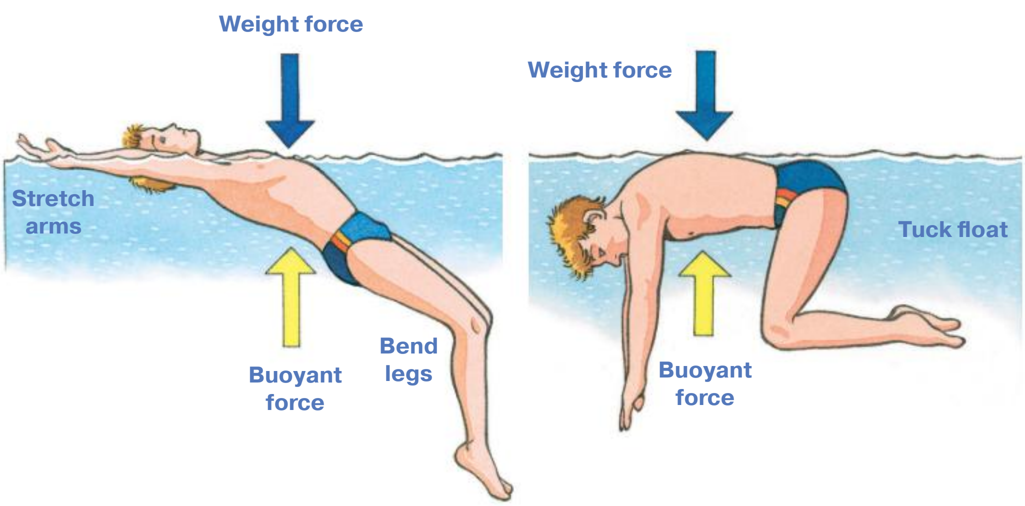


Figure 7.20 Redistribution of body parts brings the centre of buoyancy and centre of weight closer together.

Figure 7.21 Extreme redistribution enables flotation in the tuck position.

7.3 Check your understanding

1. Describe buoyant force and clarify how this upward pressure counteracts gravity.
2. Explain how Archimedes' principle shows the effects of the physical characteristics of a body on the buoyant force.
3. Explain how the relationship between centre of weight and centre of buoyancy affects flotation.

7.4 Resistive forces

When your body moves through the water, it's subject to resistive or hydrodynamic drag forces that serve to slow its progress, just as a projectile moving through the air is subject to air resistance forces.

The total drag (resistance) is the sum of the three types of hydrodynamic drag:

Total drag = ***skin friction*** + ***profile drag*** + ***wave drag***

This section discusses ways in which skin friction, profile drag and wave drag can be decreased to improve efficiency in water.

Skin friction

Skin friction, or surface drag, is the resistive force (resistance) caused by water flowing backwards along the surface of a body moving forwards through the water. The magnitude of the friction drag depends on the velocity of the flow relative to that of the body, the surface area of the body and the characteristics of the surface. Compared with the other types of drag in swimming, it's the least significant force.

skin friction
the resistive force caused by water flowing backwards along the surface of a body moving forwards

It's common for competitive swimmers to reduce skin friction by shaving their body, arms, legs and head. Many swimmers who shave their bodies report that their tactile sensitivity to the water are enhanced. Others suggest that their tactile sensitivity is reduced because when hairs move, they stimulate receptors beneath the skin. In either case, the sensation is different with and without hair, and being without hair may provide a psychological benefit for some swimmers.

The smoother the skin and swimsuit, and the smaller the surface area of the body oriented parallel to the flow, the less water in the boundary layer carried along with the body and the lower the skin friction resistance. A series of body suits were developed for the 2000 Olympics, with one aim being to minimise skin friction. These 'hydrodynamically' designed swimsuits were seamless, contained muscle and skin surface ripples, and aided core stability. They were so successful, and so many world records were being broken, that FINA (the world swimming governing body) decided to outlaw such suits.

Since 2010, competitive swimwear for men has not been allowed to extend above the navel nor below the knee. For women, swimwear has not been allowed to cover the neck, extend past the shoulder or extend below the knee. All swimsuits must be made from textile materials.

Profile drag

The most significant type of resistance in swimming at most speeds is that created by the swimmer's body 'spreading the water apart' as they move through the water. The amount of this **profile drag** depends on the size, shape and speed of the swimmer, as well as the orientation of their body relative to the flow.

profile drag
the resistive force in water caused by the size and shape of a body, together with its speed and orientation

An important fact to remember is that when you double your swimming speed, your profile drag is quadrupled, and the power you need to swim is increased by a factor of eight.

The greater the area of your body and body parts that face the flow, the greater the drag (see Figure 7.22). High-pressure zones are created on the leading surfaces of the body, and low-pressure zones are formed at the trailing surfaces where the water is moving faster and is turbulent, or full of eddies, creating a suction effect. The pressure difference results in a net force acting backwards against the body, slowing swim speed.

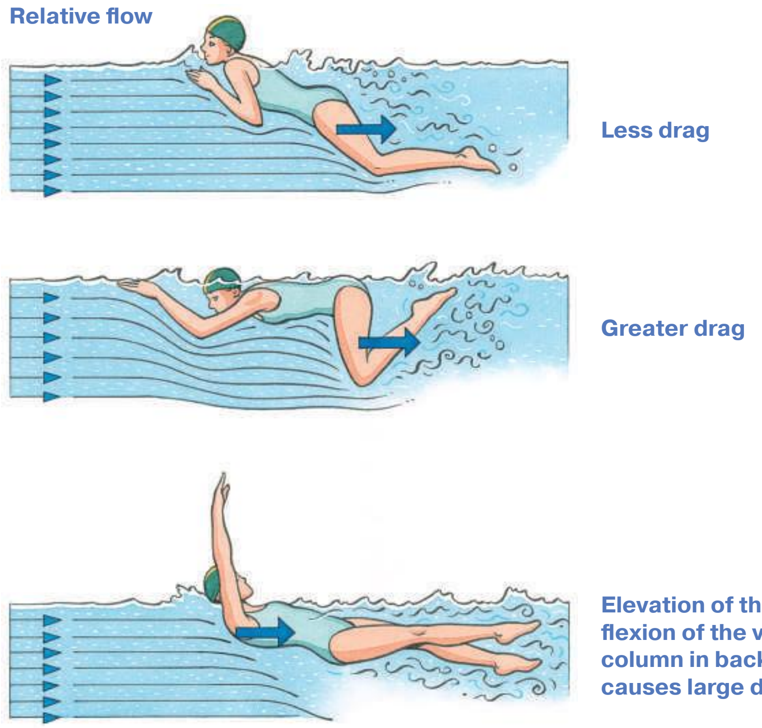


Figure 7.22 Profile drag is increased when recovering the arms and legs in breaststroke (top and middle diagrams) and when using faulty mechanics in backstroke (bottom diagram) with excessive elevation of the head and shoulders.

Figure 7.23 Kyle Chalmers holds his head in a neutral position (in alignment with the body) in order to streamline his upper body and head, reducing profile drag.

Profile drag is affected by the **anthropometric** characteristics of swimmers and relates directly to the body shape in the water. Maximum cross-sectional area of the body is a significant contributor to drag. The long, slender shape of elite swimmers, with the body tapering from shoulders to hips to feet, promotes efficient water flow and reduces profile drag. A streamlined shape means that water flows smoothly around and past the body without much turbulence. As shoulder power is the mainstay of the freestyle and backstroke swimmer, large shoulders have to be tolerated in spite of their higher profile drag.

anthropometric relating to the size and proportions of the human body

Another way to reduce profile drag during swimming is to minimise the drag-producing aspects of limb recovery movements. How the limbs are brought forwards under water during recovery is important (in particular, the action of a breaststroker's arms and legs) for two reasons. These movements expose more area to the backwards flow, which increases resistance; and moving the limbs forwards through the water faster than the body (trunk) is moving increases the resistances even more.

In addition, some swimmers may use a flawed technique that causes excessive hip sway back and forth in freestyle and backstroke, or rise and fall in butterfly. Excessive hip movements usually result from faulty stroke entries. One advantage of the use of bodysuits, at least from neck to knee, was that they restricted the amount of excessive hip sway. This reduction in movement range reduced both profile and wave drag.

Figure 7.24 Emily Seebohm's powerful breaststroke arm action elevates her shoulders out of the water; as a trade-off, she has to tolerate significant wave drag.

Wave drag

wave drag
the resistive force caused by a body moving along through or near the water surface

Wave drag is the resistive force caused by a body moving along, through or near the surface of the water, forming waves. The force applied by the body (or its segments) to the water to create these waves generates an opposite reaction force applied by the waves against the body. The force of these swimmer-created waves increases with the swimmer's speed. Even if a moving object or body is completely submerged, if it's still close to the surface, there will still be wave drag.

While wave drag is not significant at low speeds, it may be the most important source of resistance at the faster swimming speeds seen in competition. Wave drag, and the power to overcome it, increases proportionately in the same way as profile drag. As the swimmer's speed increases, so does the size of the bow wave, and the 'wall' of water presses backwards against the swimmer.

The formation of bow waves also increases greatly with the vertical movements of the shoulders or head found in many strokes. For example, the breaststroke creates a large bow wave in front of the face and chest during the pulling action, and as the breath is taken. Generally speaking, good streamlining of the body will produce lower waves with less wave drag.

Resistance in boats

In rowing and canoeing, the watercraft are also subject to major sources of resistance. As the hull moves through the water, it experiences a resistive force caused by three factors:

- the friction on the hull
- the moving wave pattern created by the hull, which requires energy to sustain it
- the turbulent wake that the hull creates behind itself.

These resistive forces mainly depend on the size and shape of the hull, the surface of the hull and the water depth.

The frictional resistance applied by the water onto the shell is also affected by the water temperature. As the temperature of the water rises, the viscosity (thickness) of the water decreases, causing the frictional drag to decrease.

7.4 Check your understanding

1 Define the three types of hydrodynamic drag which contribute to total drag in water.
2 Explain, with reference to resistive forces, why some swimsuits were banned from competitive swimming.
3 Summarise three factors which account for a boat's resistance in water.

7.5 Propulsive forces

You can see that many forces act to push a swimmer's body back in the water. But what forces propel the swimmer in the first place?

There are three theories that help to explain the propulsive forces produced by a swimmer's body as they move through the water:

- drag force
- lift force
- pump force.

Drag force

You've already learnt how drag force acts to resist the forwards motion of a swimmer's body. But drag force can also be used to propel your body in water.

Imagine that you're swimming freestyle. As you pull your hand back in the water, the water flows past and becomes turbulent at the back of your hand (see Figure 7.25). This fast-moving turbulent water results in a low-pressure zone at the back of your hand and a high-pressure zone at the front (on your palm), in accordance with the Bernoulli principle. This means that you'll want to move your hand into the low-pressure zone. As this is in the opposite direction to the hand pull, you can apply a greater action–reaction hand force against the water. The larger the hand paddle, the greater the effect.

The hand's angle of attack is also very important in optimising drag force, as the hand's orientation in the water controls the water flow over the hand. Such drag propulsion can be used more effectively in freestyle by straightening the deep S-shaped pull pathway of the hand and promoting a shallower pull.

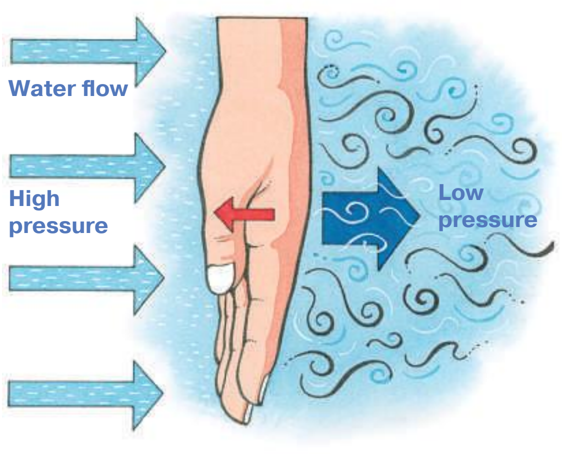


Figure 7.25
Drag force due to pressure differences

Lift force

lift force
the propelling force when swimming created by high pressure under the hand and low pressure above it

In swimming, water flow past the hand can also cause a **lift force**. In this case the hand must be shaped like an aerofoil or aeroplane wing, as shown in Figure 7.26. When water travels over the back of the hand, which has a longer surface area, it's forced to travel at a higher velocity than it would when travelling under the hand, past the palm.

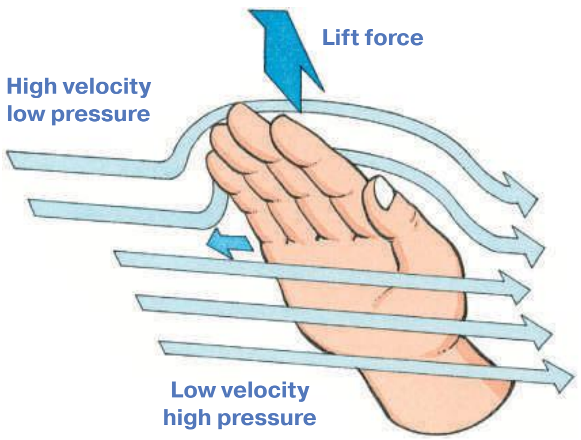


Figure 7.26 Hand shaped like an aerofoil

According to the Bernoulli principle, this will result in a higher pressure under the hand, forcing it to move from the high-pressure zone to the low-pressure zone. But a competitive swimmer doesn't want purely vertical lift; they'll change the orientation of their hand so that the 'lift' force now operates in a more horizontal direction. As the lift force is in the opposite direction to the hand pull, this gives the swimmer greater traction against the water.

Figure 7.27 shows three pitches for a swimmer's hand.

- To achieve the optimum lift force, your hand should be angled at approximately 40° to the horizontal (the surface of the water), as shown in position B.
- In position A, there isn't a great enough difference in the velocity of the water flow above and below the hand, so there is little difference in pressure. The lift force will therefore be small.
- In position C, the hand has such a high pitch that the water cannot flow smoothly over the top of the hand; the water breaks up, resulting in an almost complete loss of pressure.

A belief in the importance of lift forces has encouraged coaches to emphasise a curved hand path in all swim strokes, and the use of longer pathways to develop greater lift force application over a longer time.

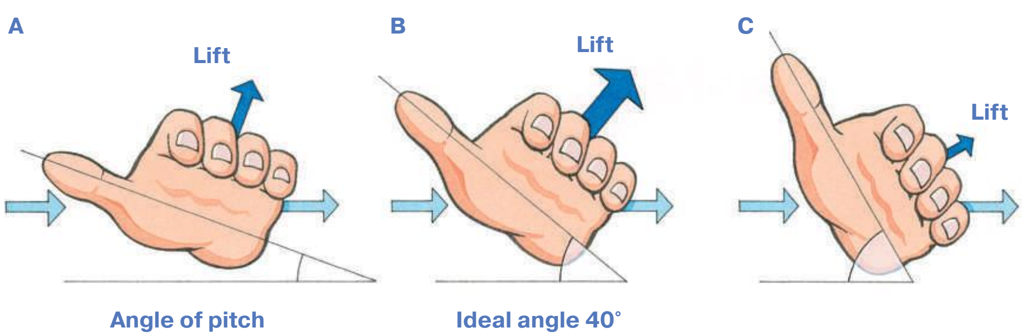


Figure 7.27 Lift effect for three hand positions; the length of the dark blue arrow indicates the magnitude of the lift.

Pump force

Pump propulsion is a more recent propulsion theory. It proposes that a swimmer's motions create a pressure gradient that 'pumps' water down their arm to propel them.

pump propulsion the propelling force created by a pressure gradient pumping water down the arm, forming a low pressure area at the back of the hand

To understand this, consider the simple model of a rotating stiff arm. As your arm rotates around your shoulder joint, the parts of your arm further from the shoulder will be travelling at a higher velocity, with your hand travelling at the highest velocity.

According to the Bernoulli principle, the area around your hand where water travels at the highest velocity will have the lowest pressure, and the area around your shoulder will have the highest pressure (see Figure 7.28). This leads to a velocity scale or gradient from high to low pressure along the arm, creating an axial fluid flow along the arm and hand towards the fingertips. This means the limb's rotation leads to a pressure gradient pumping fluid along the arm towards the hand, boosting the low-pressure area on the back of the hand as described for drag propulsion. The hand thus acts as a more efficient paddle.

Before 1970, coaches believed that the best way to propel the body through the water was to drag the hand directly backwards. In the 1970s, following observations that the hands of elite swimmers followed curved paths and that the hand was pitched in the water, the theory of lift force in combination with some lesser drag force became popular.

Pump propulsion is the latest theory in a bid to understand how the body forces itself through the water. Still, experts currently accept that drag force is the major propelling force in the water.

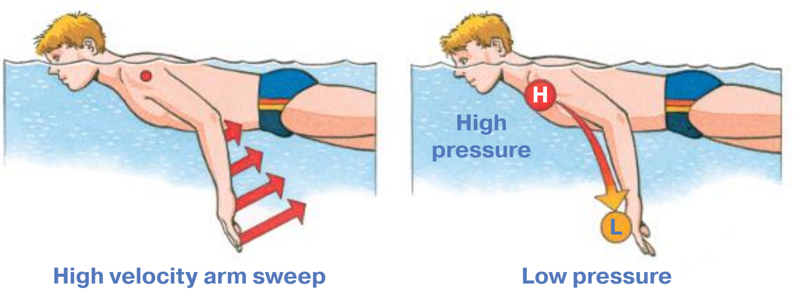


Figure 7.28 The high velocity movement of the arm during the outsweep (left) creates a velocity gradient along the arm from high pressure to low pressure (right), leading to an axial water flow down the arm and towards the hand.

Check your understanding 7.5

1. Define the three main theories relating to the propulsive forces generated by a swimmer.
2. Explain how Bernoulli's principle applies to each of the propulsive theories.
3. Summarise how a freestyle swimmer should position their arms and hands to optimise their stroke.

Resistive and propulsive forces

INTEGRATING MOVEMENT

Category: Performance
Physical activity: Swimming

Purpose

1. This activity involves investigating resistive and propulsive forces.
2. This activity involves three separate activities, which need to be performed in order.

Preparation

Time: two lessons (one for performance, one for analysis)
Location: swimming pool
Equipment: swimming costumes; digital capture device

Setup

1. Pair up with another student. Decide which of you will swim and which will record.
2. The swimmer will perform all three activities.
3. The recorder needs to capture both video and audio of all swimming activities.

Activity 1 Performance

1. Lie along the edge of the pool and move your hand and forearm through the water. Make different shapes with your hands and feel the different resistances of the water.
2. Repeat each hand position but bring your hand through the water at varying velocities.
3. Describe your experience of each position and movement to the recorder.

Activity 2 Performance

1. Select a swimming stroke you can perform reasonably well.
2. Swim a given distance with your head held higher than your trunk (in an out-of-alignment position). Count how many strokes you take to complete one length of the pool.
3. Now drop the head into alignment with the trunk and repeat, counting how many strokes you take to complete a length.
4. Describe your experience and stroke count to the recorder.

Activity 3 Performance

1. In the pool, tread water (without using your legs) by using broad horizontal sweeps of your hands. Keep the hands in a cupped position, as for an aerofoil, and experiment with your hands at various angles to the water. Sweep in a sculling figure-of-eight motion.
2. Lie on your back and perform sculling actions with your hands to move backwards or forwards through the water. Now float face-down and repeat. Breathe as for freestyle while floating face down.

3 Perform a freestyle action with your arms, and isolate your legs by keeping them together or using a tie around your ankles. Using no kick for propulsion, experiment with various arm actions.
   a First, stroke under your body using a very expansive curved pathway, such as a deep 'S'-shaped pull. (This will be helped with a sound rolling action of the body.)
   b Second, try bringing your hand under your body in a narrow curved path.
4 Perform a breaststroke action and compare the propulsive effect of the whip kick when your ankles are:
   a kept in dorsiflexion (toes and foot pulled towards the shin) throughout.
   b kept in plantar flexion (toes and foot pointed away from the shin) throughout.
   c moved from dorsiflexion to plantar flexion as your legs near the end of their drive phase.
5 Describe your experience of each position and movement to the recorder.

Data recording

DE 1 DE 6

1 The recorder captures video for all activities as described, including audio.
2 All data should be shared with your partner once the performance is completed.

Tasks

DE 3

1 Analyse the primary data from Activity 1 and 2 to examine the most significant resistive force in swimming. Justify your response.
2 Categorise the data from the treading water action (Activity 3) to determine the optimum hand position to maintain the float. Justify your decision using primary data.
3 Interpret the data to identify the hand position that required least effort when floating and performing the sculling arm action (Activity 3). Justify your response, using Bernoulli's principle as evidence.
4 For the freestyle arm action (Activity 3), determine which arm action provided greatest propulsion. Explain the reasoning for your decision.
5 For the breaststroke action (Activity 3), make decisions about the orientation of the feet for optimum action. Refer to drag and lift effects to justify your response. DE 4

Chapter review

[7.1] A projectile is an object propelled into the air or water by an external force and is affected by air resistance and gravity. The angle, height and speed of release determine the flight path of a projectile. Direction of pull of a muscle, angle at take-off and the weight of the projectile can also affect the flight path.

[7.2] The amount of air resistance depends on the size, shape, smoothness and speed of an object. The Bernoulli principle states that high-velocity air flow results in a region of low pressure, and low-velocity air flow results in a region of high pressure. With a non-spinning ball, the difference between high pressure at the front of the ball and low pressure behind the ball creates resistance, slowing the flight of the ball.

[7.2] The Magnus force creates differences in pressure on the sides of a spinning or seamed ball, forcing it to swerve in flight. The angle of rebound for a ball with no spin will be lower and slower due to friction with the surface. For topspin the angle of rebound will be lower and faster, for backspin higher and slower, and for sidespin there's no deviation if the ball lands on its vertical axis.

[7.3] The buoyant force exerts an upward pressure in water countering the gravity force. Archimedes' principle tells us that a body wholly or partly submerged in a fluid is buoyed up by a force equal to the weight of the displaced fluid. If the body has a weight approximately that of an equal volume of water, it will float perfectly. However, body tissues such as fat, muscle and bone affect body weight and therefore flotation. Centre of weight and centre of buoyancy must be in vertical alignment to float.

[7.4] Hydrodynamic drag is the sum total of skin friction, profile drag and wave drag. Three resistive forces affect a boat: friction with the hull, wave pattern and the turbulent wake.

[7.5] Propulsive forces in water are generated by drag force, lift force and pump propulsion. The Bernoulli principle uses differential pressure to explain all three theories.

Review questions

Section A: Multiple-choice questions

1 Which of the following behaves as a projectile?
- **a** a high jumper approaching the bar
- **b** a badminton shuttlecock during its flight
- **c** a basketballer standing at the free-throw line
- **d** a javelin thrower in their run-up before the throw

2 For optimal performance in the shotput, which of the following is true for the projection angle?
- **a** It should be 45°.
- **b** It should be greater than 45°.
- **c** It should be less than 45°.
- **d** It depends on initial velocity.

3 Which of the following objects, if projected for distance, would fly in a pathway that most resembles a true parabola?
- **a** badminton shuttlecock
- **b** shot put
- **c** volleyball
- **d** beach ball

4 Which of the following statements is *not* true?
- **a** A ball with no spin hitting a flat (plane) surface will rebound off that surface at a lower angle.
- **b** A ball with topspin (forward spin) hitting a flat (plane) surface will rebound off that surface at a lower angle and more quickly.
- **c** A ball with backspin (backward spin) hitting a flat (plane) surface will rebound off that surface at a higher angle and more slowly.
- **d** A ball with right spin around its vertical axis hitting a flat (plane) surface and landing on the point of its long axis will spin off the surface to the right side.

5 Which of the following describes the inverse relationship between relative velocity and relative pressure in a fluid flow?
- **a** Bernoulli principle
- **b** Archimedes' principle
- **c** Magnus principle
- **d** Buoyancy principle

6 Which of the following statements is *not* true of the Magnus force?
- **a** It is created by applying spin to the ball.
- **b** It is created by a pressure differential.
- **c** It is created by a velocity differential.
- **d** It is created by all air streams travelling over the same distance on the surface of the ball.

7 Which of the following terms describes the force acting on a body in a fluid, in a direction perpendicular to the fluid flow?

- **a** wave drag
- **b** surface drag
- **c** form drag
- **d** lift

8 Modern swim theory would suggest that propulsion is mainly due to which of the following factors?

- **a** drag force
- **b** axial flow from the hand to the shoulder
- **c** the water on the knuckle-side of the hand having a lower pressure than on the palm side of the hand
- **d** buoyant force

9 Archimedes' principle has to do with:

- **a** the physical characteristics of the body.
- **b** the weight of the body.
- **c** the density of the body.
- **d** all of the above.

10 For a body to float, the centre of weight and centre of buoyancy need to be:

- **a** in vertical alignment.
- **b** in horizontal alignment.
- **c** pressing upward on the body.
- **d** pressing downward on the body.

Section B: Short-response questions (150–250 words)

1 A soccer ball is flying through the air (from left to right) with *no* spin.

- **a** Annotate Figure 7.29 to show how energy is sucked out of the ball in flight.
- **b** Show flight direction, air streams, low- and high-pressure areas, and turbulent air region.
- **c** Discuss the direction of the Magnus force, explaining the reasoning for your decision.

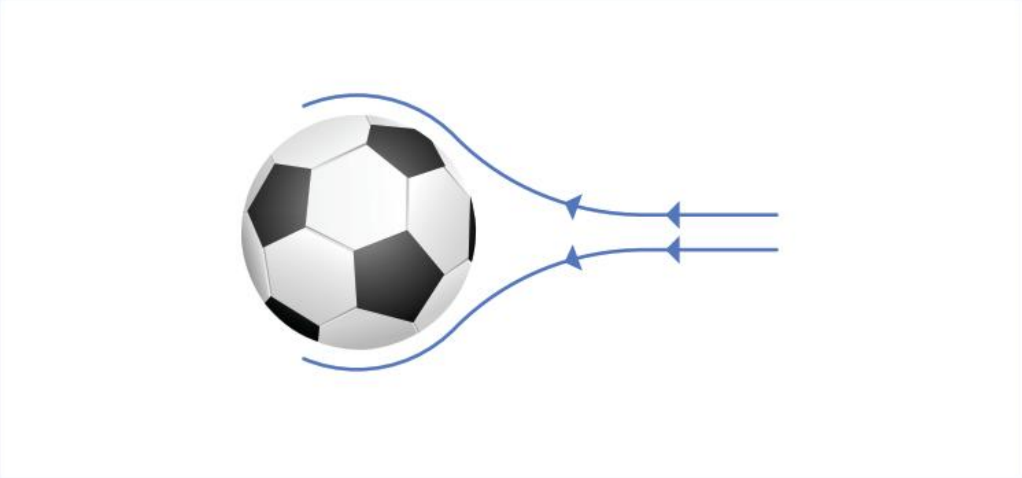


Figure 7.29
A soccer ball moving through the air with no spin

2 Figure 7.30 shows the pathways of a hammer (hammer throw) projected at selected angles from a height of 1.8 metres above ground level.
  a Complete the arc (parabola) for each pathway to ground level (dotted line).
  b Explain the advantage to be gained from a 1.8-metre height of release.
  c Which variable affecting the flight of a projectile would be the most efficient in achieving maximum distance?

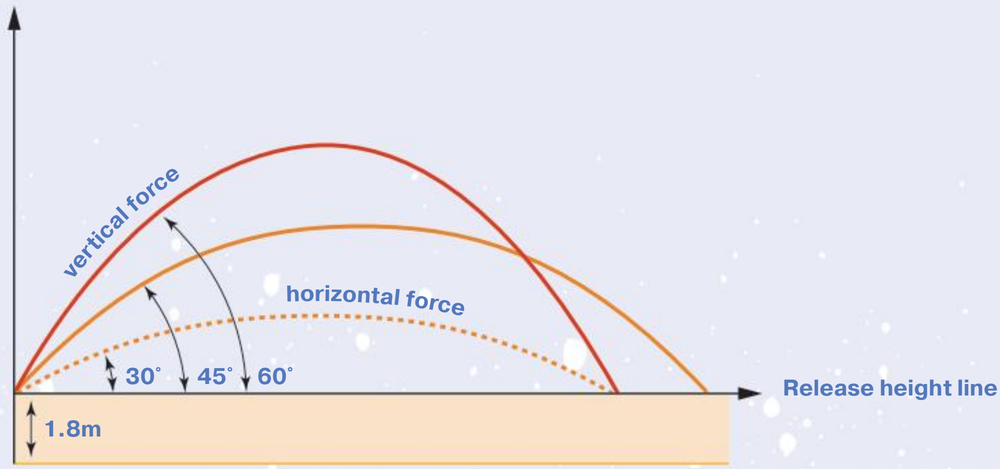
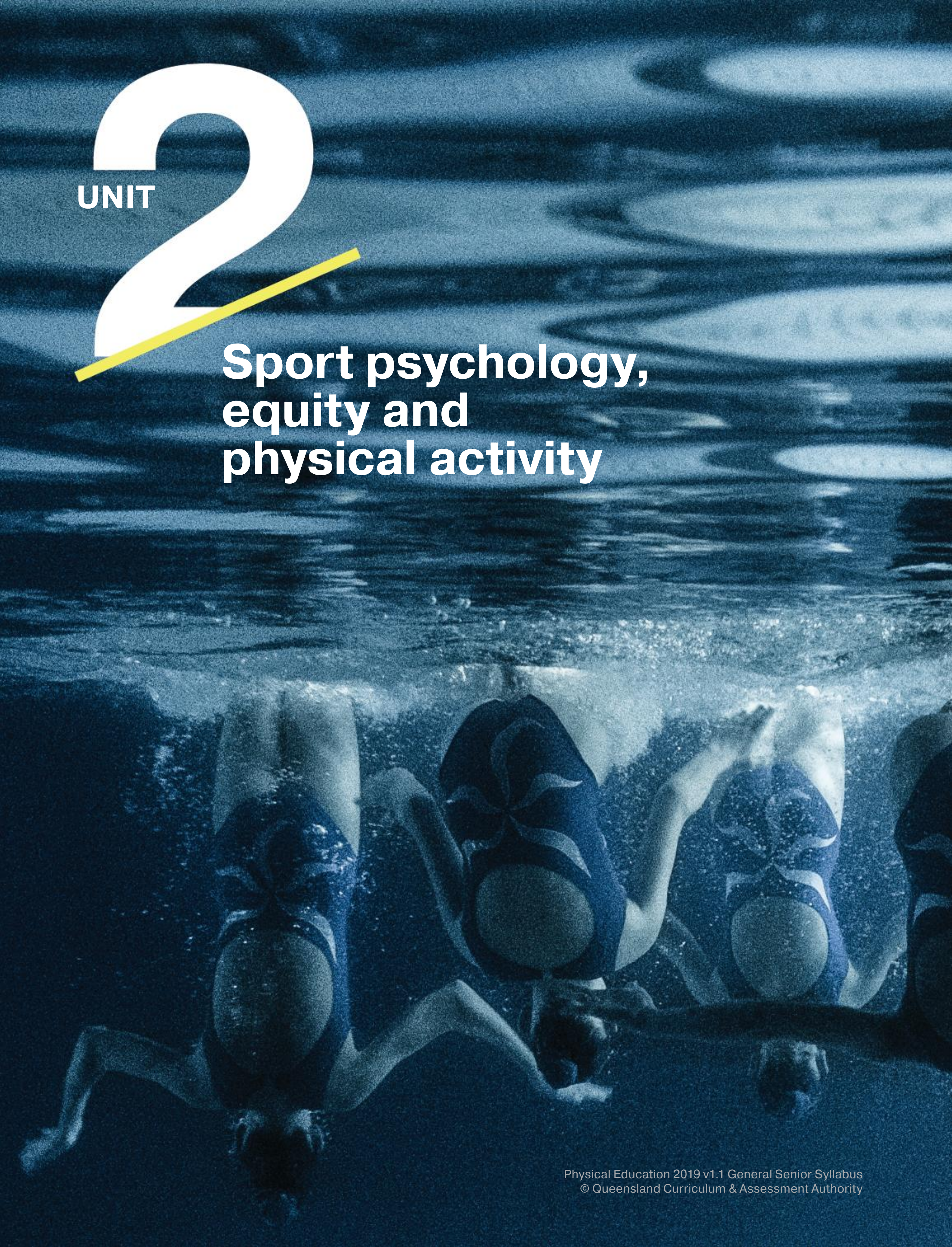


Figure 7.30
Possible pathways of a hammer throw

Section C: Extended response (400 words)

A tennis player plays a forehand drive from the back of the court with topspin. Describe the action of the racket in imparting topspin, and the subsequent arc of the ball as it crosses the net into the opponent's court. How would you expect the ball to rebound off the court, keeping in mind that the angle and speed of the rebound is relative to the incoming approach arc?



UNIT 2

Sport psychology, equity and physical activity

Unit 2 examines sport psychology and concepts of equity in physical activity, in the context of specific physical activities. In addition to demonstrating movement sequences and strategies, you will also observe, collect and analyse data to devise strategies around sport psychology and equity in physical activity.

Unit objectives

In Unit 2, you will:

1. recognise and explain sport psychology and equity concepts and principles about selected physical activities
2. demonstrate specialised movement sequences and movement strategies in the selected physical activity
3. apply concepts to specialised movement sequences and movement strategies in the selected physical activity
4. analyse and synthesise data to devise strategies about sport psychology and equity
5. evaluate sport psychology, equity and movement strategies
6. justify sport psychology, equity and movement strategies
7. make decisions about and use language, conventions and mode-appropriate features for particular purposes and contexts.

Physical activities

In Unit 2, the physical activities you explore must come from the following categories:

- Aesthetic
- Invasion
- Net and court
- Striking and fielding
- Performance
- Target.

Topic 1

Sport psychology

8 Discussing sport psychology

9 Developing psychological techniques

10 Determining optimal performance

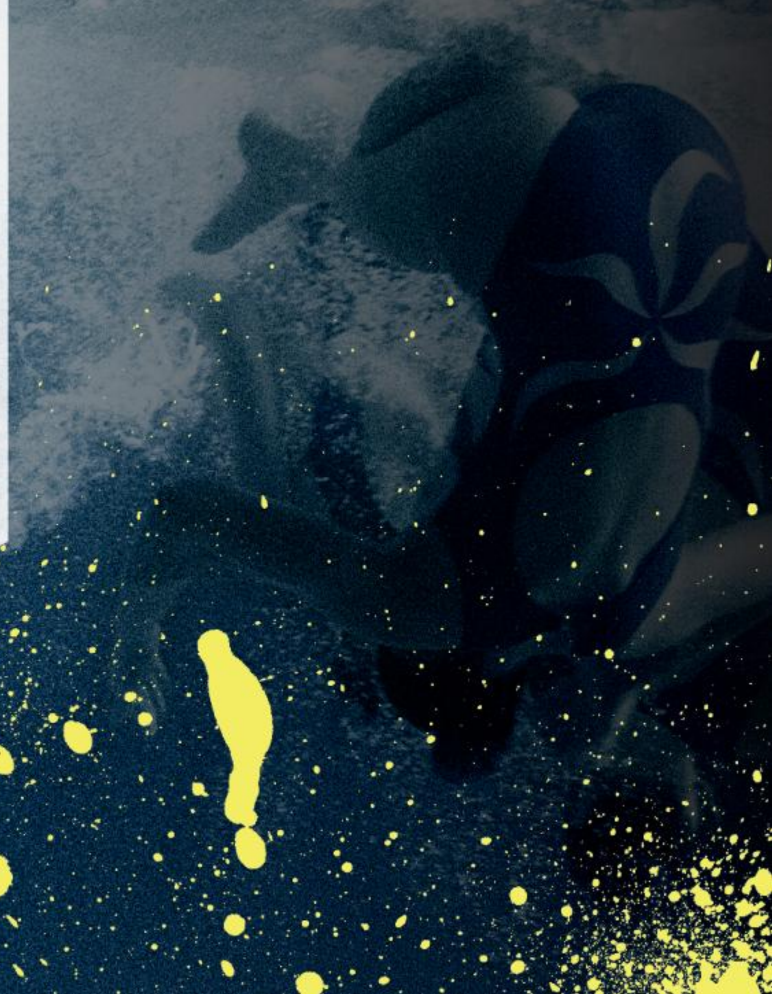
Topic 2

Equity – barriers and enablers

11 Considering access and equity

12 Manipulating barriers and enablers

13 Devising strategies for participation



8 DISCUSSING SPORT PSYCHOLOGY

Figure 8.1 The power of the brain in performance

In sport, the difference between success and failure is often between our ears. In order to improve our learning, participation and performance in physical activities, it's important for us to understand the impact of personal psychological factors. Achieving an optimal mental state leads to enhanced enjoyment and success in life and sport.

In this chapter, you'll explore psychological factors to understand how these influence personal performance. Through this, you will gain an understanding of how to enhance your own state of mind.

KEY QUESTIONS

8.1 What influences our state of mind?

8.2 How much impact does your motivation have on your performance?

8.3 How does self-image and self-belief impact performance?

8.4 How can you determine your ideal physical and mental state for performance?

8.5 How does the playing environment impact our mental state?

YOUR CHAPTER PLAN

- 8.1 Sport psychology concepts
- 8.2 Motivation
- 8.3 Confidence
- 8.4 Arousal
- 8.5 Attention and concentration
- **Chapter review**

8.1 Sport psychology concepts

As early as 1913, a **sport psychology** congress in Switzerland discussed the personal accounts of athletes and how **psychology** influenced performance in sport. Understanding how psychological factors affect an athlete's performance becomes vital in creating optimal performance. This understanding is also important for coaches and teachers when establishing a learning environment for young athletes.

Performers at all skill levels can benefit from a basic understanding of sport psychology. It can help in a range of areas, including:

- performance enhancement through mental skills training
- anxiety management and relaxation
- concentration and mental preparation
- arousal management
- team building and leadership
- post-performance debriefing
- injury rehabilitation.

According to sport psychologist Dr James E Loehr, 'At least 50 per cent of the process of playing well is a result of mental and psychological factors'.

In this chapter you will look at four of these psychological factors – motivation, confidence, arousal, and attention and concentration. These are not the only possible factors that can contribute to playing well, but they are some of the most significant.

sport psychology
the study of the psychological and mental factors that influence and are influenced by participation and performance in sport, exercise and physical activity

psychology
the study of the human mind and mental states

Figure 8.2 Understanding psychological concepts helps solve the puzzle of achieving an optimal state of mind.

Check your understanding 8.1

1. Describe how understanding sports psychology can help sporting performance.
2. Identify four psychological factors important for optimal sports performance.
3. How much of an athlete's performance may be due to psychological factors?

8.2 Motivation

motivation
the direction and intensity of effort

amotivation
a lack of motivation to act

extrinsic motivation
being engaged by external rewards, punishments or outcomes

intrinsic motivation
being engaged by the inherent pleasure of experiencing an activity

Motivation can be defined as the 'direction and intensity of one's efforts'. You can break that down further:

- *Direction* refers to an individual's attraction to certain situations; for example, an athlete's desire to beat their personal best.
- *Intensity* refers to how much effort an individual will put into the situation.

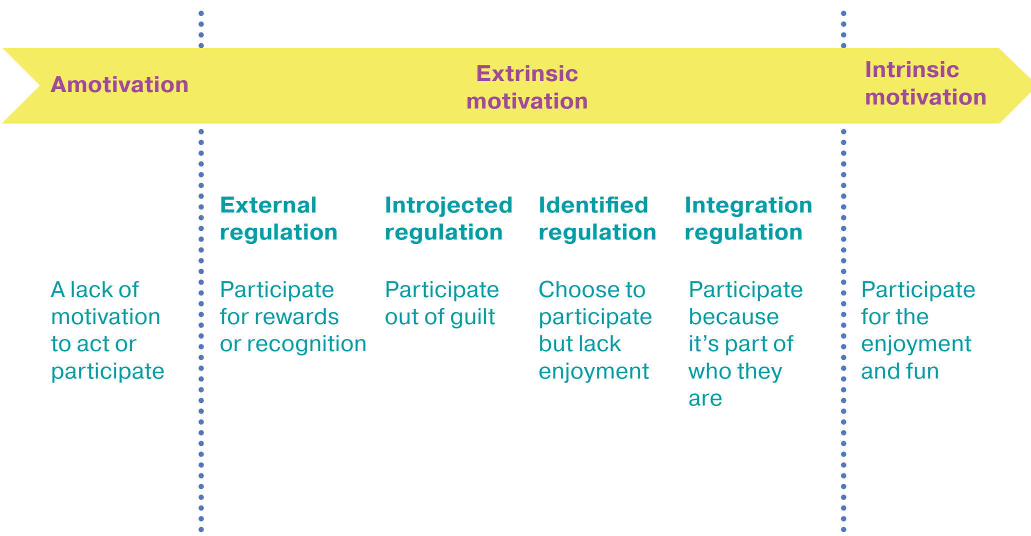
In other words, your motivation is how much you want something, and how much work you'll put into getting it.

Motivation is a process that can change over time. Motivation can influence how people feel, act and think, and so strengthen or weaken their desire to work towards a goal.

According to one theory of human motivation, motivation can be ordered along a continuum (Figure 8.3). This continuum ranges from a complete absence of motivation (**amotivation**), through engagement in activities to attain an external reward or to avoid punishment (**extrinsic motivation**) and finally to engagement in activities for enjoyment, pleasure and interest (**intrinsic motivation**).

One key principle of this theory is that you're more likely to engage in behaviours for which you feel intrinsically motivated. Another key principle is that intrinsic motivation comes from within; it can't be 'given' to someone.

Figure 8.3 The motivation continuum



Self-determination theory

The motivation continuum comes out of **self-determination theory** (SDT), a popular theory of human motivation developed by psychologists Edward Deci and Richard Ryan in the 1980s. The basic premise of this theory is that individuals are intrinsically motivated when three basic human psychological needs are met:

- autonomy – feeling of ownership through freedom of choice
- competence – feeling of success
- relatedness – feeling of a sense of belonging or social connection.

self-determination theory
human motivation theory that focuses on the degree to which an individual's behavior is self-motivated and self-determined

SDT proposes that when you are intrinsically motivated, you'll produce greater effort and enjoyment. This will then lead to greater task engagement and learning. For example, growing up you may have been intrinsically motivated to play backyard games. This could be explained in terms of your basic psychological needs for autonomy, competence and relatedness being met.

In other words, you were given freedom to choose what games you played, who played, and how they were played (autonomy). You would have chosen to play games that you were good at (competence). Finally, you played games with your friends, and didn't have parents or teachers telling you what to do and how to do it (relatedness).

Check your understanding 8.2

1. What is motivation?
2. Explain the motivation continuum.
3. According to self-determination theory, what are the psychological needs that, when met, lead to enhanced enjoyment and participation?

Evaluate and justify
motivation and self-determination

LEARNING EXPERIENCE

For each of the following statements, suggest the athlete's motivation type and degree of self-determination (if applicable). Justify your responses using evidence from any primary or secondary data.

1. I play soccer because it's who I am.
2. My coach says I could be an Olympic swimmer one day, but I still don't want to train any more.
3. I've entered a local fun run because I think I can win and the prize money is $1000.
4. I train six afternoons a week in the gym to increase my strength for rugby league. I don't enjoy the sessions, and sometimes I think about not turning up, but I know my coach will bench me if I don't.
5. As an elite triathlete, I love racing. I enjoy pushing myself in every race and always strive to beat my split times. I was born to race in triathlons.

CASE STUDY

Bernard Tomic crashes out of Wimbledon, admits feeling ‘bored’ on court

Adam Santarossa and Victoria Craw

BERNARD Tomic humiliated himself at Wimbledon, confessing to faking an injury and feeling too “bored” to play properly.

Bernard Tomic has admitted to feeling “bored” with tennis and losing respect for the game in an extraordinary press conference after crashing out of Wimbledon.

The Australian player was crushed in straight sets by No. 27 seed Mischa Zverev, who cruised to a 6-4 6-3 6-4 win.

In a brutally honest post-match press conference, the burnt-out Tomic admitted feigning an injury and having lost respect for the sport.

“To me, this is one of the biggest tournaments in the world that I have done really well in my career and, yeah, I just couldn’t find anything,” he said.

“It’s happened to me a lot. Just can’t find anything on the court. This is my eighth Wimbledon, or ninth I think. I’m still 24, and it’s tough to find motivation.”

Despite claiming, he had hurt his back on court and telling a trainer he had been injured in the warm-up, Tomic said he was actually suffering from a “mental issue”.

“It was definitely a mental issue out there,” he said. “I just tried to break a bit of momentum but just couldn’t find any rhythm and, you know, wasn’t mentally and physically there with my mental state to perform.

“I don’t know why, but I felt a little bit bored out there, to be completely honest with you.”

Source: news.com.au, 5 July 2017

QUESTIONS

1 Explain Tomic’s motivation to play tennis. Justify your response with references from the text.
2 What does Tomic mean by “it’s tough to find motivation”?
3 Explain how and why Tomic’s motivation affected his performance in Wimbledon.
4 As an intrinsically motivated athlete, write four statements that you would say after losing a match or game. Explain how these statements vary from Tomic’s response.

Environmental influences on motivation and performance

INTEGRATING MOVEMENT

Category: Invasion
Physical activity: Indoor soccer

Purpose

1 This activity involves assessing the impact of environmental influences on motivation while practicing indoor soccer techniques.
2 It involves two separate activities, which need to be set up and performed in order.

Preparation

Time: two lessons
Location: indoor soccer pitch
Equipment: soccer balls, markers, bibs; copies of Questionnaires A and B from your online resources

Activity 1: a traditional approach to practising dribbling

Setup

1 Make sure you have a print or digital copy of Questionnaire A.
2 Your teacher will demonstrate the step-over dribbling technique:
- The left foot circles the ball – without touching it – in an anti-clockwise direction.
- Dip the left shoulder so that it looks as though you will move that way.
- Now take the ball past your opponent with the outside of your right foot.

Performance

1 Form three lines along one side of the court, facing another three lines on other side of the court. Position a defender or marker in the middle, between the two lines.
2 Perform the following actions one person at a time, joining the line opposite once completed:
- walking to marker, no defender
- jogging to marker, no defender
- jogging (stationary defender, then laterally moving defender)
- running against defender.

3 Complete Questionnaire A.

Activity 2: a constraint-led approach to practicing dribbling

Setup

1 Make sure you have a print or digital copy of Questionnaire B.
2 Divide the class evenly between two 20 m × 20 m grids on the pitch.

Performance

1. Starting on the perimeter of the square, dribble to another side of the grid and then return to your starting point. Repeat until you have visited all sides. *Variations:* you can perform a 'trick' when dribbling across the grid; you're allowed to kick out the ball of another student (and they may kick out yours).
2. Form into pairs, and then partner with another pair.
3. With your partnered pair, set up a 10 m × 10 m × 10 m triangle, with a one-metre-wide goal at each point of the triangle.
4. Play one-on-one for one minute with your partner on one side of the triangle, with the other pair playing on one of the other sides. Score one point by moving between the small goals in control of the ball, from any direction.
5. Swap opponents with the other pair, and then play one-on-one for one minute again.
6. Complete Questionnaire B.

Data recording

As noted, complete Questionnaires A and B after completing the two activities. DE 1

Tasks

1. Answer the following questions about your play in Activity 2.
   a. When dribbling, how did you trick your opponent?
   b. What information were you looking for from your opponent, and how did you co-adapt your movements in relation to each other?
   c. When dribbling, how did you protect the ball from your opponent?
   d. When defending, what was your body position in relation to the attacker and the goals?
   e. What was the effect of having another 1 v 1 game in your triangle?
2. Refer back to your responses to Questionnaires A and B. Calculate your average score for each basic psychological need and overall self-determined (intrinsic) motivation score for each approach (activity). DE 3
3. Compare each approach in terms of how it satisfied each of your basic psychological needs (competence, autonomy, relatedness) and you overall intrinsic motivation.
4. Evaluate which teaching approach's practice design and delivery of instruction and feedback (Activity 1 or Activity 2) was more intrinsically motivating for you. Justify your conclusion using primary data about basic psychological needs. DE 4

http://mea.digital/qpe12_8

8.3 Confidence

A critical factor that influences participation in physical activity is an athlete's **perceived competence**. Your perception of ability within a specific physical activity focuses on the skills you think you have and is linked to your **self-confidence**, which is how much you believe you can apply the necessary skills to be successful.

These cognitive processes, which an athlete uses to judge how well they can accomplish a specific goal in sport, are based on the athlete's perception of the playing environment and their own capabilities to accomplish success. **Self-efficacy** (a term often used interchangeably with self-confidence) relates to what they think they can do in a specific situation. For example, 'I think I can serve and volley against the best returner in tennis.'

Sport and exercise psychologist Deborah L Felt and professor Erman Oncu, both researchers in the field of self-efficacy, stated that 'approximately 16% of the variance in athletic performance can be attributed to self-efficacy beliefs – a very meaningful percentage in sport performance'.

perceived competence
the ability and skills you think you have

self-confidence
a feeling of trust in one's abilities, qualities, and judgement

self-efficacy
the strength of one's belief in one's own ability to complete tasks and reach goals

These self-efficacy beliefs influence your thought patterns and emotions when participating in physical activities, and can influence your motivation to act or achieve success. According to self-efficacy theory, an athlete's level of confidence influences their motivation by the choices they make, the effort they apply and how much they persist in any given situation. Athletes who have high efficacy beliefs are more likely to pursue challenges and cope with pain, whereas athletes with low efficacy beliefs are likely to worry about injury or failure during play and lack persistence in times of difficulty.

Figure 8.4
A positive state of mind is generated from a confident mind.

An athlete's **self-belief** is determined by their level of self-efficacy. An athlete with high self-efficacy will have strong self-belief and identify as a good player.

self-belief
confidence in oneself and one's ability

These concepts build upon each other to become broader and more global:

- perceived competence – I can volley in tennis
- self-confidence – I can win points with my volleys
- self-efficacy – I can serve and volley against the best returner in tennis
- self-belief – I am good at tennis.

Given the impact self-efficacy has on performance and participation, it's important to consider the environment in which children learn. This performance environment will affect the child's self-efficacy, and therefore their motivation towards physical activity. Especially for a child who perceives their competence to be low, the environment needs to meet several key requirements:

- it avoids comparison with others
- it focuses on a player's strengths
- it encourages participation following failure
- it promotes an understanding of individual differences.

8.3 Check your understanding

1. Why is intrinsic motivation described as more long-lasting than extrinsic motivation?
2. Explain how confidence influences motivation.
3. How does the playing environment influence someone's perceived competence in a physical activity?

CASE STUDY

Tennis should be child's play for Bernard Tomic

Jeff Bond

What is behind Tomic's feeble effort and "don't care attitude"? In my professional view it is the byproduct of a motivational mindset that is insufficient to deal with the pressures of professional tennis over the long term. Many young players aspire to success and the rewards that accompany that success. But my experience is that motivation based on gaining external rewards, while initially successful, is not sustainable over time.

None of us have total control over winning and the attainment of external rewards. This lack of control (losing) ultimately leads to low self-confidence and self-belief, fluctuations in mood states, and a motivational and emotional roller coaster. Inevitably we see what we saw in Tomic's Wimbledon performance. It is similar for those of us choosing a job solely for the money. It might be OK for a while, but we soon find it impossible to enjoy the job, lose motivation and end up looking for something else to do.

The solution to this unsustainable drive towards the material trappings of success is to take a lesson from the play of very young children. They will play for hours with no external rewards, just the satisfaction and pure joy associated with doing something they like.

In tennis terms this type of internal or intrinsic motivation can be seen in the highly respected mature-age players like Roger Federer, Novak Djokovic or Rafael Nadal. It is their focus on the core processes of the sport that provides them ongoing satisfaction.

They are motivated by setting up a point and then finishing it off. The setting up is their intellectual challenge; to out-think and outsmart their opponent, and the finishing-off is the "feel good" component. Anyone who has ever hit a tennis ball off the sweet spot knows how great this feels. These processes are well within the control of the talented player.

I have a message for the parents and coaches of talented, aspiring young tennis players: play down the external rewards in sport, play down the importance of trophies and the status that comes with winning. We should teach and coach our kids to be intrinsically rather than extrinsically motivated. Don't focus on the outcomes, as appealing as they might be. The outcomes look after themselves if we immerse ourselves in, and execute, the core of what we love doing.

Source: *The Age*, 9 July 2017

QUESTIONS

1. Explain why intrinsic motivation is more desirable than extrinsic motivation.
2. Critically analyse how focusing on trophies and prizes could be detrimental to how long a child's motivation to participate in physical activity lasts.
3. Describe the relationship between extrinsic motivation and self-belief.

Engage and understand
the effects of efficacy

LEARNING EXPERIENCE

1. Recall a situation when you had high efficacy, and describe your competence in that physical activity.
2. Describe the factors that helped you create a high efficacy.
3. Recognise a situation when you had low efficacy, and describe your feelings towards and participation in the physical activity.
4. Explain the factors that contributed to your low efficacy.

8.4 Arousal

arousal
a heightened sense of physical and mental alertness or activation

optimal level of arousal
the level at which an athlete performs at their best

inverted-U hypothesis
theory that performance increases with physiological or mental arousal, but only up to a point

Arousal is your level of physical and mental alertness, and is a blend of physiological (physical) and psychological (mental) factors. It ranges on a continuum from relaxed drowsiness through to rage, and is a prerequisite for optimal sporting performance. Even though the top end – rage – is something to be avoided, arousal itself is not a bad thing.

How a player thinks about a situation creates a series of reactions that can lead to increased levels of arousal. It is in a player's best interest to be able to identify the level of arousal that leads to their optimal sporting performance. Each player's **optimal level of arousal** will be different as it depends on personal factors, such as:

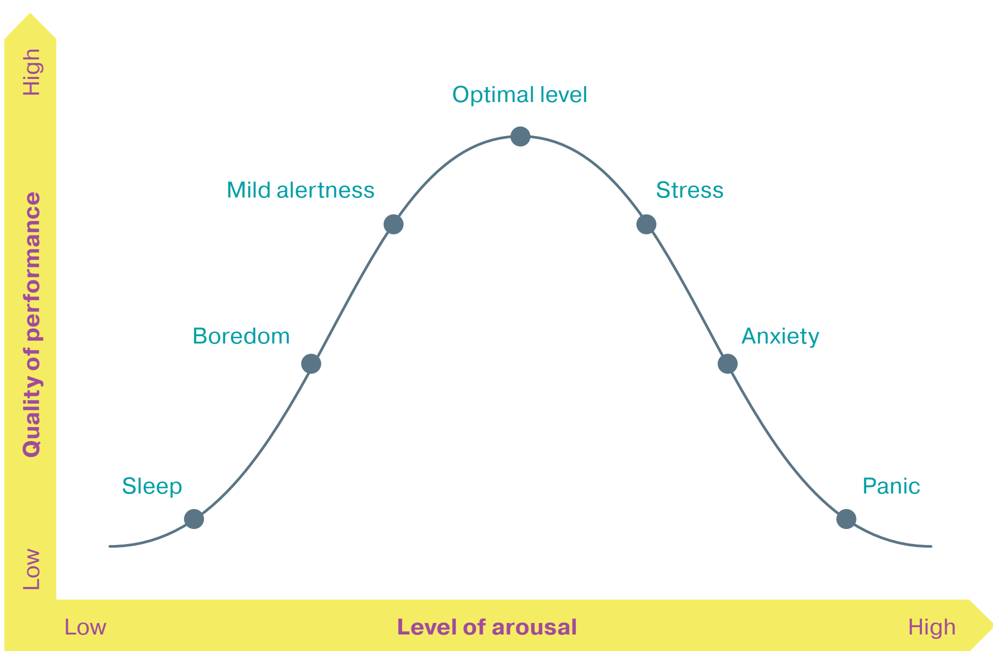
- personality traits (for example, a tendency to be a perfectionist)
- level of confidence
- expectations
- cognitive anxiety
- situational factors such as coaching style, rewards, audience and the difficulty of the task.

All of these factors influence the effect of arousal on performance.

For an athlete to optimise their performance, they need to understand their optimal arousal state. This optimal arousal will vary from situation to situation, athlete to athlete and sport to sport. A perceived positive state, such as feeling relaxed, can have a positive or negative impact on performance.

Several theories have attempted to qualify the relationship between arousal and performance. One of the earliest theories is the **inverted-U hypothesis** (sometimes called the Yerkes–Dodson law, after its researchers).

Figure 8.5 Arousal continuum: the inverted-U model of the arousal–performance relationship



The inverted-U hypothesis equates low levels of arousal with poor performance, as shown in Figure 8.5. As arousal increases, performance improves until an optimal level of arousal is reached. Beyond this peak an athlete is over-aroused, and performance deteriorates.

The relationship between arousal and performance differs greatly between sports. For instance, a golfer requires far less arousal for optimal performance than a hockey goalie.

The optimum level of arousal for a beginner is considerably lower than that for a skilled performer carrying out the same task. This partly explains why skilled performers are at their best in competitive situations whereas novices underachieve in similar situations.

Figure 8.6
The performance environment affects an athlete's arousal level

Increased arousal levels cause muscle tension and fatigue and subsequently reduce coordination, resulting in inferior performance. Muscles that are tense for long periods also require more energy; this is why in endurance events (such as marathons), or events that have long wait times between performances (such as athletics and gymnastics), athletes try to remain as relaxed as possible both before and during the event, in order to conserve energy.

Anxiety

If you've ever sat an exam, played a competitive sport or worried about a sick friend, you know what **anxiety** feels like.

Anxiety is typically related to negative emotions. A person who's anxious about an upcoming competition may not be able to sleep well and, consequently, may not perform at their best.

anxiety
a subjective feeling of apprehension, accompanied by a heightened state of arousal

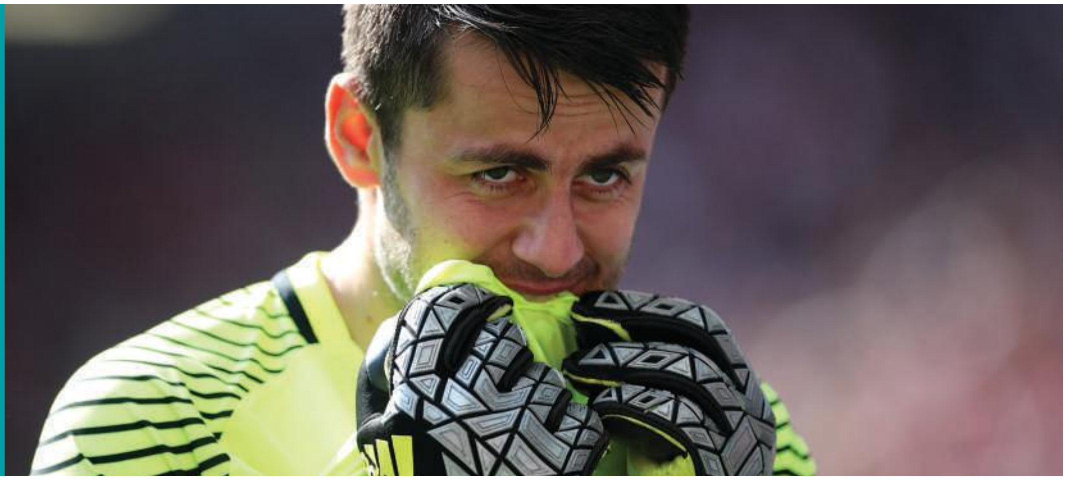


Figure 8.7 Anxiety can cripple the mind and performance.

Anxiety is a subjective feeling of apprehension that is accompanied by a heightened state of arousal. There are two dimensions of anxiety: the physiological (called **somatic anxiety**) and the psychological (**cognitive anxiety**).

- Cognitive anxiety involves having negative thoughts about an upcoming performance. For example, an athlete may fear being beaten, as they perceive their skills to be inferior to those of their opponent.
- Somatic anxiety involves physical sensations. An example of somatic anxiety would be the feeling of 'butterflies' in your stomach, sweaty palms or an increased heart rate.

somatic anxiety the physiological symptoms of anxiety

cognitive anxiety negative thought patterns towards a person's own performance

Anxiety can lead to increased levels of arousal, which can actually be helpful to athletic performance. Whether or not an athlete performs to their best will depend on whether they perceive these signs as positive or negative.

Measuring arousal

Arousal produces physiological changes in the body and can be measured using a number of physiological indicators, including muscle tension, brainwave activity, respiration rate, biochemical indicators, blood pressure and sweating.

- An electroencephalogram (EEG) measures brainwave activity. Three different brain waves (alpha waves, beta waves and theta waves) are associated with differing levels of arousal.
- An electrocardiograph (ECG) measures the electrical activity of the heart. High heart-rate fluctuations alone are not a good indicator of levels of arousal, as they can have other causes.
- Catecholamines are a group of neurotransmitters in the brain and include epinephrine, which is commonly known as adrenaline, and norepinephrine. Your body releases catecholamines into the blood when you are aroused; this measure is a reliable indicator of arousal.
- An electromyograph measures electrical activity in muscle. Muscle tension level is an approximate indicator of the level of arousal.
- A spirometer measures a person's respiration rate, tidal volume (the normal amount of air you breathe out) and vital capacity (the maximum amount of air you can breathe out), all reasonable indicators of levels of arousal.

To perform at an optimal level, an athlete needs to be aware of their level of arousal on a scale of 1–10 at any point in time. If they are under-aroused, they need to energise; if they are over-aroused, they need to relax. Indicators such as these give athletes objective information about their arousal level, which can supplement (or even replace) their own subjective awareness of their arousal level.

Check your understanding 8.4

1 Explain why arousal varies from person to person.
2 Describe the two dimensions of anxiety.
3 Explain how arousal influences performance.

Evaluate and justify emotions and performance

LEARNING EXPERIENCE

Emotions play a pivotal role in athletic performance. Emotions influence motivational processes by directing action tendencies toward (e.g. excitement) or away from (e.g. fear) a situation or stimuli. High levels of arousal have been seen to benefit performance on simple tasks that require power such as weight lifting, but can be detrimental to fine motor task performance.

1 Using your knowledge about the physiological changes caused by arousal, explain why high levels of arousal benefit weight lifting.
2 Based on your experiences and knowledge of your personal characteristics, evaluate your optimal arousal level for each of the following physical activities by placing them on an arousal continuum from 'low' to 'high'.

boxing	golf
tennis	100-metre sprint
weight lifting	archery
javelin	cheerleading
surfing	basketball
AFL	mountain biking

3 Select one of these physical activities and justify your placement of the physical activity on the arousal continuum by referring to personal factors, such as personality traits.

Measuring anxiety in a team game

INTEGRATING MOVEMENT

Category: Net and court
Physical activity: volleyball

Purpose

This activity involves recording observations about your anxiety levels and serving performance when playing volleyball.

Preparation

Time: one lesson
Location: volleyball court
Equipment: volleyballs, nets, bibs; recording tables

Setup

Form teams of six, depending on numbers and courts available.

Performance

1. Play a full 3-on-3 game of volleyball, but with the following conditions:
   - only one overhead serve allowed per player
   - a missed serve (out or into the net) results in loss of a point plus 10 burpees for the server and their team.

Data recording

1. Record how you feel about serving before, during and after the game.
2. Record the outcome (successful / not successful) of each serve you perform. DE 1

Tasks

1. Gather primary data regarding your success in serving within this volleyball game.
2. Analyse and synthesise the primary data to describe your arousal level throughout this game, using specific examples from the performance environment. DE 3
3. Reflect on the primary data to evaluate how the performance environment influenced your performance, motivation, enjoyment and confidence. DE 4
4. Applying your knowledge of self-determination theory, were your needs being met during this activity? How were they met or not met?
5. Propose changes to the performance environment and justify why these strategies would enhance your performance, motivation, enjoyment and confidence.

8.5 Attention and concentration

Attention

When you participate in a physical activity, your awareness of the environment and acknowledgement of cognitive processes is known as your **attention**. Optimal performance is determined by how you attend to the **sensory information** within the performance environment. What information is relevant, and requires your attention, varies between physical activities and playing positions.

Robert Nideffer is a sports psychologist. His background in diving led to his research in predicting and controlling behaviour. In turn, this research led to the development of a model of attention. The model, shown in Figure 8.8, identifies two dimensions of concentration: *width* (broad or narrow) and *direction* (external or internal). The width of an athlete's attention can extend along a continuum from a single cue to numerous cues. The direction of attention can also extend between internal (thoughts, feelings) and external (opponent, ball).

attention
your awareness of the environment and acknowledgement of cognitive processes

sensory information
cues within the environment that can be accessed using one or more of the senses

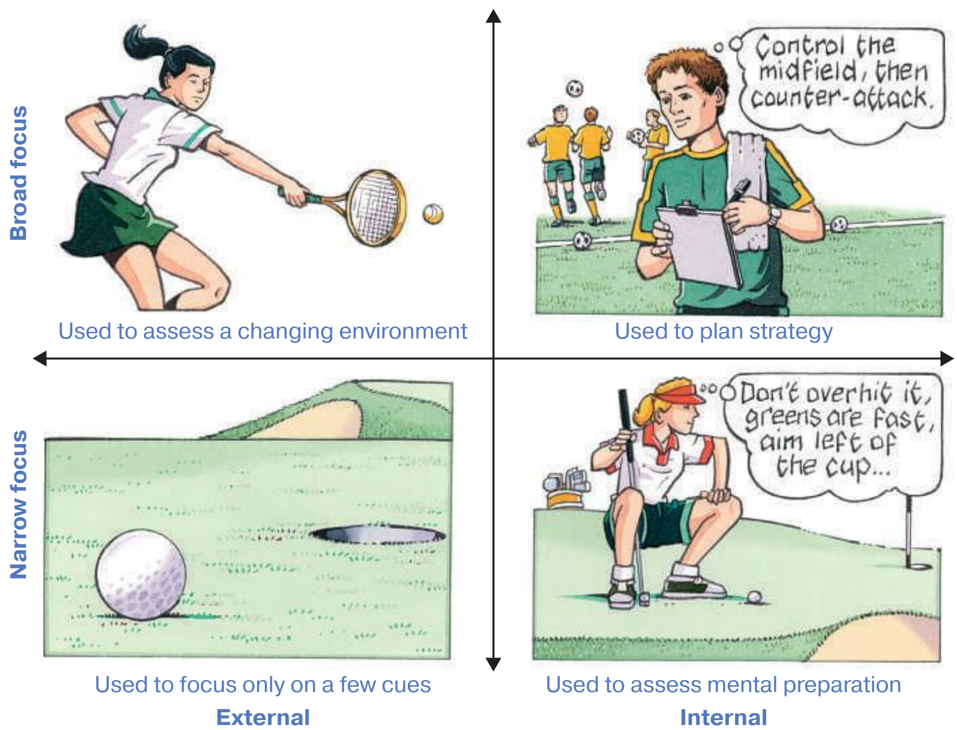


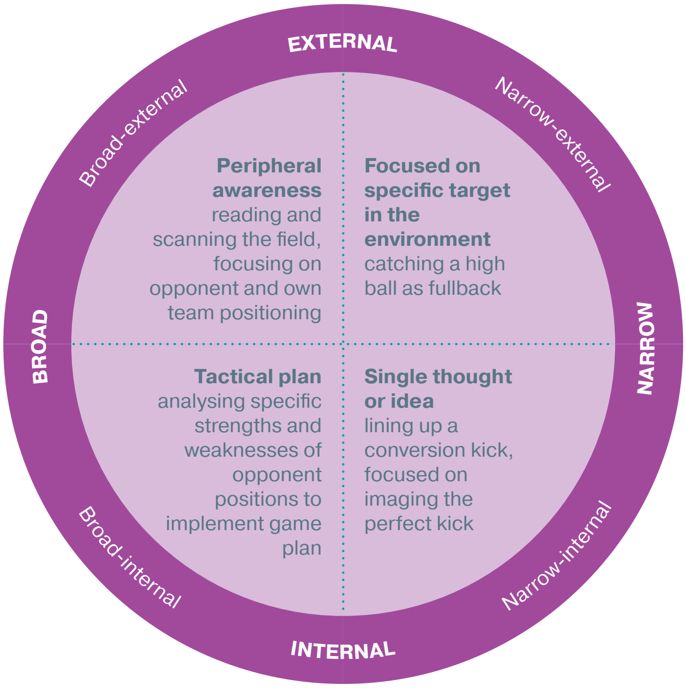
Figure 8.8 Nideffer's model of attentional focus

The combination of width and direction leads to four different categories, and is known as **attentional focus**. Athletes change their attentional focus between the four categories of attentional focus depending on the situation. Figure 8.9, on the following page, shows an example of attentional focus for a rugby league player.

An athlete's ability to change, maintain and direct their attentional focus depends on many factors such as ability, experience, playing conditions and confidence. Too much sensory information (or the inability to prioritise the relevance of the sensory information) can lead to attention overload.

attentional focus
the combination of width and direction in regards to concentration

Figure 8.9 Attentional focus of a rugby league player



To avoid overload, it's important that the skills and demand for cognitive processing (for example, strategies and decision making) are simplified for young or beginning athletes. For example, a teacher may reduce the number of rules, the size of the playing environment and the number of defenders within a game of netball to help beginning athletes develop their skills. By reducing the sensory information, the demand for skills and cognitive processing is lowered for the beginner.

Engage and understand
chipping onto the green in golf

LEARNING EXPERIENCE

For each of the following performance phases, identify the attentional focus (broad-external, broad-internal, narrow-external, narrow-internal).

1. Assessing the environment to understand the requirements of the shot
2. Applying knowledge of your own ability and previous experiences to current situation
3. Club selection
4. Focusing on the hole (distance and direction)
5. Thinking about the ideal shot and how it will feel in the swing
6. Deciding on where you need the ball to initially land, in order to finish in the hole
7. Taking the shot – feeling the swing and contact with the ball
8. Analysing where the ball landed and how far it is from the target
9. Thinking about how the shot felt
10. Evaluating the shot to identify successful and poor decisions made during the last shot

Concentration

You often hear athletes talk about 'losing concentration' during big sporting moments, but can concentration actually be 'lost'? Concentration is like a mental spotlight; it can be directed by an athlete but it is never actually turned off. It might be more accurate to say that poor performance can be caused by *misdirected* concentration.

Concentration is the ability to deliberately focus your attention on the task and block out distractors. This focus on the task can be in the form of **selective attention** (zooming in on relevant information and ignoring irrelevant information) or **divided attention** (focusing on several sensory stimuli simultaneously). In a performance environment, there are times when selective attention is desirable for optimal performance and situations when divided attention is most effective.

selective attention
a deliberate focus on relevant information, ignoring irrelevant information

divided attention
a simultaneous focus on more than one sensory stimulus

Figure 8.10 As a goalie, you need to concentrate on the opponent's body position and anticipate ball flight to successfully intercept the ball.

Flow

When an athlete is completely focused on the task at hand and their skills match the challenge of the competition, they will often report that 'they are in the zone'. This state of mind is called **flow**, a term proposed by Mihály Csíkszentmihályi (pronounced *cheek-sent-me-high-ee*), a Hungarian professor.

Csíkszentmihályi defined flow as 'the state of concentration so focused that it amounts to total absorption in an activity'. This is sometimes referred to as being in 'auto-pilot'. His research identified nine essential elements of the flow state:

1. equal balance between challenge and skills
2. transformation of time— ('It was over before I knew it')
3. clear goals
4. merging of action and awareness
5. total concentration on the activity
6. loss of self-consciousness
7. a sense of complete control
8. effortless movement
9. no need for extrinsic rewards.

Flow isn't just a desirable state of mind for athletes. Writers, actors, musicians, coders, businesspeople and even videogame players all have their flow states in which they get absorbed in their work or activity.

flow
a state of mind in which a performer feels as though they are 'in the zone'

Internal and external distractors

Distractions are the main obstacle to maintaining concentration and directing focus. Distractions within the performance environment can be divided into two categories: **internal distractors** (such as emotions or pain) and **external distractors** (such as background or environmental noise).

internal distractor
a thought or feeling that diverts attention from the present attentional cues

external distractor
an irrelevant external cue that diverts attention from the present task

choking
a process of increasing anxiety due to the perceived importance of an event

pressure
a feeling of great stress, of not being in control

Internal distractors

Many internal thoughts or feelings can be internal distractors. In a badminton match, a preoccupation with the previous poor shot selection could be a distractor. Focusing on past events takes your concentration away from the present cues required for good performance. Negative thoughts are common distractors.

Performing badly at a critical time in a match, with a high degree of perceived importance, is commonly called **choking**. Choking is a process, not a single incident. There are two factors that combine to cause choking.

First, the perceived importance of the performance causes athletes to consciously monitor movements that they normally execute without conscious control. This monitoring disrupts natural skill execution that otherwise would be automatic.

Second, as arousal increases, athletes become immersed in internal distractions, such as worry, resulting in failure to attend to important cues. Worry uses the athlete's working memory that otherwise would be used to focus on the task. Their attention becomes internally narrowed on distractors, such as the fear of losing (cognitive anxiety), the performance expectations of the audience or the fear of making a bad decision.

The culmination of perceived **pressure** can lead to muscle tightness, increased heart rate and breathing, sweaty hands and a dry mouth (somatic anxiety). The increased pressure creates more anxiety and limits an athlete's ability to change their attention to a broad external focus. As a consequence, they experience increased muscle tension, which results in poor timing and coordination.

Recent research indicates that appropriate training under increased pressure and anxiety may prevent athletes from choking in high-stake situations. This not only has implications for sporting performance but also for workplace performance in occupations where pressure is an integral component, such as police work or firefighting.

Fatigue is also a distractor from good performance, as anyone who has played high-intensity sport will attest. Poor concentration follows hand in hand with tiredness. This is why a high level of fitness plays such an important role in maintaining good sporting performance.

External distractors

Almost anything in the performance environment has the potential to become a distraction. Success can hinge on an athlete's ability to block out these distractors and maintain concentration on the relevant cues of the match.

Visual distractors are by far the most common form of external distractor. There are many opportunities in the playing environment to be distracted by visual movement in the form of spectators, your opponents, the scoreboard or even television cameras.

Auditory distractors include crowd noise, mobile phones, loud spectators, train or aircraft noise and the noise of an opponent during a match (for example, outbursts or grunts from tennis players).

Gamesmanship, such as sledging or trash talking, serves as another external distractor often used tactically by teams. This kind of tactic might be used to put an opponent off their game; for more skilled opponents who are harder to distract, it can be a way of disrupting their flow just enough to gain an advantage.

gamesmanship using ploys and tactics to gain a psychological advantage in a competition

Overcoming distractors

One way to overcome both internal and external distractors is to allow movement to occur unconsciously.

Releasing conscious control over movements, allowing movement to occur automatically, can be understood when considering the movement of walking in a straight line. This can be successfully performed by many people with little control or thinking.

Now consider what happens when this movement is applied to a different performance environment, such as walking on a high ropes course. Now the walker's concentration is likely to go to 'not falling' instead of walking. Straight line walking, within a high ropes course, can therefore bring on cognitive and somatic anxiety due to the person's perceived ability to complete the task.

Figure 8.11 In golf it's easy to be distracted by external elements, such as the crowd or weather.

Check your understanding 8.5

1. What is attentional focus? Explain what influences an athlete's attentional focus.
2. Explain how one's concentration can vary from selective attention to divided attention within a game.
3. Describe the two categories of distractors and include a specific example for each.

Attentional focus

INTEGRATING MOVEMENT

Category: All
Physical activity: All

Purpose

1. This activity involves observing how attentional focus affects performance of a specialised movement skill.
2. This activity focuses on the physical activity your teacher has selected for this topic.
3. The primary data collected in this activity could be used to support your folio task. DE 5

Preparation

Time: two lessons
Location: depends on activity
Equipment: depends on activity; digital capture device with audio recording capability

Setup

With a partner, select a specialised movement skill relevant to your physical activity (for example, chipping onto the green for golf, or shooting a free throw for basketball).

Performance

1. Take turns to perform the specialised movement skill and to film your partner's responses and their performance of the skill.
2. As you prepare to execute the specialised movement skill, verbally explain to your partner what you are focusing on.
3. Repeat the movement skill five times in a row.

Data recording

1. Record video and audio of all of your partner's performances. DE 6 DE 1
2. Share all footage with your partner when recording is completed.

Tasks

1. Analyse and synthesise your primary data, categorising how you paid attention to the sensory information in the performance environment using attentional focus (categories), internal distractors and external distractors. DE 3
2. Reflect on the primary data to evaluate how effective your focus was in creating a successful performance.
3. Create a list of sensory information you should attend to (attentional focus) to help you enhance your focus and improve your performance.
4. Now repeat and record your performance five more times. This time, while recording your execution, your partner should draw your attention to the relevant sensory information, based on your prepared list.
5. Reflect on the video recording of your performance to evaluate your effectiveness in improving your focus and performance, either by writing a short reflection or by filming your partner making a short verbal reflection. DE 4

Chapter review

[8.1] Knowledge of sport psychology is important in creating optimal performance.

[8.2] Motivation can be described on a continuum from amotivation to intrinsic motivation. According to self-determination theory, individuals are intrinsically motivated when three basic human psychological needs are met: autonomy, competence and relatedness. Extrinsic motivation is linked to engagement from an external reward, the avoidance of punishment and a sense of obligation.

[8.3] An athlete's motivation is influenced by their confidence, which is based on their perceived competence in relation to the task, other athlete performances and the playing environment. Perceived competence is a critical factor that influences participation in physical activity. Self-efficacy beliefs reflect what an athlete thinks they can do, while self-belief is determined by an athlete's level of self-efficacy.

[8.4] Arousal is an athlete's level of physical and mental alertness. The inverted-U hypothesis equates low and high arousal to poor performance. Optimal arousal differs between people and physical activities. There are two dimensions of anxiety: somatic anxiety and cognitive anxiety.

[8.5] Optimal performance is determined by how you attend to the sensory information within the performance environment. Concentration is the ability to deliberately focus on the task and block out internal and external distractors. The process of choking causes poor performance in a critical and high-pressure performance situation.

Review questions

Section A: Multiple-choice questions

1 Motivation is:
- **a** a process that can change over time.
- **b** the direction and intensity of one's efforts.
- **c** measured on a continuum.
- **d** all of the above.

2 According to Deci and Ryan's self-determination theory, an athlete is intrinsically motivated when:
- **a** there is no extrinsic motivation.
- **b** they feel competent and confident.
- **c** they feel a sense of ownership, success and belonging.
- **d** they choose to participate.

3 Athletes who have high ______ are more likely to pursue challenges and cope with pain, whereas athletes with low ______ are likely to worry about injury or failure during play and lack persistence in times of difficulty.
- **a** self-belief
- **b** confidence
- **c** motivation
- **d** efficacy beliefs

4 Arousal is:
- **a** a negative emotion.
- **b** important for optimal performance.
- **c** determined by the demands of the physical activity, not personal factors.
- **d** also known as anxiety.

5 The physiological symptoms of anxiety are known as:
- **a** somatic anxiety.
- **b** cognitive anxiety.
- **c** arousal.
- **d** choking.

6 According to Nideffer's 1981 model of attention, there are two dimensions of concentration:
- **a** width and length.
- **b** width and direction.
- **c** direction and intensity.
- **d** internal and external.

7 The categories of attentional focus are:
  a narrow-external, narrow-internal, broad-internal and broad-external.
  b narrow-external and broad-external.
  c broad-internal and broad-external.
  d narrow-direction, broad-direction, broad-width and narrow-width.

8 Concentration is best described as:
  a focusing on relevant information.
  b a mental spotlight that can be lost in a performance environment.
  c deliberately focusing one's attention on the task and blocking out internal and external distractors.
  d a state of mind where you feel like you're 'in the zone'.

9 Focusing on a previous poor shot takes concentration away from focusing on the relevant cues in the performance environment and is known as:
  a divided attention.
  b high arousal.
  c an internal distractor.
  d broad-internal attentional focus.

10 Mihály Csíkszentmihályi describes flow as a state of mind where you feel like you are 'in the zone'. His research identified nine essential elements of the flow state: which of the following is *not* one?
  a clear goals
  b effortless movement
  c a need for extrinsic motivation
  d loss of self-consciousness

Section B: Short-response questions (150–250 words)

1 Describe the ideal learning environment for a child with low perceived competence in a physical activity.

2 Explain why intrinsic motivation is preferred over extrinsic motivation.

3 Describe the process of choking and what factors can cause it.

Section C: Extended response (400 words)

Watching a media conference after a tennis match, you hear the athlete say:

> *I just wasn't mentally there today. I know this is a huge part of why I lost. I felt like I was in the zone in the first set and my shots felt easy, but in the second and third I just couldn't find a rhythm. The ball kept hitting the frame of the racquet on my returns and that just frustrated me more.*
>
> *I think I was more focused on what the crowd were yelling out to me than on the ball. Maybe having a coach would help, but I prefer to do my own thing and like the freedom of being my own coach.*
>
> *Being number one just doesn't motivate me anymore. I don't love doing this and would rather hang out with friends than slave away on the tennis court for hours. Everyone keeps telling me that I was born to be a tennis player, but I don't think I'm cut out for this. I haven't won a match in two months and to be honest with you, I'd be happy to never step onto a tennis court again.*

Evaluate how the athlete's motivation is affecting their enjoyment, confidence, arousal, attention and performance in tennis. Justify your response by referring to the stimulus and secondary research.

Figure 8.12
How is this athlete's motivation affecting him?

9 DEVELOPING PSYCHOLOGICAL STRATEGIES

Figure 9.1 Psychological strategies help athletes in a variety of performance environments

To improve performance, athletes use a range of psychological strategies. These are skills that need to be practised and regularly included in training and competition performance environments. The more effective you are at using the technique, the more you can enhance your state of mind and performance.

In Chapter 8, we explored several psychological factors: motivation, confidence, arousal and attention and concentration. In this chapter, you will learn how to regulate and enhance these factors, and how this can improve personal performance. You will investigate a range of techniques to understand how psychological techniques influence personal state of mind and performance.

KEY QUESTIONS

9.1 How can psychological techniques prepare you for performance?

9.2 How can you quickly enhance your mental state during performance?

9.3 How can you improve your attention during performance?

9.4 What techniques can keep you at the right level of arousal?

9.5 What techniques can help you achieve a flow mindset?

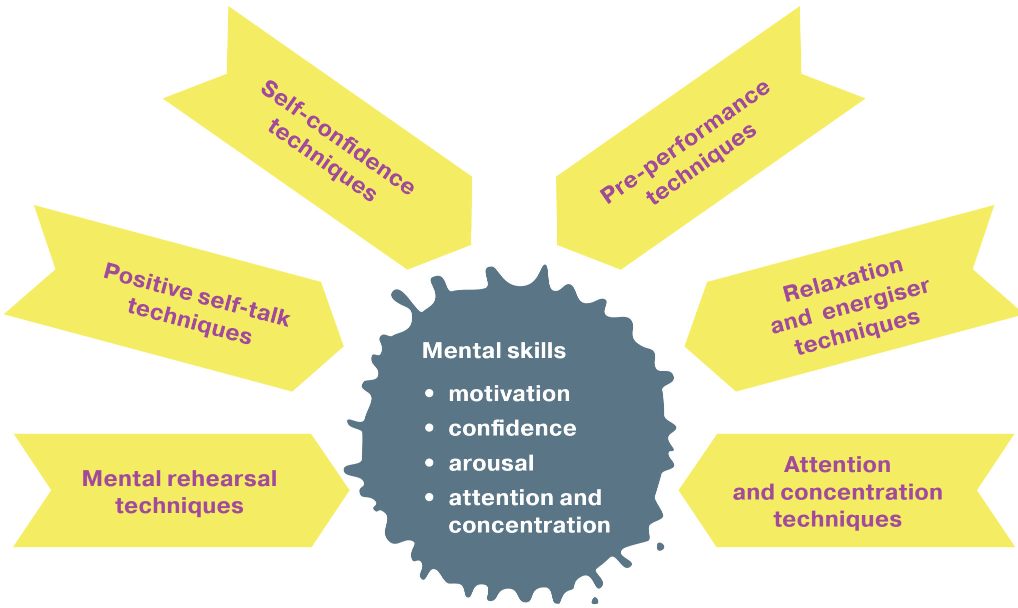
YOUR CHAPTER PLAN

9.1 Mental rehearsal

One of the simplest and most common psychological techniques is to mentally rehearse your performance. This broadly means that you mentally practise thoughts or images to prepare for and enhance performance. Mental rehearsal techniques are used beyond the sporting world – one of the most obvious examples is when actors use mental rehearsal techniques to learn their lines.

Mental rehearsal is particularly beneficial when learning a new skill, as it helps the athlete form a mental picture of what they need to do. This takes time to practise. During mental rehearsal, the athlete needs to focus on relevant cues and accurate execution and timing. Video is often helpful in providing the image for a novice athlete.

Figure 9.2 Psychological techniques develop and help regulate your mental skills to create optimal performance.



Imagery

imagery
a form of mental rehearsal that involves using all of the senses to re-create or create an experience in the mind

One specific form of mental rehearsal is **imagery**. Imagery is one of the most important psychological skills. Sport psychologist John Silva defines imagery as 'using all the senses to re-create or create an experience in the mind'. Imagery is sometimes also referred to as 'visualisation', 'mental practice' or 'mental rehearsal'. The technique involves seeing and feeling a movement prior to executing it.

Imagery is based on three ideas:

- an image can be created in the mind without an external stimulus
- the image may involve one or more of the senses
- an image is created from information stored in the memory.

In imagery, you imagine the skill being performed without moving a muscle. This imagery creates a muscle memory within your muscular and nervous systems of how to do the skill.

Research has shown imagery to be effective because the mind recognises an image the same way it does a real experience. The central nervous system processes imagined information in the same way as actual real experiences. When you vividly imagine performing a skill, you use the same neural pathways you use when actually performing the movement. This is called the **psychoneuromuscular theory**.

psychoneuro-muscular theory theory that imagining the performance of a skill uses the same neural pathways as performing the skill

One research study of downhill skiers monitored the electrical activity of skiers' leg muscles while they imagined skiing a particular downhill course. The results showed that the electrical impulses were strongest in the roughest section of the course, which, the scientists thought, would be the most demanding.

The athlete therefore uses imagery to refine specialised movement sequences regarding body position, timing, sequencing and accuracy, along with the enhancement of mental skills such as motivation, confidence and attention.

CASE STUDY

Sports visualisation: how to imagine your way to success

Mark Bailey

On the evening before a Premier League football match, Manchester United striker Wayne Rooney prepares psychologically. "I lie in bed the night before the game and visualise myself scoring goals or doing well," he once revealed. "You're trying to put yourself in that moment and trying to prepare yourself, to have a 'memory' before the game."

For Rooney, this use of imagery – the act of creating and 'rehearsing' a positive mental experience in order to enhance your ability to achieve a successful outcome in real life – is an instinctive method honed since childhood.

English Rugby Union player Jonny Wilkinson also regularly performs visualisation sessions before games. "You are creating the sights and sounds and smells, the atmosphere, the sensation, and the nerves, right down to the early morning wake-up call and that feeling in your stomach. It helps your body to get used to performing under pressure."

Once the game begins and Wilkinson is required to kick for goal, he uses a visualisation routine to help him put the ball between the posts: "I visualise the ball travelling along that path and imagine the sensation of how the ball is going to feel when it hits my foot for the perfect strike."

"The most important thing with imagery is using multiple senses, like sound, sight and smell," explains sports psychologist Dr Steve Bull, author of *The Game Plan*. "What makes (a player like) Rooney unique is his imagination. When he visualises scoring a goal, he can feel his foot hitting the ball, the smell of the grass under his foot and the sound of the crowd. This incredibly vivid imagery helps an athlete to prepare mentally, by improving their confidence, focus, clarity and speed of thought."

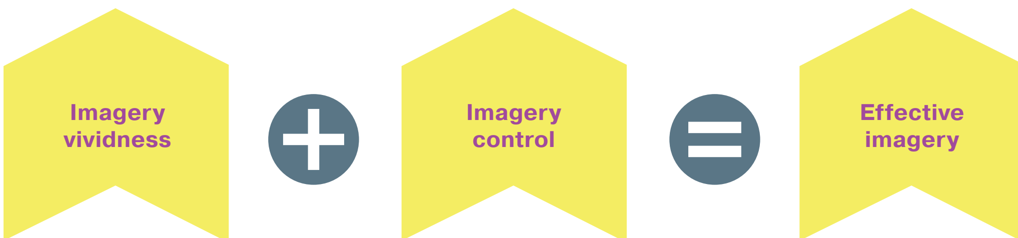
Adapted from M Bailey 2014, 'Sports visualisation: how to imagine your way to success', *The Telegraph* (UK), 22 January, 2014

1. According to Dr Steve Bull, what is important to do when using imagery?
2. What is vivid imagery?
3. Explain why imagery is an effective technique. Justify your response by using secondary data.

Factors influencing imagery

The effectiveness of imagery in improving performance depends on the athlete's ability to use the technique. Figure 9.3 shows the components of effective imagery.

Figure 9.3 The effectiveness of imagery



Athletes who can increase their imagery vividness are able to create really clear and precise images. This means the images they create are more lifelike and more likely to improve the effectiveness of the imagery technique.

Likewise, by establishing strong imagery control, the athlete can control the images they create to ensure they are desirable. An athlete with low self-confidence may struggle to control the images they create and actually imagine choking during a free throw in a basketball game. This lack of imagery control means the technique may not help to produce a successful shot when the athlete takes a free throw in a game.

Both elite and novice athletes benefit from using imagery but, due to their ability and experience, elite athletes are able to create real-life images more easily and accurately. They're more likely to be able to create vivid images, so they benefit more from using imagery than a novice athlete.

Imagery perspective

There are two main ways of viewing the image: internally or externally.

- **Internal perspective imagery** sees the performance from the perspective of the athlete: that is, actually being in the race and feeling the execution of the movement.
- **External perspective imagery** sees the athlete as though viewing a video of themselves in performance. This perspective allows the athlete to see the whole body responding and include external factors such as the opponent.

Either imagery view is acceptable, and some athletes have a preference for alternating between the two perspectives.

As well as using the visual senses, it's important to combine the use of all senses – tactile, olfactory, auditory and kinaesthetic. This could include the smell of the stadium, the noise of the crowd, or the feel of the blocks under your feet.

internal perspective imagery viewing and rehearsing the movement from the athlete's eyes

external perspective imagery viewing and rehearsing the whole body performing the movement, as if watching a video of yourself

Figure 9.4 With practice, imagining your performance through an internal or external perspective can feel calming and highly realistic.

Check your understanding 9.1

1. What determines the effectiveness of imagery?
2. Explain how imagery is effective in enhancing performance.
3. What is the difference between internal and external imagery perspective?

Apply and analyse
imagery and performance

LEARNING EXPERIENCE

You will need a paper clip and a 30 cm piece of cotton thread for this task.

1. Sit on a chair, resting your elbow on your knee.
2. Take the end of the cotton thread and hold it between your thumb and index finger, flexing your elbow to allow the paper clip to be suspended toward the floor.
3. Close your eyes and focus entirely on the paper clip, suspended from the cotton thread. You will need to sit quietly and concentrate on the paper clip.
4. With your eyes still closed, imagine the paper clip beginning to move, backwards and forwards, swinging in a perfect arc towards your body.
5. Concentrate on this movement for 30–60 seconds.
6. Open your eyes and observe the movement of the paper clip.
7. Record your observations.
8. Close your eyes. Concentrate again on the movement of the paper clip. Allow the paper clip to hang motionless on the thread.
9. Now imagine the paper clip moving side-to-side, in another perfect arc, across your body. Picture this movement in your mind and concentrate on the image of the paper clip.
10. Concentrate on this movement for 30–60 seconds.
11. Open your eyes and observe the movement of the paper clip.
12. Record your observations.

Tasks

1. Describe and summarise what you experienced in each of these tasks.
2. Determine the connections between what you imagined was happening with the paper clip and what you observed at the end of each task.
3. Predict what might be causing the movement of the paper clip.
4. Discuss how imagery might enhance your own performance.
5. Investigate and create a plan using a simple movement to trial the use of imagery in another situation.

9.2 Self-talk

Talking to yourself has been a common human habit since the dawn of time. That habit is the foundation of 'self-talk', a psychological technique that's been used since the early 1900s. The technique is based on the theory that what people say to themselves has an effect on the way they behave. Therefore, focusing on desired thoughts lead to desired behaviours.

Figure 9.5
Your self-talk becomes the messages that your brain believes and your body replicates.

Self-talk can be in the form of thoughts in your head, or words actually spoken out loud. Self-talk is an integral psychological technique for improving sport performance.

There are four main forms of self-talk:

1. positive self-talk – 'Great shot!'
2. negative self-talk – 'I'll never make the team'
3. neutral self-talk – 'I must take the dog for a walk when I get home'
4. technical or instructional self-talk – 'Drive with the arms'.

Positive self-talk is particularly effective in physical skills that require strength and endurance. Saying to yourself 'Let's go!' has a positive effect on self-confidence, concentration and motivation. But positive self-talk, while it enhances your mental state, can lead to negative outcomes; saying 'I will make this jump' in high jump may actually lead to you missing the jump.

positive self-talk encouraging dialogue that you say to yourself

negative self-talk critical and unhelpful dialogue that you say to yourself

Negative self-talk is detrimental to performance and includes critical thoughts and counterproductive emotions: ‘You can’t even beat this guy’. Negative self-talk paves the way for over-analysis of one’s ability and detracts from the task at hand. An athlete can be their worst critic if they allow it. Negative self-talk is associated with poor performance and is usually the most common form of self-talk of athletes. However, in some circumstances negative self-talk such as ‘I’m not as strong as my opposition’ can lead to increased concentration, use of strategy or effort, leading to an increase in performance.

neutral self-talk dialogue that is not directly linked to your own performance or situation

instructional self-talk dialogue that focuses on how to execute the movement

Neutral self-talk is sometimes useful for athletes in endurance events. For example, marathon runners try to put aside the feelings of pain or discomfort and think about ‘anything else’ but running.

Technical or **instructional self-talk** is particularly effective in sports relying on fine motor skills requiring precision and accuracy, such as archery and golf. Metaphors such as ‘wrist snap’ help you in developing a narrow focus of attention. Instructional self-talk is effective for a beginner as it directs the athlete’s attention to the skill and how to execute. But this self-talk can be detrimental to an experienced athlete by ‘controlling’ their attention and initiating the process of choking (see p.214).

inherent self-talk unplanned or reactive dialogue

strategic self-talk planned dialogue or specific cues used to enhance performance in specific situations

Self-talk can affect performance, but performance can also affect self-talk. This is explained by the terms **inherent self-talk** and **strategic self-talk**.

- Inherent self-talk is said in response to a specific situation, without pre-planning
- Strategic self-talk is said as a planned cue to enhance confidence, motivation or concentration.

For example, after fouling a javelin throw you might say ‘Not again’ automatically, without thought. In addition, you might use the cue ‘You’ve got this’ as strategic self-talk to enhance your confidence when you’re about to execute the javelin throw.

Engage and understand
examining self-talk

LEARNING EXPERIENCE

1. For the next 30 seconds, think of nothing. Try to empty your mind and remove all thoughts.
2. Write down what you actually thought about during that 30 seconds
3. On a scale of 1 (not at all effective) to 10 (highly effective), rate how well you ‘emptied’ your mind.
4. Explain how you felt during the 30 seconds (e.g. relaxed, frustrated).

The effectiveness of self-talk

Self-talk can cause emotional changes (arousal, motivation and confidence), cognitive changes (attention and anxiety), or both. Self-talk can influence your mood, just like your mood can influence your self-talk. The key to being successful is practising key phrases and monitoring how the self-talk influences your mental skills and performance.

To achieve optimal performance, it's important to know what type of self-talk to use and when. This depends on factors such as your personality, self-confidence and the requirements of the performance environment.

When selecting a type of self-talk, you need to consider your skill level and situation. For example, an elite athlete may use positive self-talk in competition, but instructional self-talk in a practice situation.

The acronym ST-IMPACT (see Figure 9.6) can be used as a guide for implementing effective self-talk:

- **I**dentify what you want to achieve
- **M**atch self-talk to needs
- **P**ractise different cues with consistency
- **A**scertain which cues work best for you
- **C**reate specific self-talk plans
- **T**rain self-talk plans to perfection.

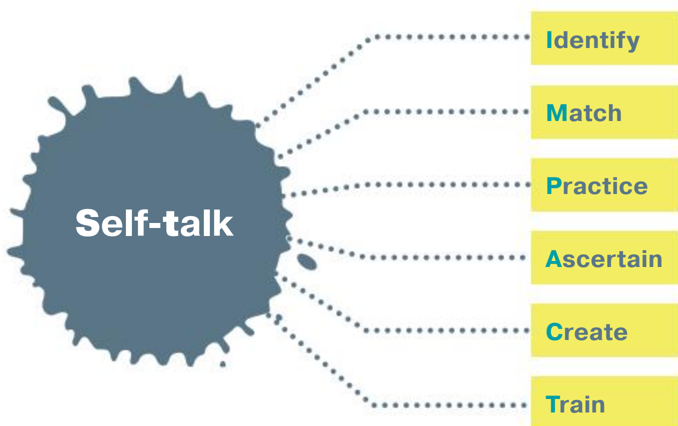


Figure 9.6 Follow the ST-IMPACT process to maximise the benefit of self-talk.

Check your understanding 9.2

1. Explain the four main forms of self-talk.
2. Describe the relationship between emotions and self-talk.
3. How can self-talk enhance an athlete's confidence?

Evaluate and justify
assessing self-talk

LEARNING EXPERIENCE

Read the following pre-game self-talk script from an athlete named Sarah:

I'm sitting on this bench, listening to our coach, with the best netballers from my district. I've waited all year to play in this competition. I'm so excited. I just want to get out on the court.

What if I don't play well though? What if I let my team down? My coach down? Maybe the coach should have played Liv in Centre first. I don't know if I can play up to this standard of netball. I didn't sleep well last night. I'm worried I'll be too slow on the court. Okay, I need to have fast feet. Fast feet! Come on, Sarah, you can do this.

Please, please, please let me play well today. Look at my family up in the crowd. They look so happy. I wonder if they'll watch every game throughout the tournament. I wonder what they're thinking right now...

Oh, I need to concentrate. What did the coach just say about feeding the ball into the circle? Okay, I need to get my head in the game. Concentrate, Sarah! Concentrate! I feel so tired. My hands are really sweaty. I just can't... I'm not going to play well today. I can feel it. I should be on the bench. I feel sick. I can't do this.

1. Categorise examples of positive, negative and instructional self-talk from the example above.
2. Explain the link between what Sarah was telling herself and her self-confidence.
3. Describe how self-talk influenced Sarah's arousal level, making specific mention of cognitive and somatic anxiety.
4. Rewrite the above self-talk script to be more effective for the athlete, using only positive and instructional self-talk.
5. What two trigger words or phrases could Sarah use to calm her nerves? Explain how these would be effective by referring to the link between self-talk and mental skills (motivation, confidence, arousal, and attention and concentration). Justify your responses using evidence from any primary or secondary data.

Practising self-talk

INTEGRATING MOVEMENT

Category: All
Physical activity: All

Purpose

1 This activity involves observing your own self-talk process.
2 This activity focuses on the physical activity your teacher has selected for this topic.
3 The primary data collected in this activity could be used to support your folio task. DE 5

Preparation

Time: 5 minutes outside of class
Location: depends on activity
Equipment: depends on activity; digital capture device with audio recording capability

Setup

Arrange your digital capture system so that you can record video and audio of yourself while you play (for example, setting up a tripod and mike for your smartphone). DE 6

Performance

Play your selected physical activity for a period of 5 minutes.

Data recording

Film yourself playing your selected physical activity. DE 1

Tasks

1 Analyse the footage to describe the specific movement sequences you performed. DE 3
2 Select one moment from the footage and describe your self-talk.
  a What were you saying to yourself?
  b What type of self-talk were you using?
3 Evaluate how the self-talk affected your psychological state (motivation, confidence, arousal, and attention and concentration). DE 4
4 Select an example of self-talk that you used and rephrase it to create a more successful outcome. Explain why the 'rephrased self-talk' is more effective for you to use.

9.3 Self-confidence, attention and concentration

self-confidence
a feeling of trust in one's abilities, qualities, and judgement

affirmation
a short statement designed to repeat to yourself in order to enhance your self-belief and self-confidence

In moments of doubt, performance can deteriorate due to declining **self-confidence**. In order to maintain or increase self-confidence during performance, athletes often use **affirmations**.

For example, an affirmation like 'I am powerful!' might be used by a weight lifter before a lift or after a missed lift. The affirmation enhances their self-belief and can lead to a more positive mindset, increasing the chances of a successful performance.

Attention and concentration techniques

During performance, maintaining concentration and ignoring irrelevant cues are vital for sustained successful play. External distractors (p. 214) can be a significant impediment to attention during performance.

Consider the hybrid sport of chessboxing, which alternates between short rounds of both chess and boxing. During the chess rounds, the fighters wear headphones that play high-volume music. This prevents them from hearing external distractors, such as the commentator explaining the play or people in the crowd shouting out moves, at the point in the game where their concentration needs to be at its peak.

Figure 9.7 Achieving optimal attention and concentration is about focusing on the right things.

As you learned in Chapter 8, an athlete's concentration and attention can vary. You can't always block out distractors with headphones, but there are a range of strategies that you can use to enhance your attention and concentration, helping you attend to relevant sensory information.

Refocusing plans

Some athletes plan specific thoughts for moments they know could occur in a match that may distract them. For example, when tennis players double-fault their serve, they may use pre-planned technical self-talk to refocus – 'Keep your eyes on the ball; hit at its peak' – rather than simply looking at the negative outcome.

Athletes need to train themselves to remove negative self-talk from their performance and replace it with positive, technical self-talk cues.

Thought stopping

Consider the thoughts of two different basketball players as each steps to the line to take a free throw:

- One thinks, 'This is an easy two points. I've made this shot 100 times before.'
- The other thinks, 'I missed the last two shots. If I miss this, it'll be three in a row.'

These two athletes may have very similar skill levels and experience, but they differ greatly in their level of confidence.

The key is to identify when you use negative self-talk and turn these thoughts into positive ones. One technique to achieve this is called 'thought-stopping'. Whenever you recognise a negative thought, say a cue word out loud (for example, 'Stop!') and then refocus on the task. Once you get better at this, you can say it quietly to yourself. The key is to recognise the negative thought and to stop its impact on performance.

Another technique is to use physical prompts as a way of thought-stopping. Linda Bunker, an American sports psychologist, once advised a professional golfer to put paperclips in her left pocket at the start of a round. With every negative thought, she would transfer a paperclip to her right pocket. It was her way of stopping the thought and acting on it. After each round she could count the number of paperclips in her right pocket to determine her progress.

Check your understanding 9.3

1. Explain how affirmations influence self-confidence and performance.
2. How can cues help you remain confident during a high-pressure game?
3. Explain how:
   a. a situation can affect an athlete's emotions, thoughts and confidence.
   b. negative thoughts can affect self-confidence, concentration and attention.

CASE STUDY

Mindfulness and meditation helped Richmond break their AFL premiership drought

Anthony Colangelo

Before the 2015 season Dylan Grimes was looking for a spark.
The Richmond defender lacked confidence in his ability and was battling to maintain peak performance for as long as AFL football required.

Grimes had been reading, and two books in particular introduced him to mindfulness and how better controlling your mind could enhance performance.

"The books outlined this flow," Grimes told Fairfax Media. "A state that athletes found themselves in by luck but I wanted to know how to find it more regularly.

"The feeling of flow," Grimes explained, is the feeling of being totally present and in control of your body, actions and mind while playing. Grimes sought help from Emma Murray, a mindfulness practitioner with an undergraduate psychology degree.

"I realised quickly with Emma [Murray] that the problems I faced – confidence or finding flow or maintaining peak performance mentality – every athlete faces the same battles," Grimes said.

"I felt instantly the problems I worked on with Emma were normal. That was a relief because sometimes I felt isolated having these mental performance problems."

Getting your attention or concentration back when it leaves, Murray explains, is like a bicep curl. "In a game if your attention goes to the score or the crowd or the mistake you just made then that can effect a player's physical output, like their timing."

"Your attention goes [Murray extends her bicep curl] and then you bring it back [Murray draws her fist back to her shoulder] and the more you practise it the easier it is to bring the concentration back."

That practice comes through visualisation, meditation, private sessions with Murray and practising mindfulness in everyday life.

Murray said athletes never come to her saying the pressure of sport or the crowds or the moment is getting to them. Rather, they want to find out "why they're ball-watching or why their timing had gone in their mark or why a rower might be struggling to keep their attention on their boat or why a gymnast is falling off the beam?"

In game fixes

So what do you do when you're on the MCG in front of 100,000 people in a grand final and your timing goes, or you're not performing at your physical peak because of your concentration?

"The biggest thing is the awareness that something's gone," Murray said. "A lot of players say they don't remember parts of big games; 'it was a blur', they say, because they're not properly present or aware of where they are and what they're doing.

"We do a lot of work in the pre-season to build that awareness."

Then it's about words and movement – the players doing certain things with their body or remembering words that help them snap back into focus.

For some players it's about their posture, puffing their chest out and lifting their head so they can communicate clearly. For others it's about always moving their feet.

Remembering words and to move in a certain way isn't new, but the way Murray teaches them to use these actions to snap into a certain mental space of control, no matter what the situation, is what's important.

So too is the environment the players learn these techniques in.

Before every weights session, Richmond's defenders meditated. Every week individuals and each line (and group within the lines) would meet with Murray to either meditate or talk about ways to improve their "mind muscle", as Murray put it.

Adapted from A Colangelo, 'Mindfulness and meditation helped Richmond break their AFL premiership drought',
***The Age*, 4 November 2017**

QUESTIONS

1. What is meant by the term 'mind muscle'?
2. Explain the benefit of 'thought stopping'.
3. What impact does mindfulness have on the athlete's emotions, confidence and performance?

9.4 Relaxation and energiser techniques

Relaxation is the state in which one is physically and psychologically free from uncontrolled tension, anxiety and negative thoughts. It's commonly characterised by feelings of ease, looseness and readiness.

The aim of relaxation training is to physiologically calm the body, shift attention away from anxiety-creating thoughts and ultimately achieve optimal levels of arousal. Relaxation training is important in maintaining optimal arousal in both training and competition performance. It's also a useful mechanism for assisting in good sleep patterns.

Likewise, energiser techniques can lift an athlete's mood, mindset, arousal and motivation. They are techniques that improve performance as a result of improving personal psychological state.

Progressive muscle relaxation

progressive muscle relaxation
tensing and then releasing muscles in order to identify and achieve a relaxed state

Edmund Jacobson's 1938 **progressive muscle relaxation** is a very common technique among professional athletes. It involves tensing a muscle group, letting go of this tension after 4–5 seconds, and then starting again with a different muscle group.

The technique heightens an athlete's awareness of the difference between tension and relaxation in muscles. The regimen works best by starting at the head and working towards the feet.

This technique requires practice before you implement it as part of a competition routine, but, once you master it, you can use it successfully at the end of a training session or before going to bed.

Abdominal breathing

Proper breathing exercises are common practice in martial arts and are key to controlling anxiety and muscle tension. Abdominal breathing is also known as diaphragmatic breathing; it involves contracting the diaphragm when taking deep breaths that cause the chest to rise and the belly to expand.

Slow, rhythmic deep breathing is a sign of a calm, controlled person. The breathing of a person under pressure tends to be shallow and irregular; sometimes they might even hold their breath. Breath holding has been shown to increase muscle tension, but taking deep, slow, complete breaths triggers a relaxation response.

Australian beach volleyball player Marcus Fergusen explains how he uses mindfulness and breathing to enhance his psychological state.

> *When the politics of Beach Volleyball get involved with the pressure of performance and results, you have to come back to breath. It makes it so much easier if you take a moment and stop, breathe and live in the moment instead of worrying about results. The breath allows me to remember how much I am in love with the sport, and actually allows me to free up and play every point as it comes.*

Being mindful in Beach Volleyball allows me to be aware of the presence I have on court. When it is a tight game or nerve racking situation it allows me to recognise the moment and accept it. Allowing me to take on the challenge and back myself in the risky situation.

Mindfulness and meditation

Dr Kristin Keim, a clinical sport psychologist, states that athletes can experience great benefits from practising meditation. Meditation has been shown to reduce stress, improve sleep patterns and recovery times, enhance endurance and improve self-identity. This results in higher self-confidence and enhanced performance. Meditation increases an athlete's awareness of and connection to their body, and is used by many elite athletes to optimise their performance.

Mindfulness is a mental technique with connections to meditation – it's certainly easier to perform when meditating. Mindfulness is the process of paying attention only to what is happening right now, rather than thinking ahead, looking back or being distracted by other concerns.

mindfulness
a mental state achieved by focusing one's awareness on the present moment

In an interview with Oprah Winfrey, the highly successful NBA basketball coach Phil Jackson explained how he uses meditation and mindfulness as part of his athletes' training. Jackson, who led the Chicago Bulls and Los Angeles Lakers to national championships, said mindfulness was the reason he is able to establish and maintain such successful basketball teams.

I approached it with mindfulness… as much as we pump iron and we run to build our strength up, we need to build our mental strength up… so we can focus, get one point of attention – so that we can be in concert with one another…

So… when things [are] going wrong for you, you sit on the bench, you take a breath and you… reset yourself. And you do that through mindfulness…

[It's also] about being authentic and coming from who you are, and what you think is important… You have to get spirit back into things.

Music

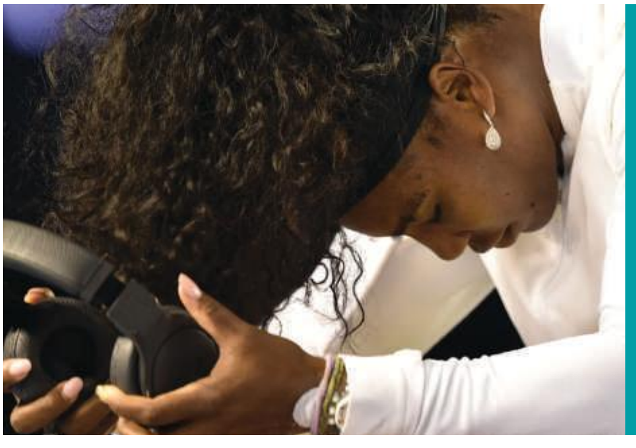


Figure 9.8 Serena Williams on court with her headphones at the 2016 Australian Open

It's been well documented that many athletes, including Layne Beachley, Serena Williams and Michael Phelps, listen to music to enhance their psychological state and improve performance.

Music forms part of the pre-competition environment for many athletes by evoking a relaxation response. An athlete can have a selection of music for relaxation on a portable device to assist in creating an optimal arousal mood. As well as relaxing the mood of the athlete, the music limits environmental distractors that may cause increased anxiety levels.

CASE STUDY

Music the fuel for performance overdrive by Olympic athletes

Nicole Jeffery

Sports psychologist Peter Terry, who has worked with British and Australian athletes at eight Olympic Games is convinced that music is a powerful tool in sport.

Terry, professor of psychology at the University of Southern Queensland in Toowoomba, says there are generally four effects of music that are supported by a large body of scientific evidence. The most obvious is "to enhance mood, to slow us down or speed us up – that's the most reliable effect", and the one Phelps uses so effectively.

But music also has been shown to improve endurance performance, assisting people to run 18 per cent longer, according to research by Terry and his English colleague, Costas Karageorghis of Brunel University. "The performance effects are fairly reliable in sports like running, cycling, rowing ergo tests," Terry says.

"When you are doing the same amount of work while listening to music, you use 1–2 per cent less oxygen," Terry says.

Before competition, an athlete's response to music is more emotional than physical. "Louder, faster music tends to raise arousal levels," Terry says. "What you are doing is modulating your mood."

Terry uses certain music as a trigger for athletes to enter their competitive mindset, often subconsciously. "It's a bit like a song that takes you back to your first love," he says. "If a song equates to performing really well, you can condition that response to it, like Pavlov's dog. If an athlete does their visualisation for the Olympics to a particular song, plans their mental game to that tune, you can forge a connection between that mindset and the song. Once that's done, you only have to play that song to generate that mindset."

Adapted from Nicole Jeffery, 'Music the fuel for performance overdrive by Olympic athletes', *The Australian*, 13 July 2012

QUESTIONS

1 What effects of music on athletes are discussed in the article?
2 How can listening to music be helpful to athletes in endurance sports?
3 What does Professor Terry say is the result of athletes listening to music during visualisation?

9.4 Check your understanding

1 Explain how the strategy of abdominal breathing can reduce performance anxiety and lead to improved performance.
2 How does the strategy of progressive muscle relaxation work to relax an athlete?
3 Explain the relationship between music, mood, motivation and performance.

The impact of music

INTEGRATING MOVEMENT

Category: All
Physical activity: Running

Purpose

This activity involves observing the relationship between the psychological strategy of using music, and arousal, mindset, emotions and performance.

Preparation

Time: up to one hour, outside of class time
Location: running track
Equipment: running gear, portable music player, headphones

Setup

1. Find songs you like that have a specified number of beats per minute (bpm). You might find this information online, or just count how many beats you hear when listening for exactly one minute.
2. Name three songs that you believe enhance or would enhance your performance. Justify your selection.
3. Load one short playlist with songs of around 90 bpm, and one with songs of around 140 bpm.

Performance

1. Select your 140 bpm playlist. Run 800 metres while listening to the playlist. Record your time.
2. Select your 90 bpm playlist. Run 800 metres while listening to the playlist. Record your time.

Data recording

Record your time for both running performances. DE 1

Tasks

1. Analyse your psychological and physiological response to the activity by describing your thoughts, emotions, physically, motivation and performance. DE 3
2. Evaluate how the song selections influenced your psychological state. DE 4
3. Evaluate how your song selections influenced your performance
4. Justify, using primary and secondary data, which of the two playlists was more effective in enhancing your performance. DE 2

9.5 Performance routines

As you learned in Chapter 8, an athlete aims to achieve a 'flow' that encourages optimal performance due to high concentration on the task. Routines in sport have been shown to be effective in allowing performers to mentally prepare for competition and achieve a flow mindset more easily.

performance routine
a routine established by the athlete in order to maintain focus

A **performance routine** involves the practice of a set routine. The aim is to ensure that a player focuses attention on the actions that they can control and that are relevant to successful completion of the skill. For instance, a basketballer might use the same routine when shooting free throws, such as bouncing the ball a certain number of times before shooting.

Sometimes referred to as 'mental plans', performance routines can be used at different times:

- pre-performance – in order to attain a flow mindset
- during performance – in order to maintain a flow mindset
- post-performance – in order to regain a flow mindset.

These performance routines should contain physical and psychological elements in order to enhance the athlete's performance and consistency. For example, in a pre-performance routine, a golfer may stand behind their ball prior to taking their shot (physical), visualise the path that the ball will fly (psychological), and imagine what the ideal swing will feel like (psychological). They may then adjust their feet twice behind the ball (physical) and say to themselves, 'You can do this' (psychological).

For performance routines to be effective, you need to consider actions or cue words that will be used to initiate a routine, let go of disappointment during performance or enhance concentration. For example, a tennis player may move the strings in their racquet in order to 'let go' of a poor shot and initiate their during-performance routine. A basketball player may use the cue words 'all net' when setting up to make a free throw in basketball.

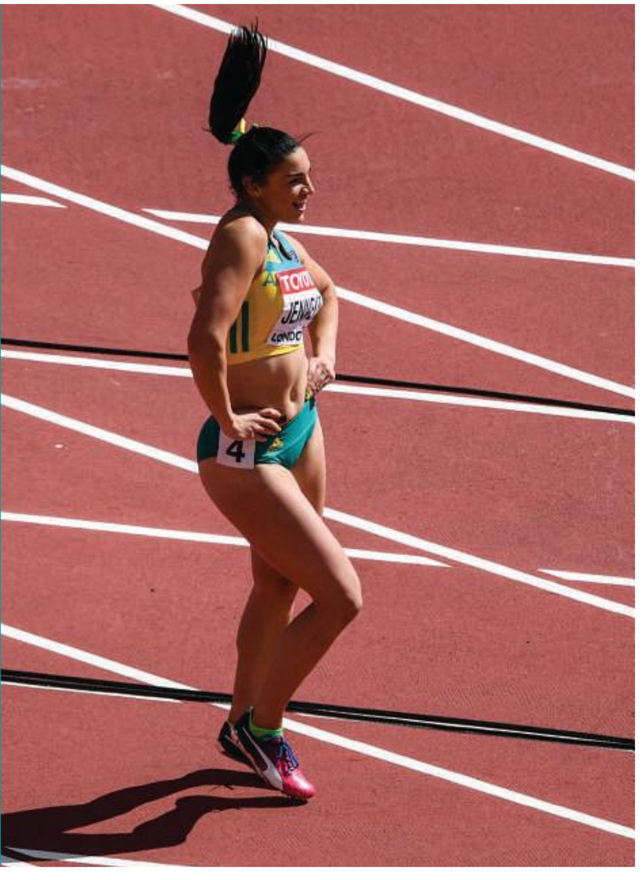


Figure 9.9 Michelle Janneke's unique pre-race performance routine earned her the nickname 'the dancing hurdler'.

Simulation training

Anyone who has played competitive sport understands that the practice environment is not always the same as the playing environment.

Running on to the court in front of a large crowd for the first time, or playing in weather conditions that are unfamiliar, can be potential distractors that impair your performance. To avoid such distractions, you can prepare by training with similar environmental distractors through **simulation training**.

simulation training training that mimics the competition environment as closely as possible

Simulation training can be brief or extensive. The preparation of the Australian Olympic team for the 2008 Beijing Olympics involved acclimatising to the heat and humidity by training in similar conditions in the northern hemisphere, months before the competition began.

Training can also simulate the conditions of a specific play situation. If your opponents use particular tactics, ensure that you are familiar with these tactics at training prior to competition. When you perform skills in training, ensure that they mimic the competition rules: for example, only one chance at a gymnastics routine or one shot at a penalty goal.

There are several keys to performing well under pressure:

- identify the skills that suffer most when you are under pressure, and put extra time into practising these skills so that you're confident in your ability to perform them.
- practise skills under pressure in training, so that this becomes the 'norm' rather than the exception.
- slow down; athletes under pressure have a tendency to rush things, especially when time is limited.
- realise that pressure is simply how we perceive a particular situation; an Olympic final and a training match use the same rules, the same strategies and the same ball, so the athlete needs to understand that pressure is something that they perceive and can control.
- identify relaxation techniques that work for you, if you know that you are prone to cracking under pressure.
- take the focus away from how you feel or the performance outcomes and focus on the skills, possibly by using cue words.

Check your understanding 9.5

1. What are pre-performance routines?
2. Explain how mental rehearsal, self-talk, relaxation and attention relate to pre-performance routines.
3. Explain how cue words are useful in directing attention during performance.

Performance routines

INTEGRATING MOVEMENT

Category: Invasion
Physical activity: Basketball

Purpose

This activity involves creating performance routines to use when shooting free throws in basketball.

Preparation

Time: several hours outside of class time
Location: basketball court or hoop
Equipment: basketball; digital capture device

Setup

Arrange your digital capture system so that you can record video of yourself while you play (for example, setting up a tripod for your smartphone). DE 6

Performance

1. Execute 10 'free throws'. Record how many were successful or not successful
2. Write a pre-shot performance routine for free throws that includes these components:
   - physical elements (for example, bouncing the ball a certain amount of times)
   - psychological elements (for example, affirmations, self-talk)
   - relaxation techniques (for example, PMR, breathing)
   - mental rehearsal techniques (for example, imagery).
3. Perform 10 free throws, using your scripted pre-shot routine before each throw. Record how many were successful or not successful.

Data recording

Film yourself playing your selected physical activity. DE 1

Tasks

1. Analyse the results to reveal how your performance varied between the two sets of free throws. DE 3
2. Evaluate how your performance was affected by using a performance pre-shot routine. DE 4

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Chapter review

[9.1] Mental rehearsal involves focusing on relevant cues and accurate execution. Imagery is a rehearsal technique where you see and feel the movement before executing it, and can be done from an internal or external perspective. High levels of imagery vividness and imagery lead to effective imagery.

[9.2] Using positive self-talk enhances your self-confidence, concentration and motivation. The dialogue of self-talk occurs internally or externally and can be planned (strategic) or unplanned (inherent).

[9.3] Affirmations are used to increase an athlete's self-confidence, which enhances performance. Refocusing plans are implemented during performance in order to enhance concentration and attention. Thought-stopping is a strategy using cues to turn negative thoughts into positive self-talk.

[9.4] The aim of relaxation training is to physiologically calm the body, psychologically move attention away from cognitive anxiety and achieve optimal levels of arousal. Techniques such as PMR, breathing, mindfulness and listening to music can all enhance the psychological state of athletes, leading to improved performance.

[9.5] Performance routines can be used before, during and after performance in order to attain, maintain or regain a flow mindset. Pre-performance routines contain physical and psychological elements designed to increase the consistency of successful performance.

Review questions

Section A: Multiple-choice questions

1 When using the technique of mental rehearsal, it's important to:
- **a** imagine the performance incorrectly and correctly so you know the difference.
- **b** rehearse the execution and timing in slow motion.
- **c** focus on relevant cues and accurate timing and execution.
- **d** use only your visual sense through imagery.

2 Effective imagery is achieved with:
- **a** low imagery vividness and high imagery control.
- **b** low imagery vividness and low imagery control.
- **c** high imagery vividness and low imagery control.
- **d** high imagery vividness and high imagery control.

3 According to psychoneuromuscular theory:
- **a** vividly imaging a skill is not an effective way to prepare for the execution of the skill.
- **b** you use the same neural pathways when you vividly image the skill as when you execute the skill.
- **c** imagery is not a form of mental rehearsal.
- **d** imagery is performed from an internal perspective but not an external perspective.

4 There are four main forms of self-talk:
- **a** positive, negative, internal and external.
- **b** positive, negative, neutral and biased.
- **c** positive, internal, neutral and instructional.
- **d** positive, negative, neutral and instructional.

5 Positive self-talk:
- **a** is dialogue that's beneficial to performance and occurs in your mind.
- **b** enhances your mental state but can lead to negative outcomes.
- **c** enhances your mental state and only produces positive outcomes.
- **d** is dialogue that is used in a training environment but not a competitive environment.

6 Affirmations can be used to:
- **a** increase an athlete's self-confidence.
- **b** enhance an athlete's self-belief.
- **c** create a more positive mindset.
- **d** all of the above

7 The strategy of 'thought-stopping' involves:
- **a** not thinking and just performing.
- **b** turning negative self-talk into positive self-talk.
- **c** turning positive self-talk into negative self-talk.
- **d** overcoming a high-pressure situation.

8 Edmund Jacobson's (1938) technique of PMR stands for:
- **a** pure movement relaxation.
- **b** performing muscle recall.
- **c** positive mind responses.
- **d** progressive muscle relaxation.

9 The state of being free from uncontrolled tension, anxiety and negative thoughts is known as:
- **a** relaxation.
- **b** cognitive anxiety.
- **c** arousal.
- **d** positive self-talk.

10 Performance routines:
- **a** are psychological routines designed to optimise performance.
- **b** involve psychological and physiological elements in order to enhance performance.
- **c** involve the athlete focusing on sensory information they cannot control.
- **d** are not referred to as mental plans.

Section B: Short-response questions (150–250 words)

1 A track athlete can be heard quietly repeating the phrase 'I am lightning fast' before a 100-metre sprint. Explain what psychological technique this is and how this positively influences the athlete's confidence, arousal and performance.

2 A tennis player can be seen completing the following actions before every serve, like a set sequence.

The athlete moves the strings on their racquet as they walk towards the ball person. They request two tennis balls, rotate them in one hand, select one and hit the other back to the ball person.

As they walk towards the baseline, they stop and perform three jumps on the spot and can be heard whispering 'explode with the legs' three times.

As they reach the baseline, they pause and look down towards the service box that they're about to hit into. The athlete can be seen taking three long breaths, bouncing the ball three times, glancing again at the service box, before beginning the service movement.

- **a** What psychological techniques are being used by this athlete? Justify using specific examples from the stimulus.
- **b** Justify why the athlete pauses to look at the service box they are aiming for.
- **c** What impact do these actions have on the athlete's concentration, confidence and flow?

Section C: Extended response (400 words)

Scenario: A competitive long jump athlete has fouled their first two jumps. In preparation for the athlete's third and final jump, how can the athlete remain positive, confident and perform optimally?

Your response should:

- analyse the situation to explain how these conditions of performance could negatively influence the athlete's arousal, thoughts and confidence.
- describe a psychological strategy the athlete could use to optimise arousal, mindset and confidence to ensure the athlete performs a successful jump.
- justify how your strategy will improve the athlete's psychological state and performance.

Figure 9.10
A range of psychological strategies can be used to improve performance.

10 DETERMINING OPTIMAL PERFORMANCE

Figure 10.1
The Australian mixed relay triathlon team celebrates winning gold at the 2018 Commonwealth Games.

It's often said that 'a team of champions doesn't always beat a champion team'. This saying highlights the complexity of establishing and maintaining an effective and successful team; there's more to a team than purely talented players.

Teamwork is an important lifelong skill within your personal and professional life. It's important to understand how to be an effective team member. This chapter uses a sporting context to look at the nature of teams, some factors that influence interactions within them and, consequently, the degree of success they achieve.

KEY QUESTIONS

10.1 What makes an effective team?

10.2 What makes a team stick together?

10.3 How can you optimise team dynamics?

10.4 How does goal setting influence performance?

YOUR CHAPTER PLAN

10.1 What is a team?

In their book *Group Dynamics in Sport*, Albert Carron and Heather Hausenblas defined a team as a collection of two or more individuals who have the following characteristics:

- possess a common identity
- have common goals and objectives
- share a common fate
- exhibit structured patterns of interaction
- demonstrate group processes such as communication and cooperation
- consider themselves to be a group.

The identity of a team is exemplified by having a team name, wearing team uniforms and attending team training, all of which set one team apart from another. The common goal, often, is that of winning.

From day one, a team develops its own structure, which is based on the expectations and perceptions of the group members. But not every team will be successful. To better understand these differences, it's important to understand the factors that affect the level of success. First, for a team to be effective there are three structural characteristics, shown in Figure 10.2, that must develop:

- group roles
- group norms
- social support.

Figure 10.2 The key features of a successful team develop from the core team characteristics of group roles, group norms and social support

Group roles

A **role** is a set of expected behaviours of the person occupying a specific position. Most sports teams have formal roles, such as a captain and playing positions with specific responsibilities.

In addition, there are the more informal roles, such as organisers or emotional stabilisers. People adopt these roles because of their skills, personality and qualities.

Figure 10.3 A team involves two or more individuals who are united by identity, goals, objectives or fate.

Role clarity

It's important for coaches or team leaders to identify the qualities of each player in the team, and to link these qualities with a specific role. How the role contributes to the team should also be discussed openly.

It's also very important to clarify any ambiguity that these roles may bring. Researchers have identified role conflict as one of the more powerful factors in player dissatisfaction. When a group discusses the expected role behaviour, it lessens the likelihood of role conflict between team members.

role
a set of expected behaviours specific to a person or position

Role acceptance

The ability to develop an effective team stems from an ability to identify roles and for players to accept these roles. Players who accept their roles are more likely to be satisfied with their responsibilities.

Role conflict

Despite players having allocated roles within the team that players have accepted, conflict may still arise when a certain player doesn't have sufficient skill, time, motivation or understanding to carry out the responsibilities of their role. This affects team cohesion.

Group norms

All groups have **norms** – structured rules that govern the way a group is organised and maintained. Typically, norms are established to maintain routines and to set standards of behaviour that help to increase team cohesion. Arriving at training on time, helping prepare equipment for practice, following acceptable dress codes and setting high standards are all examples of positive norms.

Norms have a significant influence on individuals, and it's good practice to encourage team leaders to include team members in the decision-making process about norms.

norm
a set of structured rules that govern the way a group is organised and maintained

Norms are often communicated through a Code of Conduct for a specific sport, or shared expectations that are established within a team or club. One example of strong team culture is within the sport of CrossFit. It's common practice for CrossFit gyms to display their expectations on the wall of the 'box' (the name CrossFit members use for their gym), to clearly communicate to members what the expected behaviours are for all members.

Figure 10.4 Clearly communicated norms breed shared values, accountability and consistent positive behaviours among team members.

Social support

The differences in team members' backgrounds, personalities, attitudes, expectations and abilities all contribute to the diverse make-up of a team. The one commonality between all team members is that they need to be satisfied with their place in the team. Social support has been linked to increases in feelings of team cohesion.

The ability for team members to spend time together is also relevant to building an effective team. This is acknowledged by State of Origin teams, which have pre-match 'camps' to bond with other team members. Road trips and fundraising events are other activities that contribute to the development of a team's identity and strengthen team cohesion. Teamwork divides the task and increases the success.

To build a successful team, you should follow the MAPS model:

- **M**ission – develop a clear mission statement that links with team goals. Determine what the team is trying to achieve. This could include skill improvement, winning, enjoyment, etc.
- **A**ssessment – identify the strengths and weaknesses of the team so that resources can be developed to deal with this and improve the team's potential for success.
- **P**lan – develop individual and team action plans. These should include specific behaviours with clear timelines.
- **S**ystematically evaluate – implement a periodic overview of the entire plan; look at whether goals were achieved and areas for improvement.

Check your understanding 10.1

1. What is a team?
2. Explain the three structural characteristics of an effective team.
3. Define the MAPS model.

Evaluate and justify
creating team norms and values

LEARNING EXPERIENCE

Complete the following tasks with your class sport/activity team.

1. Write a list of undesirable behaviours that could affect the performance of the team.
2. As a team, create a Code of Conduct that explains the team's norms in 5–10 statements and have all members sign it.
3. For each person in the team, write the following (these may differ from person to person):
   a. their role
   b. their responsibilities
4. Create three shared values for the team.
5. Explain how this process influenced your motivation to play with this team.
6. Justify how this process could enhance team performance, using evidence from any primary or secondary data.

10.2 Team cohesion

task cohesion a team's ability to work together to achieve a goal

social cohesion how much team members like each other or enjoy each other's company

Team cohesion is a result of a group's desire to remain together. It is the blend of two key dimensions: **task cohesion** and **social cohesion**. Task cohesion refers to a team's ability to work together to achieve its goals. Social cohesion is the degree to which members of the team like each other and enjoy one another's company.

Teams that have members who fight or form cliques would be said to have low social cohesion. Have you been part of a team that had high task cohesion but low social cohesion? The factors that contribute to making a cohesive team also contribute to its success.

Characteristics of a cohesive team

Team cohesion is not a stable trait. It is the result of the interaction between personal and situational factors, as well as effective leadership. A team in its second year of competition may not have the same 'spark' it had in its first season, even though it consists of exactly the same players as in the previous year.

A situational factor that assists in developing team cohesion is the opportunity to spend time together as a team. This instills a sense of pride and develops unity.

Personal factors that influence team cohesion include the blending of personalities that make up the team. Team members may come from very different backgrounds and experiences, but if everyone has a common team goal, cohesion is likely to result.

Effective leadership is the third factor that contributes to team cohesion. You'll look at that in the next section of the text.

Figure 10.5 The New Zealand All Blacks have members from different backgrounds, but a common goal helps them to create team cohesion.

Members of cohesive teams have these qualities:

- share common goals and beliefs
- have a collective identity
- resist disruptive influences
- work hard
- demonstrate unselfish play
- willing to sacrifice for the good of the team.

How to develop team cohesion

1. Ensure each player understands the responsibilities of all players, not just their own position. During a training session it might be helpful to change players' roles to see the difficulties their fellow team members have. For example, the centre position player in netball can become the goal shooter. This provides a better understanding of each other's playing responsibilities.
2. Establish an environment that allows open communication. The ability to communicate effectively and express feelings will go a long way to developing group cohesion.
3. Ensure that the team's success is not attributed to specific roles, so that the role of every team member is seen as important.
4. Set team goals. Team goals maintain focus on what needs to be achieved. As individual goals are achieved, new performance-based goals can be developed. Take pride in achieving set goals.
5. Learn something new about players in the team. At team meetings players can share observations of characteristics that they admire in other players.
6. Avoid the formation of cliques within a team as this only benefits a small number of players and alienates the rest of the team.
7. Encourage group identity by making team members contribute to an identity. Develop team routines or provide special privileges, such as team breakfasts.
8. Avoid excessive player turnover.
9. Make newcomers feel welcome to the team.
10. Do not expect complete social cohesion. There is always potential for conflict within teams. The absence of any conflict may indicate a lack of interest.

Evaluate and justify
team experiences

LEARNING EXPERIENCE

1. Explain a situation when you were a part of an ineffective team.
2. Describe the characteristics of that team.
3. Analyse how your motivation and enjoyment were affected by the team's dynamics.
4. Explain a situation when you were a part of an effective team.
5. Describe the characteristics of that team.
6. Analyse how your motivation and enjoyment were affected by the team's dynamics.
7. Using specific examples based on your previous experience, justify which three factors are vital in a team for you to perform optimally.

Coaches and team cohesion

Growth in coach education courses and research on coaching highlight the importance of a quality coach as central to the learning process. Like teaching, coaching requires certain characteristics to be effective. Effective coaches:

- provide positive feedback frequently
- provide a high level of technical corrections
- use questioning to develop thinking players
- are predominantly engaged in instruction
- are organised in their management of the environment
- are good communicators
- are good leaders
- are also good teachers
- are reflective on their practices.

Many of these characteristics also apply to an effective captain or team member.

10.2 Check your understanding

1 Explain the difference between task cohesion and social cohesion.
2 Summarise the characteristics of a cohesive team.
3 Justify why team cohesion is important.

CASE STUDY

Ferguson's formula

Anita Elberse

Before retiring in May 2013, Sir Alex Ferguson spent 26 seasons as the manager of Manchester United, the English football (soccer) club that ranks among the most successful and valuable franchises in sports. During that time the club won 13 English league titles along with 25 other domestic and international trophies – giving him an overall haul nearly double that of the next-most-successful English club manager …

Ferguson speaks passionately about wanting to instill values in his players. More than giving them technical skills, he wanted to inspire them to strive to do better and to never give up – in other words, to make them winners … [Ferguson's own attitude was that:] "I made up my mind that I would never give in."

Ferguson looked for the same attitude in his players. He … demanded that they work extremely hard. Over the years this attitude became contagious – players didn't accept teammates *not* giving it their all. The biggest stars were no exception.

Ferguson: Everything we did was about maintaining the standards we had set as a football club – this applied to all my team building and all my team preparation, motivational talks, and tactical talks. For example, we never allowed a bad training session. What you see in training manifests itself on the game field. So every training session was about quality. We didn't allow a lack of focus. It was about intensity, concentration, speed – a high level of performance. That, we hoped, made our players improve with each session.

I had to lift players' expectations. They should never give in. I said that to them all the time: "If you give in once, you'll give in twice." And the work ethic and energy I had seemed to spread throughout the club. I used to be the first to arrive in the morning. In my later years, a lot of my staff members would already be there when I got in at 7 AM. I think they understood why I came in early – they knew there was a job to be done. There was a feeling that "if he can do it, then I can do it."

I constantly told my squad that working hard all your life is a talent. But I expected even more from the star players. I expected them to work even harder. I said, "You've got to show that you are the top players." And they did. That's *why* they are star players – they are prepared to work harder. Superstars with egos are not the problem some people may think. They need to be winners, because that massages their egos, so they will do what it takes to win. I used to see [Cristiano] Ronaldo [one of the world's top forwards, who now plays for Real Madrid], Beckham, Giggs, Scholes, and others out there practicing for hours. I'd have to chase them in. I'd be banging on the window saying, "We've got a game on Saturday." But they wanted the time to practice. They realized that being a Manchester United player is not an easy job.

Source: 'Ferguson's formula',
Harvard Business Review 2013

QUESTIONS

1. How did Ferguson lift the players' expectations?
2. Identify a norm that Ferguson established in the Manchester United team.
3. Explain the link between Ferguson arriving at the club before 7 am and the success that the team achieved.

Coaching

INTEGRATING MOVEMENT

Category: All
Physical activity: Any team sport

Purpose

1. This activity involves using a psychological strategy as a team coaching technique.
2. This activity focuses on the physical activity your teacher has selected for this topic, or another team sport if appropriate.
3. The primary data collected in this activity could be used to support your folio task.
4. This activity involves two separate activities, which need to be performed in order.

DE 5

Preparation

Time: two lessons
Location: depends on activity
Equipment: depends on activity; digital capture devices

Setup

1 Form teams as appropriate for the sport or activity.
2 Each team needs one additional member who will record data.

Activity 1

Performance

Play a game of your chosen physical activity for 10 minutes against another team.

Data recording

Digitally capture data of your team's performance during the game. Make sure to capture video of each team member's contribution. DE 6

Tasks

1 Watch the footage as a team. Analyse the team's performance to evaluate their execution of specialised movement sequences and movement strategies. Include two positives and two areas to improve. DE 3 DE 4
2 Collate and synthesise team performance data that explains the degree of execution (e.g. successful returns in volleyball, points won and lost in doubles tennis).
3 Devise one psychological strategy to enhance team performance.

Activity 2

Performance

Play a game of your chosen physical activity for 10 minutes against another team, implementing your psychological strategy.

Data recording

Digitally capture data of your team's performance during the game. Make sure to capture video of each team member's contribution.

Tasks

1 Collate and synthesise performance data from Activity 2 to compare the second performance to the first. DE 3
2 Evaluate how the strategy improved your team's performance. DE 4
3 Using primary data, evaluate how the psychological strategy influenced team confidence, arousal, attention, concentration and team dynamics.
4 Evaluate how effective the strategy was in meeting the needs of the team.
5 Justify, using primary and secondary data, whether changes or modifications to the team's strategy are needed. DE 1 DE 2

http://mea.digital/qpe12_10

10.3 Team dynamics

Leadership

Effective leaders within sport influence others through motivation, inspiration and role modelling. Their leadership behaviours influence individual motivation, arousal, concentration, team dynamics and personal performance. Leadership can be found within a range of roles, such as coaches, parents, teammates or teachers.

Being a leader often involves putting the needs of others ahead of their own to get the very best out of their athletes or teammates. This is often referred to as **transformational leadership**. This form of leadership positively influences athletes' cognitive and behavioural responses. These leaders are highly respected for their high expectations, mentoring, ethical behaviour and effective relationships with others.

Transactional leadership is distinguished by the use of external rewards or punishments to motivate the 'follower'. This form of leadership is less effective than transformational leadership; it generates less motivation in the follower and is not built on the same high-quality relationships as transformational leadership.

transformational leadership
a leader putting the best interest of others ahead of their own

transactional leadership
a leader using external rewards or punishments to motivate others

Communication

Team strategies to enhance team performance rely on all members of the team being on the same page, timing their actions and coordinating the use of equipment and space. For this to occur effectively, communication is key.

Communication is the transfer of information from one person to another. The more efficient this transfer is, the more effective the team performance will be. Communication can be verbal or non-verbal.

Verbal communication includes short phrases or cues that have a shared meaning within the team. For example, players on a netball court can be heard communicating their movement to their teammates, or a football captain might call set plays for the team to respond to.

Figure 10.6 Communication and leadership are interrelated and vital to the effectiveness of any team.

Non-verbal communication involves actions that have a shared meaning amongst all teammates. For example, a goal shooter in netball can signal for a lob pass by positioning their body on the side and raising their back arm towards the sky. The benefit to non-verbal communication is the opponent is often unaware of, or cannot understand, the body positioning or signals used by a team.

stakeholder
someone that has an interest in a team and can affect or be affected by its actions

To enhance team communication, it's important that players and **stakeholders** are effective listeners, open to differing points of view and inclusive of others.

Norms, rules and discipline

Group norms set expectations for all members of the team regarding how to perform, behaviours that are acceptable and the shared beliefs of the team. How well members conform to these norms will be influenced by the clarity of the norms, the status of the players (such as whether they're new or highly experienced) and pressure applied from leaders such as the coach.

Once team beliefs and values have been established, creating specific rules helps breed ideal team behaviour that is consistent and accountable. Each rule needs to be agreed on, have a consequence and be clearly understood by all members of the team.

discipline
training people to obey rules or a code of behaviour

It's vital that the coach consistently reinforces the rules in order to breed **discipline** within the team. Discipline is not the same as punishment. Punishment involves giving negative consequences for undesirable behaviour, while discipline is the willingness to do what is required within the set limits. Disciplined behaviour requires self-awareness of your behaviour and self-control in order to maintain the desired behaviour.

Establishing discipline is most effective when the coach or team leader can carry out these tasks:

- model the desired team behaviours. For example, if there's a dress code that involves the players having to wear black slacks and black shoes before a game, but the coach turns up in board shorts and thongs, this undermines the importance of the team norms and threatens the players' discipline towards the dress code and other established rules.
- create rituals in the team's behaviour. Having routines regarding how the team behaves, or actions the team completes before games, not only creates familiarity but a sense of togetherness that encourages conformity to the team rules.
- embed fun into the discipline. As discussed in Chapter 8, individuals are more motivated when they perceive the task to be fun.
- recognise and praise positive behaviour. This reinforces the expected behaviour and encourages more players to display similar positive behaviour. Discipline is not just about pointing out and correcting negative behaviours.
- take responsibility for their actions. This is important when you're performing as part of a team and helps to create positive discipline.

An effective team is one where the members are committed to each other, align themselves to shared rules and norms, and care for their teammates.

Don Hellison is an American professor of kinesiology, which is the scientific study of human or non-human body movement. In his 1995 book *Teaching Personal and Social Responsibility Through Physical Activity*, Hellison proposed a model of four progressive levels of responsibility that empower self-control and breed positive discipline:

- respect for self and others, and accepting differences
- effort towards and participation in tasks while striving for personal and team success
- self-direction towards tasks displaying increased responsibility and independence
- caring for and helping others through compassion and contribution to others and the team.

Check your understanding 10.3

1. Describe two forms of leadership.
2. Why is communication important within a team?
3. Explain how discipline is different from punishment.
4. Explain the relationship between norms, rules and discipline.

CASE STUDY

Leadership the biggest difference between Blues and Maroon

Phil Gould

We have just witnessed yet another Queensland victory in the 2017 State of Origin series, their 11th success in 12 seasons.

The postmortems in the media have begun to dissect where it all went wrong for NSW.

As usual, everyone is putting the cart before the horse. Most people are trying to cure the symptoms, without addressing the real disease.

The difference between NSW and Queensland comes down to one vital factor. Leadership.

Leadership creates culture. Culture is what endures. If we look at the most significant difference between NSW and Queensland in this State of Origin environment, Queensland has by far and away the better culture.

Why? Because they have the better leadership.

The gap is widening. It's not closing. The dominant results Queenslanders have achieved on the field, are simply a reflection of their dominance away from the playing field.

The basics to success in any organisation, business, club, team, or even building a family, are –

1. Leadership
2. Communication
3. Motivation
4. Knowledge
5. Teamwork
6. Honesty in self-appraisal

It all starts with leadership. Leadership is the key.

I can talk about the other factors another time. However, it is the role of the leader to create an environment where the other factors are valued, respected, delivered, monitored and constantly looking for ways to improve …

Culture involves many things. It is basically the standards you accept in your organization, for everything. It is the respect that everyone in your organization has for these standards. The standards are pursued with a relentless honesty and integrity.

Who or what sets these standards? Well, leadership sets these standards.

It's very true that culture can change people. It can educate people. It can improve people. However, culture also means that the leadership has to be very particular about the people who are accepted into the organisation.

It takes years to build a strong and lasting culture. It only takes a couple of months to destroy one, if you don't remove the elements that could erode your values.

Now, when we mention the word leadership in football terms, everyone immediately thinks of the coach and the captain of the team.

Don't get me wrong, the team coach and captain are extremely important in the chain of command when it comes to leadership. At times they may well play an extremely important part in improving the culture of the organization. However, for continued success that goes beyond the individual, leadership goes well beyond the captain and coach of the team.

I have studied the Queensland culture for many years. Not just the last twelve seasons where they have recorded an unprecedented run of success. The foundations of their culture were formed many years before this glorious era commenced.

Pretend you are a young Queenslander, coming into this Queensland State of Origin team today, and you walk into the training camp on day one.

There in the room you look across and see Cameron Smith, Johnathan Thurston, Cooper Cronk and Billy Slater.

What are your first thoughts?

Filled with nerves, you are probably thinking, I'm not going to let these guys down. I'm certainly not going to step out of line. I'm going to do whatever they say.

Then you realize you are in the presence of greatness. I'm going to watch them and learn. I'm going to copy what they do and say.

Then you look at them again and all the nerves start to flow from your body. You look at these leaders and you realize, 'we are going to be ok'.

Then a Cameron Smith puts his arm around you and says, 'Mate, you are one of us. We believe in you'.

Did you listen to Johnathan Thurston's pre Game tribute on Wednesday night? He talked of his first time in the Queensland Origin camp. He talked of his nerves, anxiety and insecurity. Then Darren Lockyer came up to him and said ['Don't worry, we believe in you'] ...

Name me one person in the NSW State of Origin team who would have this effect on any young player coming into the team for the first time.

More often than not, over the past 12 years, the opposite has probably been true.

So Smith, Thurston, Cronk, Slater; are they responsible for the leadership and culture of Queensland?

I say they are a product of the leadership and culture of Queensland. Playing for Queensland has played a huge part in creating them as the players and leaders they are today.

So, to all those looking to solve the dilemma of how NSW can ever beat Queensland in this interstate rivalry, please look beyond this obsession with trying to find a new half-back or a fancy play that can split the defensive line.

Look at the people. Look at the leadership.

Source: *Wide World of Sports*, 14 July 2017

QUESTIONS

1. According to the article, what is the key to creating positive team culture and why?
2. What impact does the Maroons' culture have on player motivation and confidence?
3. Using evidence from the article, justify that the Maroons have strong team norms, cohesion and social support.
4. What does the author mean when he says 'to all those looking to solve the dilemma of how NSW can ever beat Queensland … Look at the people.'?

Team dynamics, psychological state and performance

INTEGRATING MOVEMENT

Category: All
Physical activity: All

Purpose

1. This activity involves observing how team dynamics affect performance.
2. This activity focuses on the physical activity your teacher has selected for this topic.
3. The primary data collected in this activity could be used to support your folio task. DE 5

Preparation

Time: two lessons
Location: depends on activity
Equipment: depends on activity, copy of the Team Dynamics Questionnaire from your digital resources

Setup

1. Make sure you have a print or digital copy of the Team Dynamics Questionnaire.
2. Join an appropriately sized team for the physical activity.

Performance

Participate in an authentic game (timeframe decided by your teacher) within your team.

Data recording

Complete, as an individual, the Team Dynamics Questionnaire. DE 1

Tasks

1. Collate and synthesise the results using the tables provided by your teacher. DE 3
2. Compare and contrast your data set with those of your teammates.
3. Comment on why there are variations and similarities in the data sets.
4. Use this primary data to justify your level of motivation, enjoyment, self-confidence and arousal when playing in this team. DE 4
5. Justify how this psychological state influences your performance on the team, and your team's performance, using secondary data. DE 2

10.4 Goal setting

Team **goal setting** can enhance team cohesion and team effectiveness. Goals give a team direction and mental focus, and enable you to focus attention on the process of achieving success.

goal setting
a means by which individuals and teams direct their focus.

Goals can be set by an individual and by a team. Sometimes it can be complicated to match individual goals with team goals. Goals are necessary for improving performance and maintaining motivation.

The researcher RS Weinberg put it this way:

> *The coach must have goals. The team must have goals – real, vivid, living goals … Goals keep everyone on target. Goals commit me to the work, time, pain and whatever else is part of the price of achieving success.*

Types of goals

Three main types of goals have been identified by researchers in sport: **outcome goals**, **performance goals** and **process goals**.

- Outcome goals focus on the result of a particular event, such as coming in the top three in the 1500 m for your age group. When focusing on this type of goal, performers usually compare themselves to other performers.
- Performance goals concentrate solely on comparing your current performance with your past performance, such as swimming 400-metres 2 seconds faster than last season.
- Process goals focus on the technique of performance rather than the overall result, such as completing the hurdles by using the correct number of strides between each hurdle and not changing lead legs. Process goals focus on the procedures that you need to perform in order to have a good performance.

outcome goal
a goal that focuses on the result of a particular event

performance goal
a goal based on comparing current performance with previous performance

process goal
a goal that focuses on the technique rather than the performance result

Figure 10.7
Goals give a team direction and focus to move forward and achieve success.

What type of goals to set?

As a general rule, performers should not solely set outcome goals, as this emphasises the achievement of particular results and may cause stress and anxiety.

A study of swimmers found that nearly half set themselves a combination of all three goals, and none set only outcome goals. Athletes in sports that rely on precision skills, such as golf and archery, benefit greatly from setting process goals.

Short-term goal setting

INTEGRATING MOVEMENT

Category: All
Physical activity: All

Purpose

1 This activity involves setting and reflecting on team goals.
2 This activity focuses on the physical activity your teacher has selected for this topic.
3 The primary data collected in this activity could be used to support your folio task.

DE 5

Preparation

Time: two lessons
Location: depends on activity
Equipment: depends on activity, copy of the Goal Setting worksheet from your digital resources

Setup

1 Make sure you have a print or digital copy of the Goal Setting worksheet.
2 Join an appropriately sized team for the physical activity.
3 As a team, complete the 'Set Goals' part of the worksheet

Performance

Participate in an authentic game (timeframe decided by your teacher) within your team

Data recording

As a team, complete the 'Reflections and Evaluations' part of the worksheet.

Tasks

1 Evaluate the effectiveness of your team's goals by using primary and secondary data
2 To prepare for your next session, justify how you would modify your team's goals in order to achieve greater success.

DE 1 DE 2 DE 3 DE 4

Effective goal setting

Goal setting is a very effective psychological skill that can be learned, like imagery or relaxation techniques. It can have positive results in both sport and life. Don't confuse goals with dreams or wishes; goals need to be realistic and achievable at your skill level.

Short-term goals are particularly important, as working towards them provides immediate feedback and incentives that motivate you to continue. The ability to accomplish pre-set goals gives you greater confidence and self-esteem.

A second important characteristic of effective goal setting is setting difficult but achievable goals, and reassessing them at regular intervals. A basic rule for setting achievable goals is to aim just above your current performance level. Athletes and teams that set more difficult goals exert greater effort and are more persistent in reaching these goals. But setting the level of goal difficulty beyond the capability of an athlete or the team isn't a good idea, as players tend to give up before reaching them.

Reassessment gives you an opportunity to reset your goals if the initial standards were set too high or too low, or if you become over-committed and are trying to do too many activities.

Working towards your goals

Sticking to your goals can be difficult, but there are many ways you can keep yourself on track and working towards them.

Always write down your goals and keep them in a prominent place, such as on your bedroom wall or on the refrigerator door. Always reward yourself when you reach a performance goal on the way to a long-term goal. And when you achieve a goal, don't take it for granted! Reflect on how you achieved it and analyse the process you went through. An effective way of doing this is to keep a journal.

Athletes often concentrate on outcome goals: goals that focus on the result of an event or game and usually involve an athlete comparing their performance with that of another athlete. But when athletes who set outcome goals don't succeed, they often blame themselves for their failure and attribute it to lack of ability. This, in turn, may lead them to avoid the activity because they feel that they can't achieve success.

If athletes set performance or process goals, they identify other determinants of success, such as improved technique, a reduction in performance time, or their ability to outmanoeuvre their opponents. All coaches should teach athletes that personal success means achieving performance goals rather than achieving outcome goals.

Guidelines for goal setting

Goals such as 'Give it your best' or 'Have fun' aren't measurable and are unproductive; they don't identify specific actions to be taken and should be avoided. Effective goals should be SMARTER – that is, they are:

- **S**pecific: exactly what do you want to achieve?
- **M**easurable: how will you know when you have reached your goal?
- **A**chievable: do you have the desire and ability to achieve this goal?
- **R**ealistic: are you prepared to spend time and effort to make your goal a reality?
- **T**ime-framed: when do you aim to achieve the goal?
- **E**valuated: goals need to be constantly evaluated and adjusted to reflect your progress.
- **R**ecorded: prioritise your goals by writing them down and sharing with your coach and team members.

See Table 10.1 for examples of how ineffective goals can be rewritten as more helpful goals.

Table 10.1 Examples of effective and ineffective goals

Poorly written goal	Improved writing of goal
Improve forehand in tennis	Prepare racquet head earlier
Improve first serve in tennis	Make ball toss more consistent in height and direction

The nature of the goals being set is very important. Your goals must spell out exactly what you want to achieve. To set a long-term goal, you must first establish a problem-solving approach to the development of short-term goals. How are you going to get there?

For example, if an athlete has the goal of representing their state in the 100-metre sprint at the national athletics championships in March, this can only be reached by meeting various short-term goals. The relationship between the short-term goals and the ultimate long-term goal can be represented as a staircase, as shown in Figure 10.14.

Figure 10.8 The staircase model of short- and long-term goals

Setting goals can help you in these ways:

- achieve more steadily
- improve the quality of your training
- improve your motivation to achieve
- increase satisfaction with your performance
- ultimately improve your performance.

Check your understanding 10.4

1 Explain the three different types of goals.
2 How does setting goals improve performance and motivation?
3 Define the acronym SMARTER and explain why this is used in goal setting.

Apply and analyse
develop your own goals

LEARNING EXPERIENCE

A sample goal-setting sheet for a skill in softball is shown below. Use the questions in this template as a guide for developing your own goal-setting task for a skill specific to your sport.

Sample goal-setting sheet for softball

Goal: to control my pitching late in the innings when I am fatigued

Type: Process – Technical Date set: ___________________

To achieve this goal (answer all six questions):

1 What do I have to do?
  a Be more assertive/decisive in swinging at the ball.
  b Develop a more appropriate spatial relationship with the ball.
  c Develop a more dynamic approach/take-off.
2 What steps do I need to put in place, in order to achieve this goal?
3 How can I measure improvement?
  a Objectively – 6 out of 10 (60%) → 8 out of 10 (80%)
  b Subjectively – feedback from coaches/teammates and video of self
4 Who can help me achieve this goal?
5 How will I know I have achieved it?
  a When I am achieving 60–80% consistently and without conscious thought
6 What barriers are going to prevent me from achieving my goal?

Applying goals

INTEGRATING MOVEMENT

Category: All
Physical activity: All

Purpose

1 This activity involves setting and reflecting on personal goals.
2 This activity focuses on the physical activity your teacher has selected for this topic.
3 The primary data collected in this activity could be used to support your folio task. DE 5

Preparation

Time: at least two sessions
Location: depends on activity
Equipment: depends on activity, goal-setting template from your online resources

Setup

1 Using the template, create two short-term goals and one long-term goal for your personal performance in the physical activity you're studying.
2 For each goal, justify which psychological strategy you would use to effectively achieve the goal.

Performance

Select one of the short-term goals and implement the strategy over a series of lessons as you aim to achieve your goal.

Data recording

Gather primary data on your success in reaching the goal. DE 1

Tasks

1 Analyse and synthesise primary and secondary data about how the psychological strategy influenced your ability to achieve your goal, and improve your performance. DE 3
2 Reflect on the primary and secondary data to evaluate your effectiveness in achieving the goal.
3 Evaluate how goal setting influenced your motivation, concentration, confidence, attention, arousal and team dynamics (if applicable) within the physical activity. DE 4
4 Justify how effective your strategy was in achieving your goal.

Chapter review

[10.1] A team is two or more individuals who have a common identity, goal and fate, and who exhibit group patterns and processes. Teams have formal and informal roles. Groups norms maintain routines and set standards of behaviour within a team to increase cohesion. Accepting individual differences creates social support within a team and means that members are satisfied with their place in the team.

[10.2] Cohesive teams are united, have a shared goal and effective leadership. Task cohesion is a team's ability to work together to achieve its goals. Social cohesion is the degree to which members of the team like each other and enjoy one another's company.

[10.3] Leadership behaviours within a team influence motivation, arousal, concentration, team dynamics and personal performance. Communication is important for a team's shared understanding, timing of actions and coordination of space and equipment. Consistently reinforcing team norms and rules breeds discipline within a team. Disciplined behaviour involves self-awareness of one's behaviour and self-control in order to maintain desired behaviour.

[10.4] Goal setting enhances team cohesion and team effectiveness. Outcome goals, performance goals and process goals are the main types of goals. Effective goal setting follows the acronym SMARTER: specific, measurable, achievable, realistic, time-framed, evaluated and recorded.

Review questions

Section A: Multiple-choice questions

1 A team is defined as:
- **a** a group of athletes playing sport.
- **b** two or more individuals with a shared identify and common goals.
- **c** two or more individuals who win.
- **d** all of the above.

2 When establishing group roles, you need to consider:
- **a** role clarity, role acceptance and role conflict.
- **b** who the captain of the team will be.
- **c** role clarity and role acceptance.
- **d** the motivation of each of the players.

3 The MAPS model used to build successful teams stands for:
- **a** mission, allocation, plan, systems.
- **b** mission, assessment, plan, systematic evaluation.
- **c** motivation, assessment, people, success.
- **d** motivation, allocation, people, situation.

4 Team cohesion is a result of a group's desire to remain together and is a blend of two key dimensions:
- **a** success and motivation.
- **b** attitude and behaviours.
- **c** task cohesion and social cohesion.
- **d** success and failure.

5 According to Don Hellison's model, there are four levels of:
- **a** leadership.
- **b** trust.
- **c** participation.
- **d** responsibility.

6 The term used to describe goals that focus on the technique of performance is:
- **a** performance goals.
- **b** process goals.
- **c** outcome goals.
- **d** SMARTER goals.

7 Short-term goals are particularly important because:
- **a** long-term goals are often never achieved.
- **b** they are easier than long-term goals.
- **c** they provide feedback and motivation for the athlete to continue.
- **d** they are realistic and controlled by the athlete.

8 Which of the following goals is effective, according to the SMARTER acronym?
- **a** Try my best
- **b** Win the regional tennis competition
- **c** Increase my 1RM back squat from 85 kg to 90 kg within the next 6 months
- **d** Improve my 50-metre freestyle time

9 Which of the following is an outcome goal?
- **a** Increase the speed of my backswing in my tennis serve
- **b** Finish first in my school cross-country race
- **c** Increase my javelin throw by 50 centimetres
- **d** Decrease my missed shots by five in my next basketball game

10 'Have fun' is not an effective goal because:
- **a** it doesn't relate to winning.
- **b** it doesn't relate to technique.
- **c** it is a performance goal.
- **d** it isn't a SMARTER goal.

Section B: Short-response questions (150–250 words)

1 From your experience as a member of a team, describe how an effective and positive team member would behave in the following situations.
- **a** Coming on to the court from the bench in a tight game
- **b** Reacting to errors made by a teammate during a match
- **c** Experiencing consistently poor refereeing decisions during a match
- **d** Participating in a training session
- **e** Taking a training session in the absence of the coach

Section C: Extended response (400 words)

At the start of the season, you're appointed as the coach of a team that has lost all of its matches in the previous season. The members of the team aren't really looking forward to another season. From observation at the first training session, it's evident that they don't really put in much effort to their training, but their skills aren't too bad.

Justify how you would improve the performance of the team. In your response, discuss:

- team dynamics
- goal setting
- psychological strategy
- team confidence, motivation, arousal, concentration and attention.

11 CONSIDERING ACCESS AND EQUITY

Figure 11.1
Taking part is often more important than competing.

Sport and physical activity plays an important role in our lives. It also has a tendency to reflect the features of society as a whole. This makes the sociology of sport an important topic of study for anyone concerned with physical education.

In this chapter, you'll explore the links between the sociocultural setting and attitudes, choices and behaviours with regards to sport and physical activity. You'll learn what access and equity mean, and understand how sociocultural influences can change people's thinking about and participation in sports and physical activity.

KEY QUESTIONS

11.1 How is participation in sports influenced by sociocultural factors?

11.2 How can these influences affect our access to and equity in sport?

YOUR CHAPTER PLAN

11.1 Sport – a microcosm of society

11.2 Equity and access

Chapter review

11.1 Sport – a microcosm of society

Champion tennis player Billie Jean King's achievements reached far beyond the tennis court. As well as her many Grand Slam wins, she's credited with:

- gaining equal prize money for women's tennis
- winning the 'Battle of the Sexes' match in 1973, promoting the spectacle of women's tennis
- advocating for gay rights in sport
- mentoring athletes in a range of sports to overcome mental and social pressures.

King is quoted as saying 'Sports are a **microcosm** of society' – that is, sport reflects and re-creates many features of our society at large. As a gay woman, King often experienced inequity, discrimination and prejudice in all aspects of life. Within the tennis community, she experienced many of the same issues and behaviours she faced in society in general.

King's story is not unique. Sport settings reflect **sociocultural** issues, whether in our own society, the society of competing teams, or on a global level. It's important to consider how these issues impact sport, and how sport can present these issues to players and audiences, in order to fully understand the place of sport in our society.

microcosm
a representation of something on a smaller scale

sociocultural
a combination of social and cultural factors

Figure 11.2
Billie Jean King is an inspiration for many, on and off the court.

Apply and analyse
sport and society

LEARNING EXPERIENCE

1 Which broader social issues are reflected in the sport settings in these images
2 Explain how these issues impact these sports settings.

Distribution of capital

sociology
the study of the influence of relationships and structures within society, and their influence on individuals

capital
something that holds value within a society

Much of the study of **sociology** involves analysing the effects of the division and distribution of **capital**. Capital refers to something valued by society, such as money, power and resources. In a capitalist society such as Australia, capital is divided and distributed unevenly. Capital is bought and sold, gained and lost, given out and taken away.

Whenever capital is gained by an individual or a group, they gain an advantage over those who do not possess that capital. For example, an athlete who is paid by sponsors is able to devote much more time and effort to training than an athlete who must spend time each day working to cover their expenses. This uneven division and distribution of capital affects **access** to sport and physical activity; not everyone has the same opportunity to participate.

The uneven distribution of capital can also affect **equity**, both in society at large and within sport and physical activity. Equity is how fairly people are treated, and the degree with which their differences are valued and celebrated. Both individuals and groups may experience a lack of equity.

access
the opportunity to participate

equity
giving value to and celebrating personal, social and cultural differences within society

Check your understanding 11.1

1. Explain how sport can be seen as 'a microcosm of society'.
2. Identify an example of how individuals might have unequal access to sporting opportunities.
3. Identify an example of how a sporting group might not provide equity to athletes.

Apply and analyse
how does capital affect opportunities to participate?

LEARNING EXPERIENCE

Figure 11.3 lists three different kinds of capital relating to sports and physical activity.

1. For each kind of capital, describe a way in which opportunities to participate are improved by possessing it.
2. For each kind of capital, describe a way in which opportunities to participate are inhibited by possessing it.

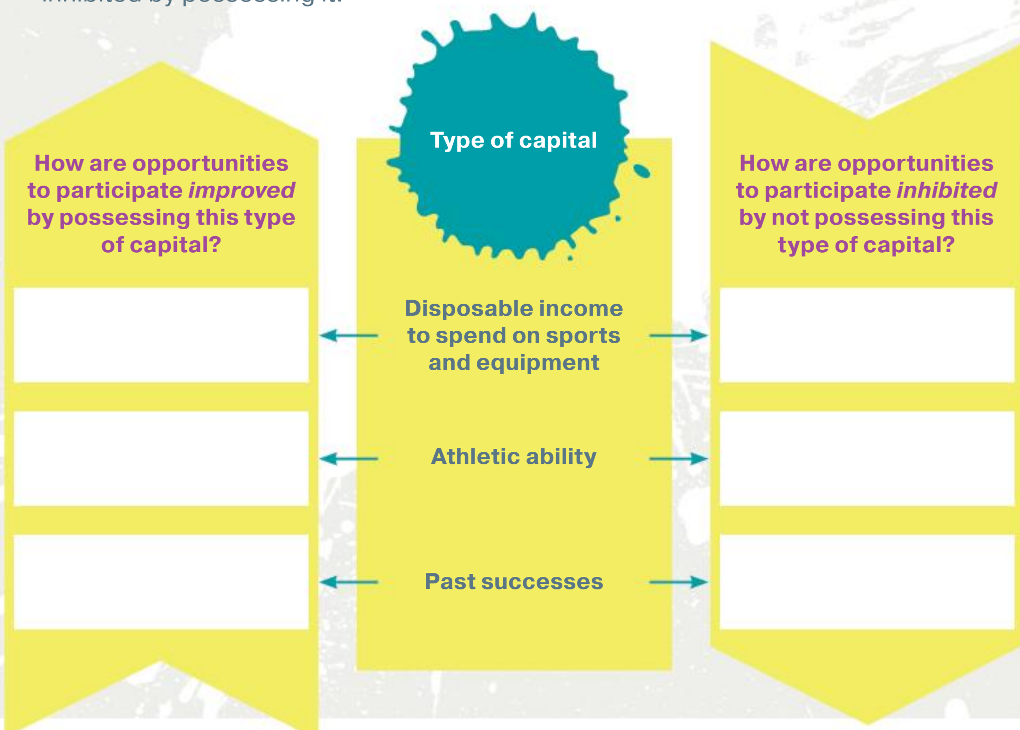


Figure 11.3 The effects of different types of capital

Distribution of capital

INTEGRATING MOVEMENT

Category: Striking and fielding
Physical activity: French cricket

Purpose

1 This activity involves observing how distribution of capital affects access and equity in a physical activity.
2 The primary data collected in this activity could be used to support your investigation task.

DE 5

Preparation

Time: one lesson
Location: open outdoor area
Equipment: cricket bat, ball

Setup

1 Assign one student to be the batter and one to be the bowler. All other students are fielders.
2 The batter stands at the stumps, with the fielders spread in a rough circle around them.

Performance

1 The bowler throws the ball towards the batter, who has one chance to hit the ball. The batter is out if they are struck below the knees by the ball, or if the ball is caught on the full directly off the bat
2 The fielder or bowler who gets the batter out goes in as the new batter. The fielder that picks up the ball becomes the new bowler, and must bowl from where they field the ball.
3 For each new batter, your teacher will vary the rules or equipment used in the game. These variations may include, but are not limited to:
   a the batter not being allowed to move their feet
   b a different-sized ball
   c a baseball bat or cricket stump for a bat instead of a cricket bat
   d bowlers being allowed to bowler overarm or underarm
   e silence to be required when bowling
   f fielders being allowed to talk to and distract the batter
   g allowing ‘one hand, one bounce’ catches.

Data recording

Observe and record how each rules variation affects the game and players.

DE 1

Tasks

DE 3 DE 4

1 Identify a player who was advantaged by the variations. Explain how they were advantaged.
2 Identify a player who was disadvantaged by the variations. Explain how they were disadvantaged.
3 Which variations in the game were desirable? Explain how these variations could be classed as capital.
4 Reflect on the reactions of the batters when non-desirable variations were introduced to the game. Comment on what you observed.

http://mea.digital/qpe12_11

11.2 Equity and access

Equity is more than just 'equality' – the state of being equal. When you take into consideration the differences between each and every individual, a true state of equality is not realistic. Differences are not issues to be removed to create equality. Rather, they are something to be acknowledged, accommodated and celebrated in order to promote access to sport and physical activity.

Access in its simplest terms is the opportunity to participate. However, many people don't have equal opportunities to participate in or benefit from sport and physical activities. Various sociocultural influences may promote or inhibit opportunities to participate in certain sports and physical activities. This in turn influences the attitudes, choices and behaviours people develop towards sports and physical activities.

Therefore, simply providing a right to access sport and physical activity doesn't mean that a person can or will take the opportunity to play. It's also necessary to address any influences that might inhibit those opportunities, possibly by adding further opportunities or incentives.

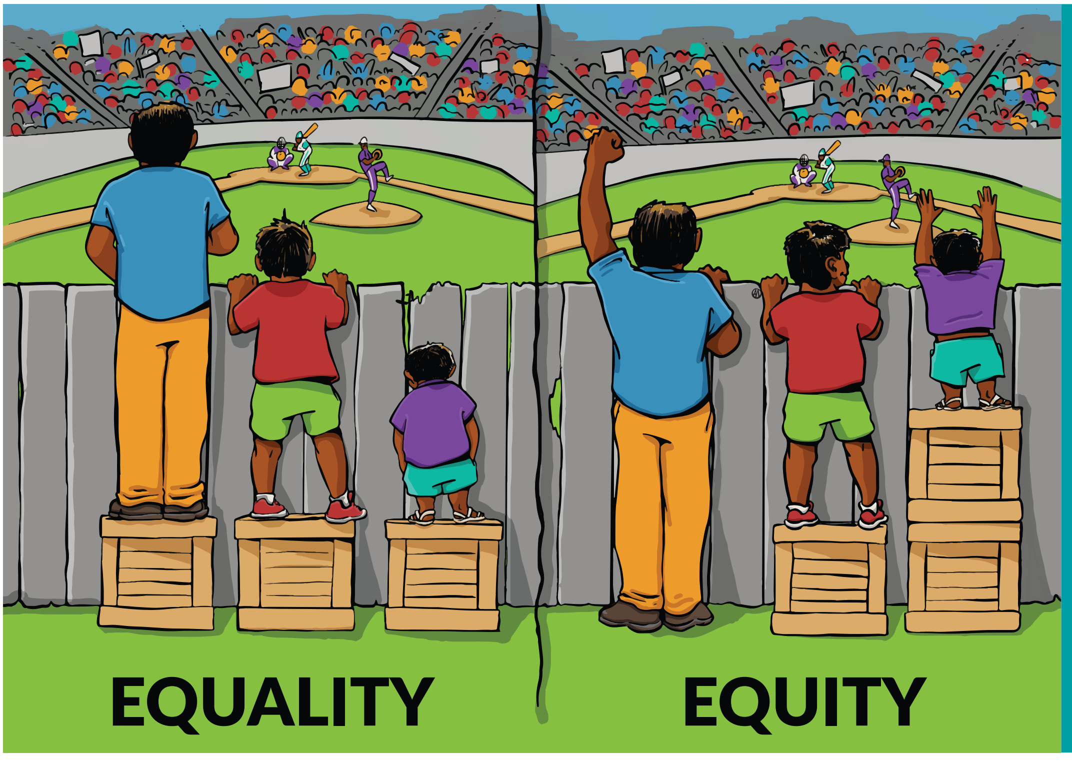


Figure 11.4 Equality ignores difference and assumes everyone has the same needs; equity takes individual needs into account to make opportunities as fair as possible.

American psychologist Abraham Maslow developed a scale of priorities for what people need in their lives:

- physiological needs – food, water, shelter and general health
- safety needs – protecting yourself from physical danger
- belonging needs – a sense of belonging and fitting in
- esteem needs – feeling valued and worthy
- self-actualisation – a feeling of achieving our purpose.

Maslow's hierarchy can be a useful tool when considering a person's access to sports and physical activities. Ask yourself, what needs are currently being met for that person? Which needs are not being met? And how will meeting the needs at the lower levels affect the higher-level needs?

Barriers and enablers

Various sociocultural factors influence the equity of access that individuals and groups experience when it comes to sports and physical activities. These factors can be categorised according to the influence they have on the relevant individual or group:

- Barriers are factors that limit access and equity.
- Enablers are factors that enhance access and equity.

A factor that makes a particular sport attractive to one person may have the opposite effect on another.

Barriers and enablers can be categorised according to the source from which they arise: personal, social, cultural or environmental. You will examine those categories in depth in Chapter 12.

Attitudes, behaviours and choices

While the direct influence of some barriers and enablers is obvious to see, others are more subtle. The effects of barriers and enablers can be seen in our individual attitudes, behaviours and choices.

- **Attitudes** are the way in which people think or feel about something. Your attitudes towards a sport or physical activity influence your willingness to participate in that activity. Other people's attitudes aren't always easily identified, since they're comprised of a person's thoughts and feelings, but they're often reflected in their behaviour.
- **Behaviours** are the way in which you act in response to something. This includes the way in which you speak, your body language, your energy levels and the effort you put in. The way in which you behave in response to a sport or physical activity reflects the value we place on it. People are more likely to behave positively towards activities that they have positive attitudes towards.
- The **choices** you make also reflect your attitudes. Generally, choices regarding sports and physical activity reflect people's attitudes, access and equity to sports and physical activities.

The attitudes, behaviours and choices of an individual towards sports and physical activity are influenced heavily by the access and equity they experience. No two people are the same. This means that equality of opportunity is unrealistic.

Equitable opportunities to participate celebrate difference, remove **discrimination** and discount **stereotypes**. In order to do this, people must identify barriers to participation, appreciate the causes and effects of these barriers, then synthesise strategies to overcome them.

attitude
a thought or feeling towards a particular thing

behaviour
the way in a person acts in response to a particular stimulus or situation

choice
a conscious decision between a range of alternative options

discrimination
unjust treatment of individuals or groups based on differences

stereotype
a commonly held, simplified belief about a group within society

Disability as a barrier and enabler

An obvious example of barriers and enablers influencing physical activity is the area of personal disability – but this is also an example of how that influence can change.

The conventional term 'disability' covers a range of physical and intellectual impairments. The Australian Bureau of Statistics defines disability as 'any restriction or lack of ability (resulting from impairment) to perform an activity in the range considered normal for a human being'.

For much of human history, people with disabilities were prevented from participating in organised sports; their requirements and restrictions were seen solely as barriers. But from the 1980s onwards, there have major developments in the provision of access to sports and physical recreation for people with a disability.

Early initiatives provided separate, segregated facilities and services, as it was considered that people with a disability had different needs, interests and capabilities from other people. That attitude is continuing to change, though, and the current emphasis is much more on integration and inclusion. This includes the development of adaptive sports or para-sports, which are modified or designed to be appropriate for performers with disabilities. It also involves improving access to sporting facilities designed to cater for all members of the community.

The change in perspective to focus on equity and access means that while barriers to physical activity definitely still exist for people with disabilities, those barriers are being recognised and (hopefully) addressed. It also means that more enablers are developed to create opportunities for people with disabilities to engage in sport and compete with their peers.

Figure 11.5 Sports and physical activities are becoming more accessible for people with disabilities.

Check your understanding 11.2

1. Describe how our attitudes, behaviours and choices reflect our access and equity in sports and physical activity.
2. What is the difference between a barrier and an enabler?
3. Explain the difference between equality and equity. Justify your response by providing an example.

CASE STUDY

The Invictus Games

The Invictus Games is a sporting event founded by Prince Harry in 2014. It is an international competition across a variety of adaptive sport, in which all of the competitors are wounded, injured or unwell defence personnel. The purpose of the Games, as stated by Prince Harry, is to 'demonstrate the power of sport to inspire recovery, support rehabilitation and demonstrate life beyond disability'. In October 2018 the Games were held in Sydney.

The Invictus Games is part of a range of adaptive sports competitions that are becoming more widespread and mainstream. The 2018 Commonwealth Games included para events in the mainstream program, and wheelchair tennis was played on Rod Laver Arena during the 2018 Australian Open.

Although the barriers to sports and physical activity posed by disability are often great, it is important to consider strategies to overcome these barriers, while also celebrating the important role sport can play in the lives of people with disabilities.

'Up until my awareness of the Invictus Games, all I had been doing was living in memories. In my mind my life has been over and I was just waiting to be done because I'm not capable of doing or living like I used to. I'm starting to think however, that my game has just begun.'

Invictus Games competitor, Team USA, 2016

QUESTIONS

1 Identify key enablers that might allow people with disabilities to engage with sports and physical activities.

2 Explain how sport can act as a form of capital for people with disabilities.

3 Important steps have already been made to improve equity and access to sport and physical activity for people with disabilities. Suggest further steps that could be taken to further improve access and equity.

Recognising diversity

INTEGRATING MOVEMENT

Category: Net and court
Physical activity: Volleyball

Purpose

1. This activity involves observing how diversity and differences affect a game of volleyball.
2. The primary data collected in this activity could be used to support your investigation task. DE 5

Preparation

Time: one lesson
Location: volleyball court
Equipment: volleyball, net; digital capture devices (optional)

Setup

Form into even-sized teams.

Performance

Play three short 'first to five points' games of volleyball. For each game, a variation to the standard rules will be imposed on one of the teams:

1. In the first game, one team is not allowed to speak. Any word spoken by any team member results in the point being awarded to the opposition
2. In the second game, one team may not block or spike the ball at any time. Any block or spike will result in the point being awarded to the opposition
3. In the third game, one team must play in a sitting or kneeling position. Standing up will result in the point being awarded to the opposition

Data recording

1. Record scores and/or video the performance for later analysis. DE 1
2. Observe how each rules variation affects the game and the players.

Tasks

1. Were all the players given equal access to the games? Explain why or why not. DE 3
2. Comment on the equity experienced by each team. How were certain teams advantaged? How were certain teams disadvantaged?
3. Reflect on the attitudes and behaviours exhibited by players on the teams that were disadvantaged. Give some examples of how they reacted. DE 4
4. Reflect on the attitudes and behaviours exhibited by players on the teams that were advantaged. Give some examples of how they reacted.

Chapter review

[11.1] Sport is a microcosm of society. Many sociocultural issues from wider society affect and are reflected in sports and physical activities.

[11.2] Each person is an individual with many biological and social differences. These impact their attitudes, behaviours and choices in sport and physical activity. Equality discounts differences and assumes that everyone has the same opportunities.

[11.2] Access is the opportunity to participate in sport and physical activity. Enablers are factors that promote access and equity; barriers are factors that inhibit access and equity.

Review questions

Section A: Multiple-choice questions

1 A ‘microcosm of society’ means that:
- **a** sport has its own little world.
- **b** society reflects what happens in sport.
- **c** sport reflects and replicates the sociocultural issues in society at large.
- **d** sport plays a large role in society.

2 Equality is defined as:
- **a** the state of being equal.
- **b** the state of being equitable.
- **c** recognising and celebrating difference.
- **d** the opportunity to participate.

3 Equity is defined as:
- **a** the state of being equal.
- **b** the state of being equitable.
- **c** recognising and celebrating difference.
- **d** the opportunity to participate.

4 A barrier:
- **a** is a factor that prevents participation.
- **b** forms a shield or wall.
- **c** stops people from participating in sport.
- **d** is a factor that inhibits access and equity.

5 An enabler:
- **a** is a factor that allows participation.
- **b** helps people achieve a goal.
- **c** is a factor that promotes access and equity.
- **d** is a factor that promotes equality.

6 The four categories of barriers and enablers are:
- **a** personal, social, cultural and environmental.
- **b** individual, institutional, social and cultural.
- **c** personal, structural, cultural and environmental.
- **d** societal, individual, environmental and cultural.

7 Discrimination is:
- **a** separating things according to differences.
- **b** unjust treatment of individuals or groups based on differences.
- **c** singling out people for doing the wrong thing.
- **d** prejudice against people who can’t participate.

8 Attitudes are:
- **a** commonly held beliefs about something.
- **b** rebelling against social norms.
- **c** ways in which we act in social situations.
- **d** thoughts and feelings towards something.

9 Behaviours are:
- **a** thoughts and feelings towards something.
- **b** the way we act in response to something.
- **c** commonly held beliefs towards something.
- **d** beliefs about how to speak and act.

10 Choices are:
- **a** thoughts and feelings towards something.
- **b** commonly held beliefs about something.
- **c** conscious decisions between a range of alternatives.
- **d** selecting the correct answer.

Section B: Short-response questions (150–250 words)

1 Consider a sport or physical activity that you enjoy, are good at or participate in regularly. Identify some of the key reasons you play. Explain how these reasons could be considered enablers.

2 Think of a sport or physical activity that you have never played and have no interest in trying. Determine some reasons for you don't play or want to play. Explain how these reasons could be considered barriers.

Section C: Extended response to stimulus (400 words)

The Gaelic sport of hurling (see Figure 11.6) is considered by many to be the fastest field sport in the world. In Ireland, men's and women's professional games draw huge crowds due to the spectacle of this fast, violent sport. The women's game is called camogie in Gaelic, but is essentially the same game.

The way the game is played draws similarities from Gaelic football and lacrosse. The objective of the game is to score by using a wooden paddle to hit a small, hard ball between the uprights or into the net of the opposition's goals. Hitting the ball through the uprights gains one point, while scoring into the net, which is guarded by a goal keeper, is worth three. The ball may be moved around the field by carrying it in the hand for four steps, hitting it with the paddle, slapping it with the hand or by kicking it with the foot. Although jersey grabbing, striking and one-handed jabs with the paddle are forbidden, shoulder charging and tackling with two hands on the paddle are completely legal. This, along with a plastic helmet being the only protective gear, gives hurling a reputation of being brutal.

1. Do some research into the game and have your teacher show you some footage of it being played. Is hurling a sport that you are interested in playing? Explain why or why not.
2. Identify key barriers that currently inhibit your access to hurling. Suggest ways in which these barriers could be overcome to increase your access to the sport.

Figure 11.6
Hurling or camogie (the women's game) is a fast, brutal game that is popular in Ireland.

12 MANIPULATING BARRIERS AND ENABLERS

Figure 12.1 Dylan Alcott has manipulated many barriers in becoming a highly successful athlete in a variety of sports.

To promote access and equity, it's important that we first identify the key barriers and enablers that affect an individual or group. Because each person is unique, the barriers and enablers they experience are also unique. What might be a barrier for one person may be irrelevant for another, or act as an enabler for someone else.

Chapter 11 mentioned four types of barriers and enablers – personal factors, social factors, cultural factors and environmental factors. In this chapter, you'll examine all four in depth, and consider how they can be overcome or addressed.

KEY QUESTIONS

12.1 How do personal preferences and attitudes affect our access to sport?

12.2 How can access and equity be improved for society as a whole?

12.3 What factors affect access and equity in different cultures?

12.4 How can environmental factors be manipulated?

YOUR CHAPTER PLAN

- 12.1 Personal factors
- 12.2 Social factors
- 12.3 Cultural factors
- 12.4 Environmental factors
- Chapter review

12.1 Personal factors

We're drawn towards playing sports we enjoy, are good at and that make us feel good, while avoiding those that do not. Why do we feel this way?

Your individual personality, values and perceptions influence your attitudes, behaviours and choices regarding sport and physical activity. The degree to which you engage in a particular sport can be largely based on whether or not you see it as being worthwhile.

For most people, the access and equity we experience depends largely on our willingness to seek out and engage in sports and physical activity. Even the most accessible, equitable opportunities for sports require us to make the choice to participate. In order to make this choice, you must have sufficient motivation to participate. You must also have sufficient confidence in your ability to participate effectively.

Motivation and confidence are influenced by our **self-concept** and **self-esteem**. Your self-concept is the way in which you view yourself as an entire person. It is how you see yourself physically, how you believe others perceive you and what you feel are your physical and mental capabilities. Your self-esteem is how you feel about your self-concept. If we feel good about ourselves and our abilities, we are more likely to engage with sports and physical activities, and do so confidently.

self-concept
the way in which you view yourself as an entire person

self-esteem
how you feel about your self-concept, the feelings you have about yourself

biological
stemming from the scientific make-up of an organism

Apply and analyse
the influence of personal preferences

LEARNING EXPERIENCE

1. Consider and list all the sports and physical activities you enjoy playing and watching.
2. Categorise the sports in your list.
3. Distinguish common characteristics that make you enjoy these sports. Choose three common characteristics that most attract you towards a sport or physical activity.
4. Compare your answers as a class.
5. Compare classmates who are attracted to the same characteristics of a sport as you. Do you share common personality traits with these classmates?

Nature versus nurture

Every one of us is born with **biological** traits, inherited from our parents and pre-programmed into our DNA. These traits determine many of our physical, mental and emotional capabilities and potentials.

But humans are also social beings who learn from everyday interactions with one another. Along with the **genetic predispositions** you inherit from your parents, social interaction moulds your individual **identity**. It's only through social interaction that your genetically predetermined capabilities and potentials can be reached.

genetic predisposition
an increased likelihood of developing a particular trait or characteristic

identity
the characteristics or qualities that define an individual

The phrase 'nature versus nurture' is often used when comparing a person's biological or genetic traits with the aspects of their identity they learnt through their social setting. Aspects of your identity, such as your personality, preferences and values, significantly influence your attitudes, behaviours and choices. Personal factors are therefore a logical starting point for investigating barriers and enablers.

somatotype the different body shapes that humans have

ectomorph body type tending towards slenderness with a low component of body fat

endomorph body type tending towards low muscle tone with a high component of body fat

mesomorph body type tending towards muscularity, with high muscle and low body fat components

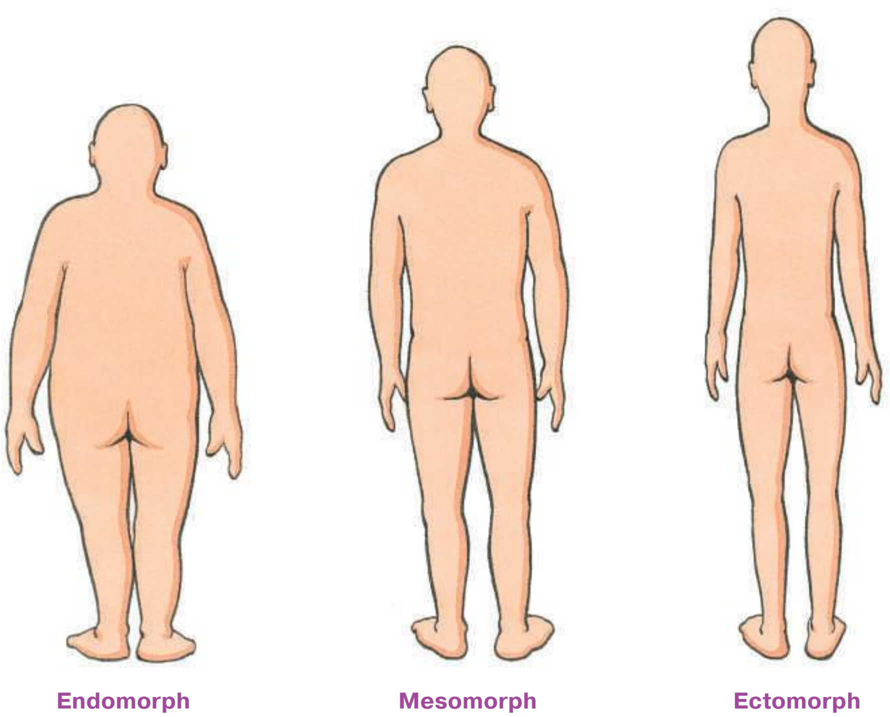
Genetic predisposition and physical abilities

The classical Greek philosopher Plato suggested that 'we are bound to our bodies, like an oyster to its shell'. He meant that people are born with a body that has genetically predetermined capabilities, potentials and limits. While you can reach these capabilities and potentials through training and practice, you're still limited by what your body is genetically able to achieve. Your **somatotype**, motor skill development, age, diet, physiology, training level and injury risk play important roles in your ability to play a particular sport or physical activity.

Somatotype refers to the different body shapes that human beings take. There are three commonly accepted somatotypes (see Figure 12.2):

- **ectomorph** – a body type tending towards slenderness, with a low component of body fat
- **endomorph** – a body type tending towards low muscle tone, with a high component of body fat
- **mesomorph** – a body type tending towards muscularity, with a high muscle component and low body fat component.

Figure 12.2 The three common somatotypes



Mesomorphs, and to lesser extent ectomorphs, are the primary somatotypes positively associated with enhanced performance. However, different sports require different physical attributes, and there is no one body shape that is best at all activities. For example:

- 'Pure' mesomorphs are best suited for strength-based activities such as body building or boxing, or high-movement sports such as football (soccer).
- Mesomorphs with ectomorphic tendencies are slender but have muscle, making them best suited for speed-based sports such as sprinting or swimming.
- Mesomorphs with endomorphic tendencies have muscle and significant body mass, making them best suited for sports such as baseball, golf or wrestling.

Successful athletes tend to have somatotypes similar to those individuals who are already successful in their chosen sport. This may be true even if they enter the sport with a different somatotype. Research has established that body shape and somatotype can be altered by participation in exercise, sport and physical activity.

In addition to your somatotype, other genetic predispositions that can influence sporting ability include sex, height, weight and slow- or fast-twitch muscle fibres. Genetics can also contribute towards physical disabilities, such as vision and other impairments. Such factors can contribute to the limits to which individuals can train their bodies, and the effectiveness with which they can perform a sport or physical activity.

Figure 12.3 The liberoes (yellow shirts) have not inherited the genes from their parents to be as tall as the other players in the volleyball team.

CASE STUDY

Talent identification programs

In the lead up to the 2006 Winter Olympic Games, potential Australian athletes were recruited to the sport of skeleton. Skeleton is a sport where competitors run, then slide at high speed down an icy track headfirst on a small but heavy sled. The Australian Institute of Sport (AIS) and Sliding Sports Australia saw skeleton as a potential sport in which Australian athletes could be quickly trained to adapt and succeed, based on their natural speed and power.

This type of recruitment is not unusual. Many sporting bodies use fitness testing to identify potential sporting talent. The AIS and state sporting organisations have run fitness testing programs in high schools to identify young Australians who possess ideal somatotypes and fitness levels for particular sports. The South Australian Sports Institute use their Facebook page to encourage young athletes to post their fitness test results to identify new talent.

The AIS suggest that these types of programs have been useful in identifying successful athletes in sports such as rowing, skeleton and cycling. However, this type of testing only considers the nature side of the nature versus nurture debate.

QUESTIONS

1 Why are fitness testing-based talent identification programs successful in recruiting athletes for fitness-based sports, such as rowing, skeleton and cycling?

2 If an athlete is identified as having a genetic potential to succeed at a particular sport, what other factors must be taken into account if they are to actually become successful at it?

3 Explain why similar talent identification programs may not be suitable for skill-based sports, such basketball, cricket or badminton.

Personality traits

The setting in which you grow up and the significant people in your life shape your personality and identity. You observe how others speak, behave and react to different situations. You see what they value and prefer. Your observations then influence your own behaviours, attitudes and preferences.

neurological
related to the brain and nervous system

While many personality traits can be learnt from social interactions, research suggests that there are **neurological** factors that influence our personality. Certain brain functions, chemicals and thought patterns are likely to change the way in which we behave. These have been linked to genetics. This genetic predisposition towards certain personality traits combines with learnt behaviours, attitudes and preferences to form an individual's personality.

Psychologists around the world have developed a large number of questionnaire-style personality tests. The purpose of these tests is to identify how a person is likely to react to different scenarios based on their personality.

For example, people who are **introverted** may be more likely to choose individual sports that require less interaction with other people. Meanwhile, people with an **extroverted** personality may be more comfortable playing team sports that require communication and interaction. People with aggressive **temperaments** may be drawn to contact sports, while those who are more cautious may seek different alternatives.

Intellectual and mental states may also play roles in influencing choices. People suffering from depression or anxiety might withdraw from sports and physical activities. Some people like to continue their sport despite intellectual and mental challenges, because it provides them with camaraderie and challenge and all the benefits of exercise.

introverted
a personality type tending to be shy, quiet and socially awkward

extroverted
a personality type tending to be outgoing, loud and socially confident

temperament
a person's nature, affecting their behaviour

Figure 12.4
This young fan has learnt from those around him how to react to an opposition goal.

Gender

A significant contributor to our identity is our **gender**. Nearly all people are born physiologically male or female (a person's **sex**) but a person's gender is a socially constructed phenomenon. (The construction of gender is covered in more depth later in the chapter.)

Lots of physical activities are segregated (separated) by sex, in particular the vast majority of competitive sports. We're brought up to associate certain sports and physical activities with certain genders, although people increasingly participate in whatever activities they enjoy, regardless of their gender.

Masculine-coded sports are generally more physical and aggressive with a focus on dominating the opposition. This reflects a history of women being excluded from sports, and gender stereotypes for men.

On the other hand, **feminine**-coded sports and physical activities are generally less physically aggressive and more conservative. This reflects stereotypical expectations of women being gentle or delicate. Non-contact sports, such as netball, were traditionally viewed as being 'feminine'.

Despite personal abilities and preferences, people may be less inclined to access sports and physical activities that have had a history of association with a particular gender.

gender
the constructed state of being masculine, feminine or other

sex
the anatomy of an individual's reproductive system, and secondary sex characteristics

masculine
qualities socioculturally associated with being male

feminine
qualities socioculturally associated with being female

Apply and analyse
what makes a sport masculine- or feminine-coded?

LEARNING EXPERIENCE

1 Construct a table with the following headings. List sports that are mostly associated with masculinity or femininity.
2 Classify common characteristics of the sports in each list.

Table 12.1 Masculine- and feminine-coded sports

Sports mostly coded as masculine	Sports mostly coded as feminine
Common characteristics of sports mostly seen as masculine	Common characteristics of sports mostly seen as feminine

3 Compare and contrast the common characteristics. As a class, discuss what causes a sport to be considered masculine or feminine.

Evaluate and justify
how might gender influence engagement with a sport?

LEARNING EXPERIENCE

Consider the images below. Both illustrate men and women participating in sports and physical activities not commonly associated with their gender.

1 How might people react to women playing masculine-coded sports?
2 How might people react to men playing feminine-coded sports?
3 How might people's attitudes towards the gender associations of these sports act as a barrier to participation?
4 Decide how this barrier may be overcome to promote access.

Figure 12.5 Women playing rugby league

Figure 12.6 A male figure skater

Previous experiences of physical activity

Previous experiences with a sport or physical activity are important when you choose whether or not to engage with that activity. You tend to remember clearly experiences that cause you to feel strong emotions. When you feel strong emotions due to engagement with a sport, you associate these emotions with that activity. This association influences your further engagement with that activity. To put it simply, you're much more likely to play a sport you've enjoyed in the past, and to avoid ones that you have not.

Physical activity causes your body to release **endorphins** – hormones that reduce pain and stress, and that cause positive feelings. These endorphins make many people simply feel good as a result of physically moving. In addition to this, there are some common positive emotions that may be associated with sports and physical activities:

- a sense of achievement
- success
- pride
- feeling valued when contributing to a team
- increased self-esteem
- improved body image.

endorphin
a hormone secreted within the brain and nervous system that activates the body's opiate receptors

But physical activity can contribute to aches and pains, and cause people to feel tired. There are also some common negative emotions that can be associated with sports and physical activities:

- embarrassment at failure
- anger
- frustration
- a sense of letting the team down.

Figure 12.7 Factors such as a coach's behaviour play a role in a person's previous experiences with a sport or physical activity.

The emotions you associate with past experiences with certain sports and physical activities can also be influenced by other factors, such as:

- support or lack of support from teammates and coaches
- relevant success or failure
- how realistic your self-efficacy beliefs are
- your emotional **resilience**.

resilience
the ability to withstand and overcome hardship

12.1 Check your understanding

1 Describe the three types of somatotype that humans have.
2 Explain what is meant by 'nature versus nurture'.
3 List five personal factors that may act as barriers or enablers for sport and physical activity.

Personal factors

INTEGRATING MOVEMENT

Category: All
Physical activity: Running

Purpose

1 This activity involves observing your own attitudes to two different running games.
2 This activity involves two separate activities, which need to be set up and performed in order.

Preparation

Time: one lesson
Location: running track
Equipment: two practice markers (witch's hats), timer

Activity 1: 10-metre challenge

Setup

Place the witch's hats 10 metres apart.

Performance

1 When your teacher signals you to start, sprint between the markers for the number of times your teacher calls out.
2 After you've completed the correct number of sprints, rest until your teacher signals you to start again.
3 Each time you start running again, increase the number of sprints by one.

4. You have one minute each time to complete the required number of 10-metre sprints and rest before starting again.
5. Keep going until you can't continue.
6. Your teacher will call out how much time is left and how many intervals you need to do, and give you verbal encouragement.

Activity 2: Edor

Edor is a game that is Indigenous Australian, played by children in North Queensland and the Torres Strait.

Setup

1. Form two equal-sized teams.
2. Place a marker at each end of the playing area. Each team defends one of the markers.

Performance

1. One player at a time from the team is up. They are called 'Edor'.
2. Edor must try to grab the opposing team's marker. The opposing team stops Edor by tagging them. The player that makes the tag yells out 'Edor' and then must try to get the other team's marker.
3. The process repeats until Edor gets the opposing team's marker.

Tasks

1. Compare the two activities. What are some key differences in these activities? DE 3
2. Recall your thoughts when initially reading or hearing the instructions for the 10-metre challenge. How did you react when you found out what you were going to do?
3. Recall your thoughts when initially reading or hearing the instructions for Edor. How did you react when you found out what you were going to do?
4. Compare your attitude towards each activity. Was it better towards one activity? Which activity did you enjoy more?
5. Reflect on your classmates' behaviours and attitudes when performing each of the activities. Which did they engage better with?
6. Evaluate how the type of activity might influence engagement with running games. Which of these activities are you more likely to engage with in the future? DE 4

http://mea.digital/qpe12_12

12.2 Social factors

socialisation
the process of learning to behave in a way that is acceptable in your society

Socialisation is the process of personal learning and social development, which occurs as we interact with one another and the world. It's an ongoing process, as you constantly adapt to changes in society.

Throughout your life, as you interact with the people around you, you learn what types of behaviours are considered 'normal' among the different groups to which you belong. For instance, early in your life you may have learnt that the following behaviours are considered 'normal':

- saying 'please' when you want something
- covering your mouth when you cough
- not talking with your mouth full.

social norm
a form of behaviour that is usually accepted as correct by the majority of society

These 'normal' actions are considered **social norms**, and you're exposed to more and more complex behaviours and norms as you grow older. As individuals, people often choose to conform to these so they can fit in with their culture. Not following social norms often appears as strange, attention-seeking or inappropriate behaviour.

This same process occurs as people are socialised into sports and physical activities. The process of socialisation guides people to the activities that are considered normal in their cultural setting. This is socialisation *into* sport, and relates to the level of access we experience. People also experience socialisation *through playing* sports and physical activities. This affects their experiences within the sport, and relates to the level of equity they experience.

These social factors act as barriers and enablers to access and equity in physical activities.

Evaluate and justify
sporting social norms

LEARNING EXPERIENCE

Consider the sporting social norms shown in Table 12.2.

1. Hypothesise how these sporting norms may have originated, giving reasons to support your hypothesis.
2. Add another sporting social norm that you conform to in the third row.
3. Evaluate the sporting norm you conform to in Table 12.2. Why do you conform to it? Who has influenced you to conform to this norm?

Table 12.2 Sporting social norms

Sporting social norm	Hypothesis on the origin of the norm
Lawn bowls is played by old people	
People from Queensland should be interested in rugby league	

Agents of socialisation

Significant others in our lives are responsible for teaching us to conform to social norms, customs and values. These significant others are called **agents of socialisation**.

These agents provide you with explicit and implicit messages on how to form your everyday attitudes, behaviours and choices. When it comes to sport and physical activity, they can influence the sports that you choose to play and the manner in which you play them. They convey socially acceptable ways to perform skills, apply tactics, communicate with teammates, and interact with the opposing team, and officials. Research suggests that the most powerful agents of socialisation are those whom you admire, trust and are exposed to the most.

agent of socialisation
a significant other that acts as a catalyst for compliance with social norms

Apply and analyse
agents of socialisation through your life

LEARNING EXPERIENCE

1 The timeline in Figure 12.8 maps out stages of a person's life. Identify agents of socialisation that would hold greater influence on a person's attitudes, behaviours and choices regarding sports and physical activities at each stage of their life and place them on the timeline.

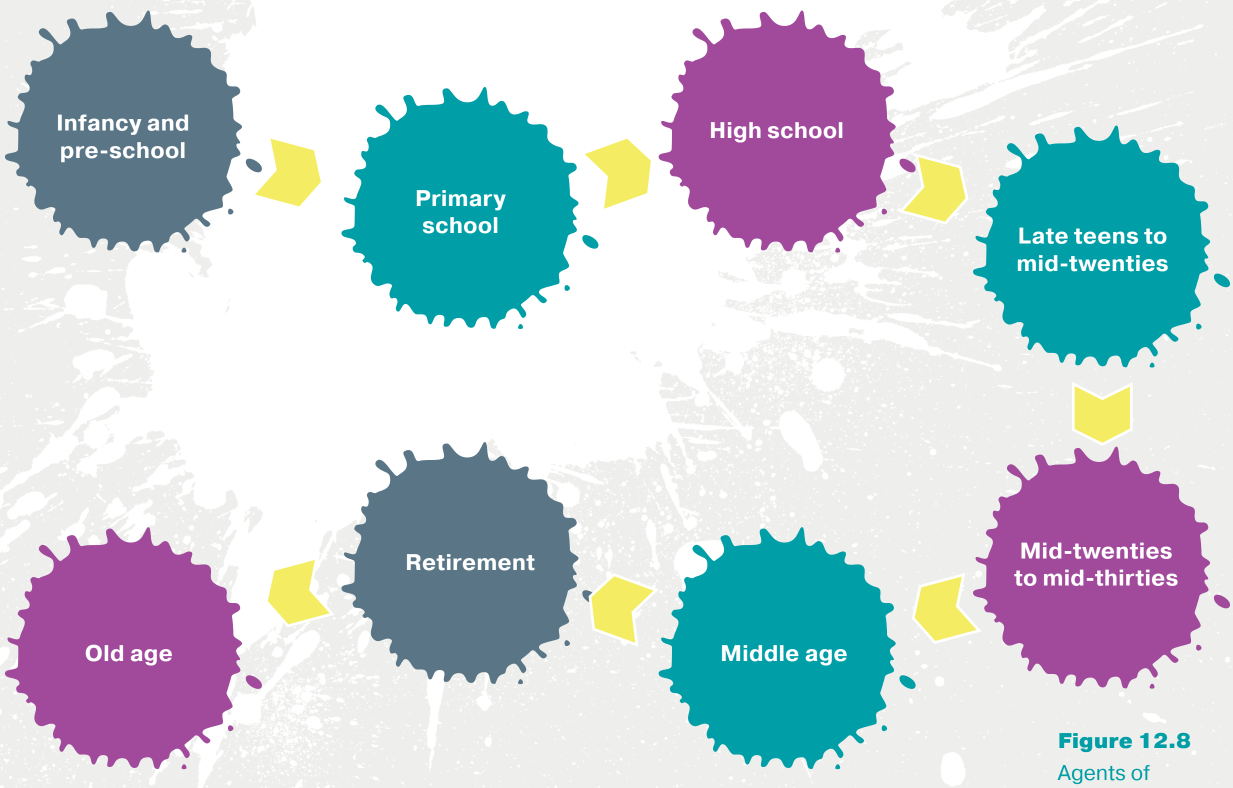


Figure 12.8 Agents of socialisation through a person's lifetime

2 Name three other factors that may affect which agents of socialisation hold more influence over a person's attitudes, behaviours and choices.

Early years

From the moment you're born, you completely depend on your caregivers. Those closest to you care for you and prepare you for life within your society and culture. When you are a young child, family members such as your parents and siblings determine the experiences you have with sports and physical activities.

Families can help children develop important motor skills by playing and practising sports and sports skills, such as catching and throwing. More importantly, families can instil in children the attitude that sports and physical activities are something to be enjoyed and shared with others.

Numerous research studies have concluded that children brought up among those who value and encourage participation in sports and physical activities are more likely to develop lifelong passions and involvement in similar activities. It has also been found that children with older siblings who participate in sports are more likely to participate themselves.

Childhood

For young children, their family usually controls their access to sports and physical activities. A child's experiences depend on the attitudes, behaviours and choices of parents and other family members. If your family members don't provide positive initial experiences for you, you are less likely to seek access to and experience equity in sports and physical activities in the future.

Figure 12.9 Families can encourage their children to develop positive attitudes towards sport and physical activities.

As you grow older, opportunities for sports and physical activity become more structured and **institutionalised**. As this happens, your family still plays an important role in terms of access but other agents of socialisation, such as **peers**, teachers and coaches, come into play.

When you started school, your teachers became additional authority figures in your life. They assumed the role of informing you about the rules and procedures of everyday life at your school. A large part of many schools' everyday activities is sport and physical education. Teachers can establish and develop positive attitudes towards sport and physical activity in their students in the following ways:

- including physical activity as part of their **pedagogy**
- providing for physically active lunch-time activities
- providing enjoyable, equitable and inclusive physical education lessons
- taking time to involve themselves with extra-curricular sports.

institutionalised
made normal through regular and common practices

peer
someone who shares common characteristics, such as age, with another person

pedagogy
the methods that a teacher uses to facilitate learning

Adolescence

By mid- to late-primary school, you're much more aware of the attitudes, values and beliefs of your peers. These begin to exert more of an influence on your attitudes, behaviour and choices. You start to want to fit in with those around you, and to play the same sports as your friends. Mobile phones and social media enhance the speed and extent of this process.

Children at this age also start to compare themselves with other children. Physical abilities are obvious tools for comparison. Think back to when you were in Year 5 or 6. Who were the most popular kids? Chances are they were the ones who were good at sport. By comparing your abilities to others, you start to build ideas of your competence in sports and physical activities. This influences your self-efficacy and self-esteem. As discussed in Chapter 11, we're more likely to participate in and enjoy sports when we're confident.

As sport and physical activities become more structured and institutionalised for older children and teenagers, the role of coaches, managers, teachers and instructors becomes more important. Schools and clubs organise players into teams with assigned coaches. They create school and club cultures with defined practices and norms.

The relationship between the coach and their players is important in achieving and maintaining positive experiences with sports and physical activities. A good coach will help you to reach your potential, not only through practice drills and game awareness but by fostering a passion for the game and demonstrating belief in you. They model the social norms required to be a successful participant in the sport or activity they're coaching.

On the other hand, agents of socialisation who set bad examples at this age can act as barriers. Children whose families put unnecessary pressures on them to succeed in sports often associate physical activities with feelings of failure and unworthiness. Coaches who focus on star players and aren't equitable with court time or substitutions can cause similar effects. Poor behaviour on and off the field by peers or family members can leave players feeling embarrassed or ashamed, especially when derogatory comments or ridicule are involved.

Adulthood

After leaving school, many people don't have structured sport programs available to them. They must seek out opportunities for physical activity themselves. This can be individually based, or as part of a club or social group or team.

Motivating factors for participation often begin to change in early adulthood. Young adults and older adults are more likely to play sport and undertake physical activity for social reasons or to stay fit and healthy, rather than for competitive reasons.

Evaluate and justify
participation trends survey

LEARNING EXPERIENCE

In small groups or as a class, develop a survey. This could be done using an online tool such as Google Forms or SurveyMonkey, or simply on paper or through face-to-face interviews. Have your class and a cross-section of students at your school complete the survey.

Your survey should collect data on the following for each participant:

- all sports and physical activities that the participant regularly plays or is involved in
- reasons that the participant plays these sports and is involved in physical activities
- all sports and physical activities that the participant's parents and siblings play or used to play
- the sports and physical activities that the participant's close friends regularly play and are involved in
- the sports and physical activities offered by the participant's school
- the ten sports that the participant thinks are the most popular among their peers
- the ten sports that the participant thinks are most popular in Australia
- any other information you and your classmates think will be useful.

1. Collate the data that you receive from your survey.
2. Analyse this data and identify any trends in the participants' responses.
   a. What proportion of participants in the survey play or are involved in the same or similar sports and physical activities as their family and peers?
   b. Referring to the process of socialisation, explain why the participants are likely to choose these sports and physical activities.
   c. What proportion of participants in the survey are involved in sports or physical activities that are different from their family and peers?
   d. Hypothesise factors that may have influenced the participants to choose these sports and physical activities.
   e. Identify sports and physical activities that appear regularly in the data.
   f. Hypothesise sociocultural reasons for the popularity of these sports and physical activities.
3. Reflecting on patterns in your data, decide which agents of socialisation have the biggest influence on the participants' choices of sports and physical activities. Justify your decision using primary data from the survey and your knowledge of the process of socialisation.

Social construction of gender

Nearly all humans are born clearly male or female. This distinction, your biological sex, relates to the physiological, genetic and hormonal make-up of your body. Your biological sex is determined by the chromosomes you inherit from your parents.

However, gender – the way in which humans present as male or female – is overwhelmingly determined by sociocultural factors. People learn through socialisation the social norms or expectations for males and females in many ways. For example:

- the clothes we are expected to wear
- the way we are expected to speak and act
- the interests we are expected to have
- the sports and physical activities we are expected to play or be involved in
- the roles we are expected to have in our society.

Figure 12.10 From the moment we're born, we're influenced by social norms expected of our sex.

Various agents of socialisation contribute to the social construction of gender. Your family, for example, may have dressed you, cut your hair, bought you specific toys and treated you in ways they thought were appropriate because of your sex. Girls are encouraged to play with dolls and have tea parties, while boys are given AFL footballs and toy guns, and allowed to wrestle in the dirt. **Stereotypical** traits expected of girls are that they are nurturing, caring, passive and patient. On the other hand, boys are expected to be active, aggressive and loud. However, most of us are a mixture of all sorts of traits, and research has demonstrated that our individual differences are more significant than divisions into categories based on our sex.

stereotypical relating to a simplified perception based on an observable characteristic of a person or group

By the time children reach school age, gender roles are well established. Peers become important socialising agents and can reinforce (or challenge) perceived gender roles. For adolescent males, sporting ability and achievement have historically been an important form of recognition. For girls, sporting success has historically been overlooked or downplayed.

Gender and the media

An important socialising agent in the reinforcement of gender roles in sport is the media. Recent progress in equity for women's sport has seen an increase in women's cricket, soccer, AFL and netball being broadcast in Australia. But sporting prowess still dominates mainstream ideas of masculinity in Australia because it is often considered the most desirable form of masculinity, even when most men do not attain it. This dominance is seen and reinforced in various ways:

- discrepancies in the payment of male and female athletes
- timeslots allocated to women's games
- attitudes of the public towards the spectacle of women's games.

Although modern society is more accepting of challenges to gender roles in sport than it has been in the past, sport remains a male-dominated domain. Girls who are sporty are often called 'tomboys' or 'butch' because their skills or power challenge some elements of female stereotypes. On the other hand, boys who lack sporting ability or avoid sports due to personal factors often have their sexuality called into question. Homophobia underlies this kind of bullying. The use of labels such as 'butch' and 'gay' rely on the understanding that being labelled as gay is negative.

Access and equity in sport can also be influenced by society associating a particular sport or activity with a particular gender. Sports that require physicality, aggression, speed and power have historically been viewed as masculine. Sports that require grace, poise and style, or that have been modified in the past to accommodate female players, are viewed as feminine. Some sports are viewed as gender neutral, such as tennis, swimming and hockey. People who resist social norms of gendered sports have sometimes been met with ridicule. However, there is now a concerted effort to enable all people to participate in whatever sport or physical activities most interest them.

CASE STUDY

'I'm going to be an AFL player': Daisy Pearce excited ahead of AFL Women's opener

Daisy Pearce

Daisy Pearce is the captain of Melbourne's AFL Women's team.

It feels so real now that it must be – I'm going to be an AFL player.

Like all debutantes, I feel as if it is a dream come true and I know that the next few days will be a giddy blur of nerves and excitement, reflection and anticipation.

For me, it is a dream that began with a red-raw foot in the backyard of my childhood home in Wandiligong, near Bright in north-eastern Victoria. The red-raw foot was the result of kicking a football that was too big for me – with shoes on.

I liked playing all sports, but I was captivated by football from a young age. I loved the unpredictability of footy. Which way will the ball bounce? Where will that player kick it? Strangely, even the unpredictability of what decision the umpire would make.

Not much is certain in football and I've always found that exciting.

As a kid, and still now, the freedom of football also sets it apart from a lot of other sports. There are very few limits or restrictions on where or when or how far you can run. Aside from the interchange and team structures, you never have to wait your turn, everyone on the field is 'in the game' and has the ability to make an impact at all times.

My propensity to turn to a sport where it was always my turn and where I wasn't told where I had to stand provides a clue as to what type of kid I was – determined and stubborn, I danced to my own beat. These characteristics proved vital for my journey into the game at a time when girls weren't encouraged to play and the most prominent women in football clubs were generally found in the canteen.

Kick-to-kick with my brothers in Jolimont Park when Mum or Dad drove us down to watch a game at the MCG often drew unwanted attention. People would literally stop and point, stunned by the novelty of a girl kicking a drop punt. I was once asked by a confused passer-by whether I was a girl or boy. Confused simply because I could kick a footy.

The world around me made me think I must be the only girl in the country who played football. Thankfully, I was determined enough to ignore this delusion and I had parents who weren't ruled by what was 'normal'.

Mum and dad signed me up for Auskick, I played in the school team and in the under-13s and under-15s at Bright Football Club – always the only girl. I was far from a child prodigy, but I was ultra-competitive and having developed earlier than a lot of the boys, I had a bit of size on my side.

The whole club and my teammates were always very supportive, but I was on the receiving end of more than my fair share of tedious sledges from opponents about 'the girl'.

As a small child, I had dreamt of playing professionally like my idols on TV, but then a more realistic 12-year-old me worked out that all my heroes were men and I accepted playing simply because I loved it. I had resigned myself to the fact that inevitably, as per the league's policy on girls, I would have to stop playing beyond under-15s and that I'd better enjoy it while I could.

I was unaware of the existence of the Victorian Women's Football League, so when I moved to Melbourne to live with my mum after my parents separated, I started playing volleyball at school. My competitiveness and application held up in the change of sports and I ended up playing for Victoria at two junior national volleyball championships.

After a two-year hiatus, it was a good day when I found out the school would be entering a girls' football team in an interschool sports program for the first time. It was an even better day when at school footy the umpire told me I should come down and train with the Darebin Falcons, a women's team in the VWFL.

I turned up at training two days later, I was named on the wing for that weekend's match and haven't played a competitive game of volleyball since.

That was 12 years ago now, but I can remember standing in the carpark of the ground we trained on in Reservoir (where team selection took place before we had club rooms) and being picked for my first game with Darebin as vividly as I can being drafted to Melbourne last year. Less impressive maybe to most but equally significant – I could play footy again.

The role and perception of women in football has evolved enormously since then and while I'm sure there are still many invaluable women keeping clubs afloat by running the canteen, thousands of others have stepped out on to the field as players, coaches and administrators.

We are on the cusp of the inaugural AFL Women's season and my selection for this weekend's game has been somewhat of a more demanding process than my first game for the Falcons was back in 2005.

More than 1200 players nominated for the draft. I was one of 216 players selected across the eight teams and I have just completed the most gruelling pre-season training program I have ever done. While the training has never been harder I have enjoyed the challenge because I now have access to the coaches, resources, facilities and support I need to help me improve every time I hit the track.

With Sunday being the first game of Melbourne's first season, there is no form or history to measure our team against. The long list of unknowns is a little nerve-wracking but I take solace in knowing that every player, coach and staff member has invested in what we want to achieve and that there is a great energy in the group.

This Melbourne team is unashamedly playing to win, but one thing that we will hold close on Sunday is that the next generation of young footballers will be tuning in to discover their new role models – role models that some of us never had. With that in mind, the fact that I am going to be an AFL player is less important than the simple fact that now, I can be an AFL player.

Source: *The Age*, 1 February 2017

QUESTIONS

1 What social sporting norms does Daisy Pearce identify in the article?
2 What agents of socialisation helped Daisy Pearce to resist sporting norms about AFL?
3 What aspects of AFL are usually associated with being masculine?
4 What aspects of AFL did Daisy Pearce find appealing when she was young?
5 Think of two other sports, one usually seen as masculine and one usually seen as feminine. What gender neutral features can you find in each sport?

Social diversity

Different groups within a given society place value on different sports. The amount of value a group places on sports and physical activity in general varies greatly as well.

Australia is a multicultural society, populated by a diverse range of people from many different backgrounds. Each group of people has their own particular culture that values particular sports and physical activities. Generally, Australian society celebrates participation and achievements in all sports and physical activities.

Still, through the process of socialisation, different groups prioritise certain sports, depending on the age, gender, physical ability, cultural background and **socio-economic status** of people in that group.

socio-economic status
level in society based on social and economic factors such as education, location, income and wealth

Check your understanding 12.2

1 Define what are meant by agents of socialisation.
2 Give three examples of how different agents of socialisation can affect participation in sports and physical activity at different stages of people's lives.
3 Define what is meant by the social construction of gender. How does it affect participation in sport and physical activity?

Apply and analyse
sporting preferences of groups in Australian society

LEARNING EXPERIENCE

1 Copy and complete Table 12.3, which identifies sociocultural sporting preferences of people within Australian society. Which groups within our society are stereotypically associated with these sports?

Table 12.3 Sport and physical activity preferences

Sport and physical activity preferences	Group
Yoga, Pilates, aerobics	
Road cycling	
Rugby union	
Lawn bowls	
Dance	
Rugby league	
Touch football	
AFL	
Soccer	
Wheelchair basketball	

2 Consider your answers in Table 12.3. Explain how age, gender, physical ability, cultural background and socio-economic status could act as barriers and enablers for certain sports and physical activities.

12.3 Cultural factors

We all live within a culture – but what is 'culture'? The American Sociological Association defines it as the 'languages, customs, beliefs, rules, arts, knowledge, and collective identities and memories developed by members of all social groups that make their social environments meaningful'.

sociologist person who studies societies, how they are arranged and how they operate

cultural capital desirable assets that a person possesses, which can be used for sociocultural gains

The **sociologist** Pierre Bourdieu developed the term **cultural capital** to denote things that a culture values. Common behaviours, practices, objects and characteristics are examples of cultural capital. It becomes normal for people in a culture to value the same things. Because of the value associated with cultural capital, the people who possess it gain power over those who do not.

Because culture includes shared assumptions, beliefs and values, it needs to be considered when you evaluate access and equity to sport and physical activity. These assumptions, beliefs and values influence our individual attitudes, behaviours and choices with regard to sports. Cultural factors can act as barriers and enablers to access and equity in sports and physical activities.

One common element in our lives is the emphasis Australian culture puts on the value of sport. It's generally considered 'normal' to be interested in sport and to enjoy some form of physical activity. This also means that cultural pressure is put on those Australians with little or no interest in sport.

Figure 12.11 Cathy Freeman's victory in the 400 metres at the 2000 Sydney Olympics remains an important symbol of Australian culture.

Sporting cultural capital

INTEGRATING MOVEMENT

Category: All
Physical activity: Any team sport

Purpose

1 This activity involves observing the importance of sporting cultural capital in team sports.
2 This activity involves playing or watching a series of short games in three different team sports. Some possibilities might be basketball, touch football, volleyball, tee-ball, futsal (indoor soccer) or relay races.

Preparation

Time: two lessons
Location: depends on activity
Equipment: depends on activity

Setup

1 At the start of each game, your teacher will appoint two captains.
2 The captains will take turns to choose one person at a time for their team.
3 Once the teams for each game are filled, any remaining students will act as observers.

Performance

Play each game, and repeat the team selection process at the start of each new game.

Data recording

Both players and observers need to watch and record data about the players and observers. DE 1

Tasks

1 Reflect on the team selection process. On what basis did the captains choose their teams? Were there common characteristics that the captains were looking for? Did these change depending on the sport? Could these characteristics be considered cultural capital? DE 3
2 Consider the behaviour, comments and body language of the players who were chosen. What does this indicate about their emotions, self-esteem and self-efficacy?
3 Consider the behaviour, comments and body language of the players who were not chosen. What does this indicate about their emotions, self-esteem and self-efficacy?
4 Evaluate the characteristics that the captains were seeking in their players to the concept of cultural capital. How does possessing cultural capital influence access and equity? DE 4

Sport as a cultural phenomenon

Sports and physical activities play an important part in any culture. All cultural groups have sports, games, dances and activities that play important roles in their society. In Western culture, sports and physical activities have served various cultural purposes throughout history.

As humans moved from being hunter-gatherers to form settled communities, games were played for enjoyment. Governments and armies started to develop sports with rules that acted as training for their soldiers. The ancient Greeks and Romans held sporting competitions with events that simulated the skills necessary for war, such as archery, javelin and chariot racing. These ancient sporting spectacles drew large crowds and became important, regular cultural events.

Through the eighteenth, nineteenth and early twentieth centuries, games and sports became much more structured and institutionalised. Certain sports and activities, such as horse-riding, badminton and croquet, were played by the upper classes and were seen as symbols of power and status. Other games and sports, like soccer and cricket, were played between villages, neighbouring factories and schools to entertain the middle and lower classes.

The latter half of the twentieth century and early twenty-first century saw businesses taking advantage of sports as spectacle. Businesspeople seized the opportunity to make money from spectators, advertising and sponsorship. Sports became professional, with huge potential earnings for the best players. The media broadcast popular sports, further increasing their popularity and the wealth they create.

Sports and physical activities are still played for all of these reasons (among others), although preparation for war is now largely replaced by the goal of staying fit and healthy. But the work and life demands of people in most cultures have changed, as have our entertainment options, the variety of sports we have access to and the costs of being involved in physical activities. The sports and physical activities valued by our culture reflect our culture's attitudes towards the reasons those sports are played.

Demographic, generational and cultural change

Culture is fluid in nature. What's stereotypically considered normal or desirable in a society can vary depending on the **demographic**, **generation** or particular culture in question. The value placed on certain sports and physical activities can be influenced by several factors:

- recent success or achievement
- media coverage and advertising
- portrayal of the sport in media and entertainment
- the availability of facilities and equipment
- cultural **trends**
- amounts of disposable income
- amounts of free time available to participate in sports and physical activities
- levels of education, literacy and numeracy.

demographic
a specific portion of the wider population with common characteristics

generation
a group of people born in the same time period

trend
a general change or development in ways of thinking

Certain sports and physical activities are considered norms for certain demographics. Middle-aged women might place more value on Pilates and yoga. Boys who attend private schools might value rugby union, while those who go to state schools might value rugby league.

Similarly, what's popular and valued changes from generation to generation. There's currently more value placed on good school results than might have been true for earlier generations. This means children tend do more schoolwork and study, with less time for both organised and incidental sports and physical activities.

The same is true for working adults and parents, who value putting in the hours at work over physical activity. We also have numerous options for entertainment through video games, the internet, television and streaming services. Leisure time that past generations would likely have spent being physically active is now often taken up with school, work and sedentary (seated) entertainment.

Apply and analyse
generational change in sports participation

LEARNING EXPERIENCE

1 Analyse the data presented in Table 12.4. Identify key changes in the types of sports and physical activities that used to have the greatest participation.

Table 12.4 The most popular sports by participation in Australia in 1996 and 2017

1996		2017	
Sport	Participants	Sport	Participants
Swimming	1.63 million	Soccer	1.08 million
Aerobics	1.38 million	Golf	686 000
Golf	1.12 million	AFL	636 000
Tennis	938 000	Netball	626 000
Cycling	626 000	Tennis	586 000
Tenpin bowling	438 000	Cricket	563 000
Billiards/snooker/pool	373 000	Basketball	532 000
Netball	286 000	Touch football	272 000
Cricket	229 000	Swimming	268 000
Surfing	225 000	Rugby league	248 000

Source: Australian Bureau of Statistics (1999) Source: Australian Sports Commission (2018)

2 Research significant events that occurred between 1996 and 2016 that may have influenced the participation trends of key sports presented in the data. Explain why these events may have influenced participation trends.

3 Are there certain sports or physical activities whose participation rate changes were unexpected for you? Why were they unexpected?

4 Comment on the overall trend of participant numbers in all of the top ten most participated-in sports between 1996 and 2016. What might be some reasons for the overall changes?

Institutional rules, policies and procedures

social institution
a group that governs the behaviour and expectations of individuals

Each society is distinguished by a number of fixed and interrelated social structures, such as families, schools, clubs, religions and governments. These **social institutions** help to determine laws, rules and patterns of behaviour that are acceptable.

In terms of access and equity, social institutions such as families, schools, sports clubs and governing bodies play major roles in shaping our attitudes, behaviours and choices of sports and physical activities. Each of these social institutions develop cultures around the sports and activities with which they're concerned.

Different institutions value cultural capital in the form of skills, personalities, attitudes and objects. People who possess the capital that's valued by the institution in question will, in turn, find themselves valued.

Families

You've already learnt about the important role of the family in the socialisation process. As part of this process, family members pass on and reinforce the values of the culture to which they belong.

Parents and siblings are exposed to the shared assumptions, beliefs and values about sport in their culture. They then act as role models for the types of sports and activities that are valued, the extent to which they should be participated in, and the manner in which they should be played. You learn about cultural values, such as fair play and competing to the best of your ability, from your family.

Schools

Schools are important social institutions for providing access and equity to sports and physical activities. Through physical education programs, children are taught to value sport and physical activity as part of a healthy lifestyle.

Most schools develop a sporting culture that values such concepts as teamwork, respect, fair play, commitment and giving your best effort. Many schools also offer high-performance sporting programs. This reflects the value that Australian society places on excellence, skill and winning.

Sporting clubs

In addition to schools, sporting clubs are key providers of structured sport and physical activity. Clubs, as social institutions, foster cultures based on shared beliefs and values.

Junior clubs tend to value participation, fair play and skill development. In adult and more competitive sporting clubs, these values include individual talent and ability, gaining a competitive edge and ultimately winning. People who aren't elite athletes may therefore view sporting clubs as a barrier to their participation, as they don't possess the cultural capital, in the form of skills and talents sought by the club.

Governing bodies

Almost all sports and physical activities are overseen by a governing body, such as FIFA, the AFL and Cricket Australia. Some of these are private enterprises, while others are closely linked to state and federal governments.

Governing bodies ultimately want to promote and grow their sport. As a result, they often promote core values and beliefs that reflect those of society at large. Governing bodies want to be viewed as desirable so as to grow their player, fan and sponsorship bases.

Figure 12.12 Sportsmanship and respect are values in Australian society that are reflected in how players are expected to behave.

Apply and analyse
the sporting culture of your school

LEARNING EXPERIENCE

1. Examine your school's sporting program. Make a list of all the sporting opportunities available to students.
2. If possible, collect some statistics on how many students participate in your school's sporting program. It may be necessary to estimate this if actual statistics aren't readily available.
3. Your school should have a sporting code of conduct, behaviour policy or similar document. Locate and read this document.
4. Consider the amount of sport available at your school and the policies towards sport that your school has. Describe how your school values sport and physical activity.
5. Consider the attitudes, behaviours and choices of students at your school when it comes to participating in sports and physical activities. Compare these to the policies of your school. Identify and explain any key correlations or disparities between the two.

Government input

The role of the government – whether local, state or federal – is to serve the community and take actions to improve it. A large portion of government spending goes into the health system. Many common health issues can be improved through physical activity. By getting the community active through sports and physical activities, many health issues can be minimised. This reduces the social and financial costs of preventable health issues.

Local, state and federal governments in Australia spend large amounts of money each year in the development, establishment and maintenance of a range of sport and physical activity programs and facilities. Some of these are intended to be accessible for the whole community:

- bike paths
- green spaces
- exercise trails
- play equipment
- park-run programs.

Others target specific groups in the community:

- Local Sporting Champions grants
- council swimming pools
- Indigenous Sport and Active Recreation Program
- grants for schools and sporting clubs
- sport-specific stadiums and arenas.

Governments also direct funding towards athlete development at the elite level of sport:

- the Australian Institute of Sport
- the Australian Olympic Commission
- state academies of sport.

Because politicians need to gain votes and popularity to be re-elected, the allocation of government funds towards these programs usually follows the cultural beliefs and values of society. A 2013 report for the Parliament of Australia found the following patterns of federal government spending on sport in Australia:

- Government funding into elite programs peaked after poor performances by Australia at major sports such as the Olympics.
- Funding for elite sport peaked in the lead-up to the Sydney Olympics in 2000.
- Government funding increases for sports immediately after well-publicised successes, such as after the Socceroos qualified for the FIFA World Cup in 2006.
- In between major sporting events, such as the Olympics and World Cups, funding tends to be directed away from elite sport and toward programs to improve the rates of physical activity for the general population.

Government funding is an important source of money that many sports clubs and schools rely on. It's therefore an important influence on access and equity to sport and physical activity.

Mass media and marketing

Over the last century, Australian media has evolved from print-only newspapers to radio, to film and television and then to multimedia online content. There are thousands of television channels, news feeds, apps and streaming services vying with each other to present you with the best, up-to-date experience with news, events and current trends.

In order to gain the widest audience possible, media outlets must appeal to the beliefs, values and interests shared by the majority of people. Sport and physical activity is an important form of cultural capital in Australia, so sport is of great interest to media outlets – most Australians have an interest in it, value it and will watch it.

In the relationship between sport and the media, money, exposure and popularity are three important forms of capital – that is, something considered valuable that can be used to gain influence and power. Sports that receive more coverage gain more popularity, through the socialising effect of the media. As a flow-on effect, sports that have a bigger fan base due to their exposure and consequential popularity attract more media coverage.

As media outlets battle for viewers, they try to outbid each other to buy the broadcast rights. Along with advertising and sponsorship, this brings in more money to the sport. This creates a cycle, shown in Figure 12.13, in which the dominant sports in a society maintain their dominance through continued and renewed exposure, popularity and resultant income.

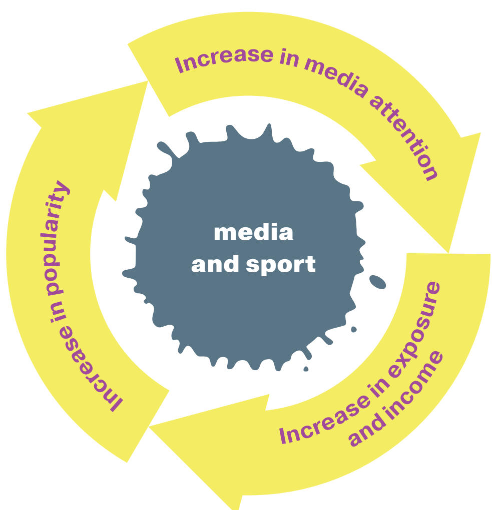


Figure 12.13 The cyclical relationship between the media and sport

The media is an important agent of socialisation; it constantly bombards people with images and messages about social norms. With the vast majority of society receiving the same messages and images, a society's culture is inevitably influenced too. What is considered cultural capital reflects these social norms.

The types of sports people are exposed to in the media are the sports that their culture values. This acts as an enabler for access and equity to popular sports and physical activities portrayed regularly in the media, and as a barrier for those that are not.

12.3 Check your understanding

1 What cultural capital will members have if a sporting club prides itself on winning above anything else? What cultural capital will members have if a sporting club prides itself on having the most teams or players in the district?
2 Describe two reasons that governments fund sporting organisations.
3 Describe the relationship between the media and sport, referring to culture, cultural capital and socialisation.

Apply and analyse
the popularity of sports: watching versus participating

LEARNING EXPERIENCE

Consider the statistics in Table 12.5.

1 Compare the two lists, and identify similarities and differences.
2 Choose one of the sports in the regular viewers list (left) that doesn't appear in the participation list (right). Justify why, although not popular for participation, this sport is still broadcast by the media.
3 Choose one of the sports in the participation list that doesn't appear on the regular viewers list. Explain how the lack of media popularity might influence the attitudes, behaviours and choices of people who play this sport.

Table 12.5 Watching and participating in sport

Most popular sports by regular viewers, Australia 2012–2013		Most popular sports by participation, Australia 2017	
Sport	Regular viewers	Sport	Players
Summer Olympics	9.23 million	Fitness/Gym	5.57 million
Commonwealth Games	8.21 million	Swimming	1.60 million
Australian rules football (AFL)	7.83 million	Golf	835 000
Cricket	7.45 million	Soccer	779 000
Winter Olympics	7.27 million	Yoga	722 000
Tennis	6.83 million	Tennis	583 000
Rugby league	6.73 million	Netball	538 000
Horseracing	6.32 million	Athletics, track and field (includes jogging and running)	538 000
Soccer	4 million	Pilates	505 000
Cycling	3.9 million	Basketball	451 000

Sources: Roy Morgan (2014) *Public opinion press release Finding Number 5488*; Australian Sports Commission (2018) *AusPlay shows the sporting behaviours of a nation*.

12.4 Environmental factors

Environmental factors can also play a role in people's access and equity to certain sports and physical activities. The physical ability of the human body to perform the necessary movements and skills can be influenced by the surrounding environment. As society becomes more aware of the impact human life has on the environment, people may also question how our choice of sports and physical activities affects the environment.

In addition, most sports and physical activities require a particular playing area or space. Depending on the sport or physical activity, this could be as simple as a small flat floor area for yoga, an open grassy area for field sports or a highly specific and engineered race track.

The natural environment

The attitudes, behaviours and choices you make about what kinds of sports and physical activities you play, if any at all, are influenced by the place in which you live. Your geographical location, **climate** and local weather patterns act as barriers and enablers for different sports and physical activities. You also have to take into account dangerous natural phenomena that may affect access to sports and physical activity, such as dangerous waves or currents, wild animals or terrain features like cliffs or caves.

climate
the common atmospheric or weather conditions of a region

Geography

Where people live is a key factor in determining the physical activities they engage in. Certain landscapes are better suited to some sports and physical activities than others. For instance, mountainous or desert regions don't allow easy access to the open grassy areas required by many sports.

Some sports and physical activities require particular features of the natural landscape, such as rock climbing, surfing or skiing. Your proximity to such geographical features influences the equity you experience in such sports. It's a lot easier for you to access sports and physical activities that are suited to the landscape in which you live.

Climate

The climate in which people live also influences the types of sports and physical activities they engage with. **Temperate** climate zones allow for year-round access to outdoor sports and physical activities, but the stresses other climates can place on the human body can influence access and equity.

temperate
mild or moderate

Tropical or **arid** climates may restrict access to outdoor activities or physically demanding sports. Heat or humidity can make such activities unplayable due to the risk of heat stroke, dehydration or exhaustion. On the other hand, water-based sports and physical activities, or those performed inside, are likely to be more popular.

arid
dry, hot and inhospitable

Likewise, cold climates present specific barriers and enablers. Snow and ice act as significant barriers to outdoor sports and physical activities played in more temperate climates. The restrictive nature of the clothing required to avoid hypothermia and frostbite poses another barrier to outdoor sports and physical activities. But a frozen landscape provides access to a range of winter sports that wouldn't otherwise be available.

Weather

Weather patterns also influence access and equity in sports and physical activity. Patterns of prolonged fine weather promote engagement with outdoor sports and physical activities. In locations that frequently receive rain and wind, indoor sports and physical activities are preferred over outdoor ones.

The different seasons often bring different weather patterns with them. This is reflected in the organisation of sports into seasons.

Evaluate and justify
why is cricket a summer sport?

LEARNING EXPERIENCE

Cricket is played for an extended period of time during the day. The shortest form of the game takes at least three hours to play, with some games lasting up to five days. It requires players to wear heavy protective clothing. The skills of the game involve many bursts of high-intensity physical activity, such as running between wickets, bowling, chasing the ball, diving, throwing and catching.

Cricket is also traditionally a summer sport. Summer temperatures in Australia are regularly over 30 °C; there is often high humidity, and afternoon rain and thunderstorms are common occurrences.

1 Research the origins of the game of cricket. Compare the weather and climate of Australia to England where the game was developed. Explain the reasoning behind playing it in summer.
2 Evaluate the practicality of playing cricket in the Australian summer. Justify whether or not the cricket season would be better placed at another time of year.

The built environment

Human beings have drastically changed the landscapes in which they live. The construction of buildings, roads, parks and other structures, along with their associated environmental impacts, influences people's access and equity to sports and physical activities.

Changes that humans make to our environment can have lasting impacts. Certain building methods and materials, chemicals like fertilisers and pesticides, and the remnants of wars can render parts of the landscape unusable.

Australia has a relatively low population density and strict regulations on buildings, industries and pollution. This means that Australians don't experience the barriers to sports and physical activities posed by a lack of space or excess pollution that some other societies must deal with. But our built environment still poses challenges that must be dealt with to promote access and equity in physical activity.

Figure 12.14 The Brisbane River was once a popular place for residents to swim, fish and relax, but dredging, pollution and urban development have changed that.

Urbanisation

In 2013, the Australian Bureau of Statistics found that two-thirds of Australians lived in capital cities. Of the remaining one-third, most live in the regional cities and areas on the eastern and south-western coasts. This means that most Australians live in highly developed areas, with roads, houses, shopping centres, high-rises and other buildings dominating the landscape.

As urban sprawl continues around our cities, areas that were once **green spaces** – open fields, parks or bushland available for public use – are now being developed. Increased demand for housing, transport and other amenities in these areas means that space is taken up by infrastructure. This often comes at the expense of green spaces, or space suitable for sport and physical activity.

green space
land that is covered with grass, trees or other vegetation, either natural or planted

When space for sport and physical activity is at a premium, this means that it becomes a more sought-after form of capital. This can restrict access for people who don't have the means to pay to use it.

Planned facilities

In a society such as Australia, where sport and physical activity play a significant role in our culture, urban and town planners now deliberately provide green spaces and other facilities to enable access to sports and physical activity.

Many housing developments and urban renewal programs incorporate examples of physical activity facilities into their designs:

- parks with playgrounds and sporting facilities
- walking and bike tracks
- space for gyms, pools and other fitness clubs
- preservation of significant natural features, such as lakes, bushland and beaches
- development of green spaces on former wastelands, rubbish tips or building sites.

The built environment is also a significant enabler for sport and physical activity. Built facilities are designed to be safer than natural ones. You're far less likely to injure yourself on a paved running track than while running cross-country through bushland. A chlorinated, temperature-controlled pool is also safer to swim in than a river or lake.

Without cleared and levelled playing fields, artificial courts, indoor halls and gymnasiums, many of the sports and physical activities Australians value wouldn't have developed. Roads, cars and public transport also allow people to cover distances and access activities that they couldn't access from their home location.

Environmental impact

For an increasing number of people, humans' environmental impact plays an important role in their everyday lives. Recycling, reusable shopping bags and renewable energy are all examples of people's efforts to improve their relationship with the environment.

For some sports and physical activities, the impact on the environment may influence people's attitudes, behaviours and choices. Questions are regularly raised about the treatment of animals in horseracing and greyhound racing. Motor-racing competitions have moved to bio-fuels and technological advancements to make cars more environmentally friendly. Other sports equipment manufacturers make efforts to use sustainable sources for their materials.

The impact of sports and physical activities on the environment is likely to increasingly influence people's attitudes, behaviours and choices in the future.

12.4 Check your understanding

1. Give two examples of how climate can be a barrier to sport and physical activity and two ways that climate can be an enabler.
2. Describe features of the natural environment, apart from climate, that affect people's choices about sports and physical activity.
3. Explain how the built environment is both a barrier and enabler to sport and physical activity.

Apply and analyse
location and sporting choices

LEARNING EXPERIENCE

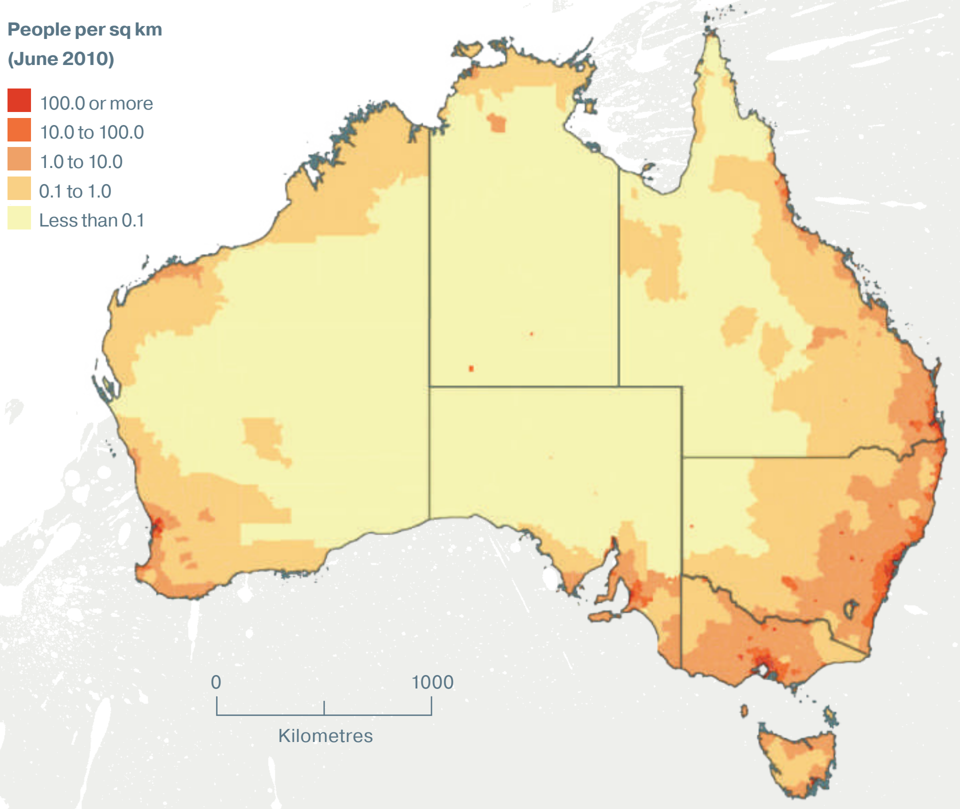


Figure 12.15 Distribution of the Australian population

Source: *Regional Population Growth, Australia (3218.0)*

Figure 12.15 shows the distribution of the Australian population. Use the information presented in the map to answer these questions:

1. In which parts of the country does most of the Australian population live?
2. Analyse the types of sports and physical activities people in the most populated areas would have ease of access to. Justify this by identifying enabling factors they may experience.
3. Classify the types of sports and physical activities people in the most populated areas may not have access to. Justify this by identifying barriers that they may experience.
4. Categorise the types of sports and physical activities people in the least populated areas would have ease of access to. Justify this by identifying enabling factors they may experience.
5. Determine the types of sports and physical activities people in the least populated areas may not have access to. Justify this by identifying barriers that they may experience.
6. Reflect on the access and equity to sport and physical activity you have experienced. Explain any correlations (connections) between this and where you live.

Chapter review

[12.1] People's individual personality, values and perceptions influence their attitudes, behaviours and choices with regard to sport and physical activity. Personal factors that may act as barriers and enablers include individual motivations, confidence, genetic predispositions, personality, gender and previous experiences.

[12.2] The process of socialisation influences people's attitudes, behaviours and choices with regard to sport and physical activity. Social factors that may act as barriers and enablers include social norms and the social construction of gender.

[12.3] What's considered valued within our society influences our attitudes, behaviours and choices with regard to sport and physical activity. Cultural factors that may act as barriers and enablers include a person's individual culture, demographic and generation, institutional rules that control participation in sport, government funding and the mass media.

[12.4] The environment in which people live influences their attitudes, behaviours and choices with regard to sport and physical activity. Environmental factors that may act as barriers and enablers include geographical location and features, climate and weather, the built environment, urban development, sport facilities and transport infrastructure.

Review questions

Section A: Multiple-choice questions

1 Motivation, confidence, self-esteem and self-concept are all important personal factors that can act as barriers and enablers because:
- **a** people need motivation to succeed in sports and physical activities.
- **b** people are more likely to participate in a sport or physical activity that they are enthusiastic about, are confident in their ability to perform in, and that makes them feel good about ourselves.
- **c** studies show that sport and physical activity are necessary for good self-concept and self-esteem.
- **d** if people have poor confidence and self-esteem they are not likely to do well in sport and physical activity.

2 Somatotype refers to:
- **a** a person's body shape and composition.
- **b** a person's physical abilities.
- **c** a person's general level of fitness.
- **d** a person's personality type.

3 Our personality type is developed by:
- **a** our life experiences.
- **b** chemicals, structures and genetics within our brains.
- **c** a mixture of sociocultural influences and how we think.
- **d** a mixture of genetic predisposition, sociocultural influences and experiences, and neurological processes.

4 Which of these is *not* an agent of socialisation?
- **a** family
- **b** the media
- **c** past experience
- **d** peers

5 A social norm is:
- **a** a behaviour that is considered correct by the majority of society.
- **b** something that is normal in social settings.
- **c** something that is made socially acceptable.
- **d** a behaviour that needs to be made normal by society.

6 Demographic refers to:
- **a** a sociological demonstration.
- **b** a particular group within society.
- **c** a group of people born around the same time.
- **d** people who share common abilities.

7 Cultural capital refers to something that is:
   a centrally located in a culture.
   b important to people in a culture.
   c something in a culture that can lead to social gain.
   d something that makes one culture better than another.

8 The types of sport and physical activity that are culturally valued can be influenced by:
   a recent success, media coverage, disposable income and education.
   b recent success, media coverage, sporting ability.
   c recent success, media coverage, diet and exercise.
   d recent success, media coverage, personal preferences and education.

9 An example of a factor from the natural environment that could act as a barrier or enabler to sport and physical activity is:
   a useable space.
   b urban expansion.
   c air and water quality.
   d climate and weather.

10 An example of a factor from the built environment that could act as a barrier or enable to sport and physical activity is:
   a proximity to the water.
   b green space.
   c the allowance for parks, bike tracks and green spaces in urban planning.
   d wild animals.

Section B: Short-response questions (150–250 words)

1 Soccer currently has the greatest number of participants in sport in Australia. Explain which personal and social factors you believe are the biggest enablers for access and equity in soccer.

2 Recently there's been a large increase in public interest in women's sport. Examples of this include W-League Football, the AFLW, Big Bash Cricket and Super Netball. Explain which social and cultural barriers needed to be overcome to allow for this increase in public interest.

3 Using your knowledge of the relationship between mass media, marketing and sport, predict how social norms surrounding women's sport might be different ten years from now.

Section C: Extended response to stimulus (400 words)

With growing populations in large cities, one problem that faces many local governments in Australia is transport. Congested traffic causes commuter chaos, lost production for businesses and contributes to pollution and stress among the population.

One suggestion to improve this is through the promotion of active travel, primarily by encouraging people to commute to work by bicycle. While many people ride to work each day in Australian cities, they still make up only a small portion of the population. This means there must be significant barriers in place that influence potential cyclists to choose not to ride to work.

Identify significant barriers for potential cycle commuters. In your response, propose recommendations for manipulating these barriers in order to maximise access and equity to bicycle commuting.

Figure 12.16 Cycling to work reduces congestion on the roads, pollution and stress.

13 DEVISING STRATEGIES FOR PARTICIPATION

Figure 13.1 Runners participate in the Bridge to Brisbane fun run

As society changes, people constantly invent new ways of interacting and communicating with each other. Trends change and what is considered important and valued shifts as people adapt to these changes. The barriers and enablers to sport and physical activity people experience in the future will change as well.

In this chapter, you will consider how barriers and enablers change, and develop strategies to promote access and equity in sports and physical activity.

KEY QUESTIONS

13.1 What strategies are already in place to promote access and equity in sports and physical activities?

13.2 What sociocultural changes to sport and physical activity can you expect in the near future?

13.3 What strategies can be developed to deal with barriers and enablers that develop as a result of sociocultural change?

YOUR CHAPTER PLAN

- **13.1** Existing strategies and programs
- **13.2** Emerging trends in Australian sport and physical activity
- **13.3** Devising strategies for participation
- **Chapter review**

13.1 Existing strategies and programs

Governments around the world have recognised the social and economic benefits of an active population. Private businesses have also identified the sport and physical activity sector as a huge source of income. We therefore see countless sport and physical activity initiatives, clubs, memberships, events, programs and awareness campaigns implemented each year. While some are intended for the betterment of society and others are for financial gain, they all share a common goal: to overcome barriers to sports and physical activity and promote access and equity in sports and physical activity.

There are likely dozens of strategies and programs in place in your local area, not to mention thousands across Australia and perhaps millions around the world. This section considers a few examples and how effective they might be in promoting access and equity.

Parkrun

Parkrun is an organisation that provides a social, timed, 5-kilometre run every Saturday morning in hundreds of locations across the globe. Tens of thousands of runners take part in Parkrun every week. It's open to anyone who wants to participate and the runs are inclusive, safe and free.

Parkrun overcomes a number of potential barriers to enable access and equity to physical activity.

Running is usually an individual activity that requires **intrinsic motivation**. Maintaining the motivation to participate may prove difficult for people with extroverted personalities, who require more social interaction. The social aspect of Parkrun provides opportunities for interaction with other like-minded runners. This social interaction may also provide **extrinsic motivation** through competition between friends, verbal encouragement from other runners, and other people recognising and celebrating individual achievements.

intrinsic motivation being engaged by the inherent pleasure of experiencing an activity

extrinsic motivation willingness to engage with a task or activity due to rewards or outcomes gained from completing it

Figure 13.2 A Parkrun in Leeds in the United Kingdom

Finding time to run in a busy weekly schedule can be difficult for many people. Many people may choose to engage in other, more sedentary activities in their leisure time. You're less likely to skip a scheduled Parkrun event than an individual, impromptu run before or after work.

Our culture celebrates success and achievement in sport. The timed aspect of Parkrun provides runners with the opportunity to set goals and achieve personal best times without the need for buying and using individual timing equipment.

However, while Parkrun is successful in providing key enablers for access and equity, there may still be some barriers for potential participants:

- Parkrun is held in parkland in large cities, so the geographical location of some people is an obvious barrier to participation.
- The mass-participation style of Parkrun may prove a potential barrier for individuals with negative self-image and self-esteem. They may feel embarrassed about their fitness levels or body image in comparison to fitter, faster participants.
- The necessity for participants to run prevents people whose age, disability or injury may limit their ability to physically run.

Get Active Queensland Accreditation Program

In Chapter 12, you learnt that coaches are key agents of socialisation, and that past experience is an important individual factor influencing access and equity. Junior sport coaches have a lot of control over team selections, the manner in which the team plays and the culture of the team. This means that coaches have strong influences over the experiences of young sports participants.

The Queensland government has identified the role quality coaches play in developing lifelong positive attitudes, behaviours and choices towards sports in young people. Because of this, since 2002, the Get Active Queensland Accreditation Program (GAQAP) has provided free coaching courses to teachers, trainee teachers and community volunteers.

Figure 13.3 Coaches have an important role in influencing future attitudes towards sport and physical activity

The intention of GAQAP is to better equip junior coaches to foster positive attitudes, behaviours and choices towards sports in their players. By educating coaches about the importance of effective skill development, equitable team management and ethical conduct, young players should have positive experiences in their sport.

However, structured coaching programs can create certain barriers for equity.

- The governing bodies that run coaching programs incorporate talent identification and high-performance practices into junior coach education. This may lead coaches to focus on the more talented players in their teams.
- The use of traditional technique and drill-based coaching methods may act as barriers for players with differing learning styles.
- For junior teams especially, while a coach may be highly knowledgeable in the skills and tactics of the game, the relationships they have with their players are more important in fostering positive attitudes, behaviours and choices.

VicHealth: Changing the game

A key barrier to women and girls participating in organised sports is the perception that the competition, aggression and physicality often associated with organised sport isn't compatible with socially acceptable 'feminine' behaviour.

The Victorian government conducted a number of research programs that found that not enough women were sufficiently physically active. They also found that participation rates in sport dropped off significantly for women as they got older.

This led in 2017 to VicHealth, the Victorian health department, funding six sporting codes as part of the 'Changing the game' initiative. The purpose of this was to work with women and girls that didn't normally participate in traditional, organised sports programs. Each code used the funding to create sporting programs tailored to specifically encourage female participation:

- Victorian Amateur Football Association (VAFA) developed AFL Active. This is a non-contact workout based on the type of skills used in Australian rules football. The workout can be performed anywhere and can be altered to suit people's different skills and requirements.
- Cycling Victoria started the Social Spin program, which provides spin classes on stationary bikes for beginner female cyclists. It removes the dangers of cycling on the road, promotes social interaction and provides bikes for the participants.
- Gymnastics Victoria developed a series of online videos called 'Move My Way'. These videos demonstrate strength and flexibility workouts that women can do in at home on their own.
- Netball Victoria introduced Rock Up Netball. This program encourages women to participate in social, impromptu netball sessions that involve skills development, fitness and game play. The sessions are modified to suit people's different skills and requirements.
- Surfing Victoria's Coasting program introduced women and girls to stand-up paddle boarding. The program provides women-only classes and focuses on having a fun, social experience.
- Tennis Victoria is in the process of developing its Get Into Cardio Tennis program, which will provide a simple tennis-based workout.

Each of these programs aims to enable and promote access and equity by removing barriers such as physical contact, competitiveness, expensive equipment and time commitments. The social aspects, low cost and ease of access of most of the programs act as enablers for access and equity.

13.1 Check your understanding

1 Describe the potential benefits of organised sport or physical activity programs.
2 Identify one potential enabler from each of the programs described above.
3 Summarise one potential barrier from each of the programs described above.

Evaluate and justify
devise your own equity strategy

LEARNING EXPERIENCE

In this section, you've explored a range of strategies that currently exist to promote access and equity in sports and physical activities.

1 Identify a key barrier to access and equity to sport and physical activity that currently exists in your school or local community. The barrier may exist for all members of the school or community, or be limited to a group within it.
2 Develop a strategy that will overcome this barrier and act as an enabler for participation in sport and physical activity.
3 Evaluate your strategy by identifying possible limitations to it. Use the framework below to develop your response.

What is the barrier you have identified?	
Classify the barrier as personal, social, cultural or environmental. It could be more than one of these.	
Describe how the barrier inhibits access and equity.	
Develop a strategy to overcome this barrier. Describe how this strategy will be implemented	
Identify any possible limitations to your strategy.	
Make recommendations as to how these limitations could be addressed.	

13.2 Emerging trends in Australian sport and physical activity

In 2013, the Australian Sports Commission (ASC) engaged the help of the Commonwealth Scientific and Industrial Research Organisation (CSIRO) to identify recent changes in the way Australians engage with sports and physical activity, and to make predictions and recommendations as to how access and equity in sports and physical activities can be improved in the future. The result of this study was a report called *The Future of Australian Sport: megatrends shaping the sports sector over the coming decades*.

The CSIRO defines a **megatrend** as a combination of economic, social and environmental trends that together change our attitudes, behaviours and choices in everyday life. *The Future of Australian Sport* identified six megatrends that it predicts will shape the future of sport in Australia.

Figure 13.4 The Australian Sports Commission has made extensive predictions and recommendations about sports and physical activity in Australia.

1. A Perfect Fit – personalised sport for health and fitness
2. From Extreme to Mainstream – the rise of lifestyle sports
3. Everybody's Game – demographic, generational and cultural change
4. More than Sport – the attainment of health, community and overseas aid objectives via sport
5. New Wealth, New Talent – economic growth and sports development in Asia
6. Tracksuits to Business Suits – market pressures and new business models

megatrend
a combination of economic, social and environmental trends that together change attitudes, behaviours and choices in everyday life

Although the effects of these megatrends on Australian society are already beginning to take effect, the CSIRO predicts that the impact of each megatrend will become greater over the next thirty years. Each of these megatrends is interconnected. One particular trend may play a role in more than one megatrend (see Figure 13.5).

Megatrends 1–4 identify changes in individual motivations for participation and engagement in sports and physical activities. The 'New Wealth New Talent' and 'Tracksuits to Business Suits' megatrends deal largely with elite sport, sponsorships and the **commodification** of sport. While this is still an important area of study for sports sociology, this chapter focuses on the other four megatrends.

commodification
treating services, ideas or people as commodities or objects of trade

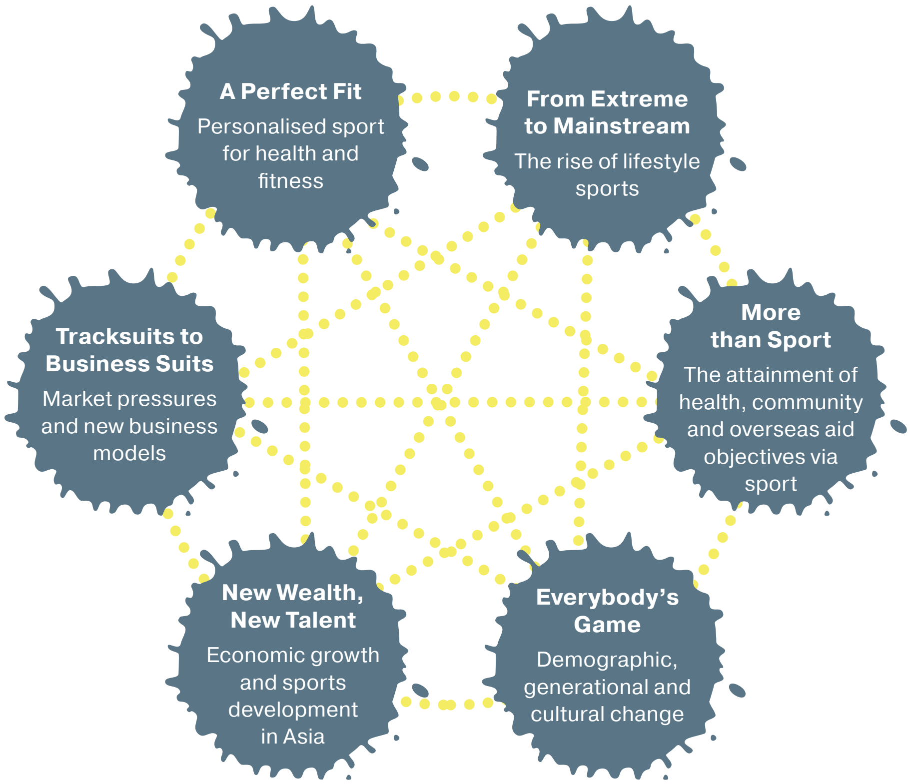


Figure 13.5 The interconnected nature of megatrends in sport and physical activity

'A Perfect Fit'

The first megatrend, 'A Perfect Fit', deals with an increase in the personalisation of physical activities. It identifies a shift in participation from regular, one-size-fits-all sports and physical activities to individually tailored workouts.

In the past, the majority of sports and physical activities were scheduled for particular times in fixed locations. With increasing time commitments for work, study and commuting, people are less likely to commit to regular, organised sports and physical activities.

On the other hand, physical activity that can be done anywhere at any time has increased in popularity. Many people's motivation for participation in sports and physical activities has changed from social interaction and enjoyment towards the achievement of personal goals, such as improved body image and achieving health benefits.

A number of factors have contributed to this trend:

- an increase in the accessibility and affordability of fitness clubs, gyms and personal trainers
- an increase in social pressure to conform to athletic body images
- an increase in the availability of fitness equipment available for home use
- the widespread availability of fitness tracking and wearable technologies.

Apply and analyse
personalised physical activity as a barrier and enabler

LEARNING EXPERIENCE

Consider the two trends described below. Determine how each could act as both a barrier and enabler for sports and physical activity by completing the table. Predict how this trend may influence access and equity in the future.

1 *Wearable technologies*
Wearable technologies include such devices as smartwatches, fitness bands, smart glasses, Bluetooth headsets, GPS trackers and heart-rate monitors. These technologies allow users to easily record and track their efforts, set goals and achieve personal bests. It's estimated that in 2016, more than 300 million wearable devices were sold worldwide. Some sources predict that by 2020, this could approach the 1 billion mark.

2 *Social media and physical activity*
Social media has changed the way in which people document their everyday lives. It's become a social norm to upload and share personal bests, updates on workouts and photos in activewear on platforms like Facebook, Instagram and Twitter. People can also compare their own participation in sports and physical activities with that of their friends and followers.

Trend	How might this trend act as an enabler?	How might this trend act as a barrier?	How might this trend influence access and equity in the future?
wearable technologies			
social media			

Figure 13.6 Wearable technologies and social media contribute to the personalisation of physical activity.

'From Extreme to Mainstream'

The second megatrend documents the rise in popularity of lifestyle, adventure and extreme sports. This is evident in a number of ways:

- BMX, rock climbing and skateboarding all being included in the Olympic games
- the Winter Olympics and X-games drawing millions of viewers worldwide
- the Queensland government providing close to $200 000 in funding for mountain-bike trails in 2017.

Although these sports have a competitive element to them at the elite level, much of the focus is on progression and expression in and through the sport. The inherent risk element to these sports makes them seem exciting and cool, acting as a type of cultural capital (see p. 306) for those who engage in them. These sports often have a strong link to a person's identity through the way they dress, talk and behave. This concept of 'living the sport', rather than simply playing it, acts as an enabler for continued participation.

Many extreme sporting organisations now provide introductory classes and programs to get more people into their sports. The invention of action cameras such as the GoPro has also allowed people to capture their experiences and post them to social media.

YouTube has reported that 100 hours of GoPro footage is uploaded *every minute*. Often the focus of these videos isn't who can jump the highest or do the most extreme trick, but just about getting out and having fun. The growing social norm of documenting fun and adventure helps to further promote engagement in lifestyle, adventure and extreme sports.

Figure 13.7 The advent of miniaturised action cameras has changed the way we engage in extreme sports.

'Everybody's Game'

In an increasingly globalised world, Australian society is increasingly diverse. As our population grows and changes, the types of sports and physical activities Australians engage with will undoubtedly change as well. The CSIRO outlined several significant generational, demographic and cultural changes that will affect access to physical activity.

Lifestyle changes

Australians currently earn more than they ever have, and a growing number of people have disposable income available to spend on sport and physical activity. But this increase in wealth also involves a shift in the nature of people's jobs.

Current trends have seen jobs become more sedentary, with overtime and non-fixed work hours considered normal. While these changes increase the need for people to engage in physical activity, often they're too **time-poor** to engage in regular, organised activities.

time-poor
not having enough time to do things

An aging population

As our society becomes more wealthy and knowledgeable, our population has aged. Modern medicine and healthcare allows us to live longer and enjoy healthier lives. Research suggests that Australians are increasingly engaging in sports and physical activities into old age. Veteran's and master's categories in many sports are popular, and less physically demanding sports, such as lawn bowls and golf, continue to have strong participation rates.

Many health clubs and gyms have also started to offer classes and courses designed for older participants. As our population continues to age, this area will continue to grow.

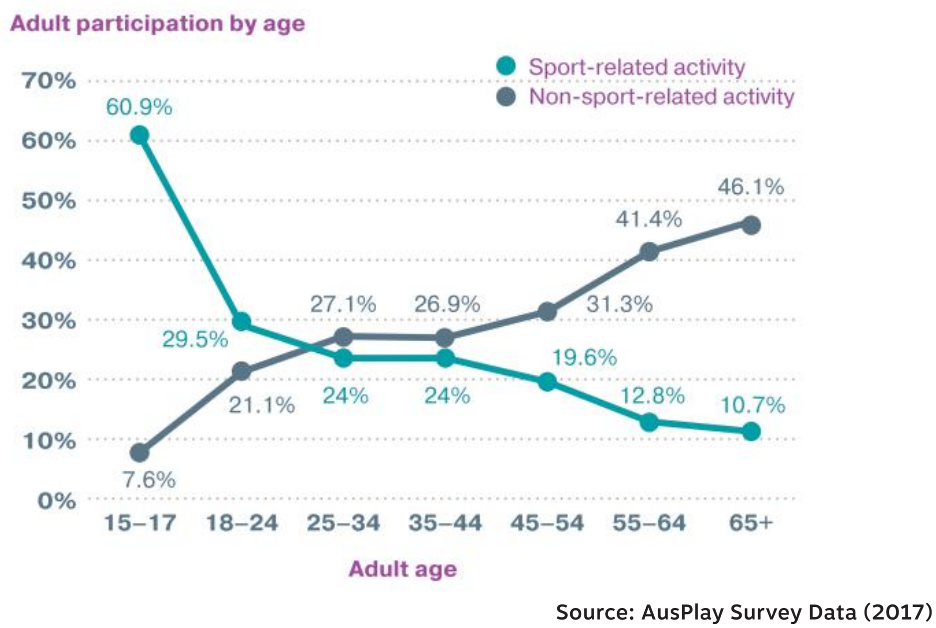


Figure 13.8 Participation rates of Australians in organised sports compared to non-sport related physical activities

Multiculturalism

The relative stability of the Australian economy and society attracts thousands of migrants each year. These migrants bring with them a variety of diverse cultural beliefs and values. This is especially evident in the field of sports and physical activities.

The rise of soccer – the sport with the greatest number of participants in Australia – is largely due to the influence of immigration from Europe, Africa and Asia. As communities from these regions have integrated into and influenced Australian society, they've passed on the value of soccer from their own cultures into Australian culture.

'More than Sport'

For the governments that control funding for sports and physical activities, sport can be seen as an opportunity to meet health and community objectives. As links between physical activity and health issues continue to be studied, governments continue to fund physical activity programs to offset the social and economic costs of health issues such as:

- obesity
- diabetes
- heart disease
- depression.

Numerous studies also suggest that sport and physical activities can improve social issues, such as school attendance, substance abuse and crime rates. It's in the interest of the government to run sporting programs in areas where such issues are prevalent. Involvement in sport and physical activity can:

- improve the self-esteem and self-worth of participants
- act as an incentive for good behaviour and school attendance
- take up free time that could otherwise be used for self-destructive or antisocial behaviour.

On an international stage, sport and physical activity events can be opportunities to improve international relations, promote our country to the world and develop social, economic and diplomatic ties with other countries. Events such as the Olympics and World Cups have long-lasting positive effects on host countries.

13.2 Check your understanding

1. Identify the first four megatrends outlined in *The Future of Australian Sport*.
2. Describe how one of these megatrends might impact access and equity in sport and physical activities.
3. Explain how these megatrends are connected and affect each other.

CASE STUDY

The Indigenous Marathon Foundation

The Indigenous Marathon Foundation aims to help 'close the gap' of Indigenous Australians' health and education through four community programs. These programs use inclusive running programs to help foster resilience, improve health and fitness levels and create leaders in Indigenous communities. The four programs are:

- The Indigenous Marathon Project (IMP) – this project takes twelve Indigenous Australians each year on a six-month course. This course has two parts. The physical component is a training program to prepare the participants to compete in the New York marathon. The education component is a Certificate IV in Sport and Recreation, Level 1 Athletics Coaching Accreditation, First Aid Training and Media Training. The goal of this project is to create inspirational role models who will help spread the message of active and healthy lifestyles.
- The Indigenous Communities for Activity and Nutrition (I CAN) – this project involves IMP graduates helping to implement an eight-week program in primary schools that target healthy eating and regular physical activity.
- Deadly Running Australia – Deadly Running Groups are established with the help of IMP graduates to help Indigenous Australians prepare for Deadly Fun Runs. The aim of these groups is to promote regular physical activity in Indigenous communities and develop self-esteem, confidence, belonging and sense of achievement in the participants.
- Frontrunners – The Frontrunners program aims to assist graduates of the IMP project to establish their own careers and businesses by providing loans and grants.

Visit the Indigenous Marathon Project website to research them further, then respond to the questions below.

QUESTIONS

1. Identify barriers that the Indigenous Marathon Project overcomes to provide Indigenous Australians in remote communities with access and equity in sport.
2. Explain how the project overcomes key barriers.
3. Explain how sport acts as cultural capital for graduates of the IMP program.

Who wants to play?

INTEGRATING MOVEMENT

Category: All
Physical activity: All

Purpose

1. This activity involves organising a lunchtime sports tournament and then analysing primary data.
2. The primary data collected in this activity could be used to support your investigation task.

DE 5

Preparation

Time: at least two lessons
Location: depends on activity
Equipment: depends on activity

Setup

1. As a class, choose a team sport (e.g. basketball, futsal, doubles badminton) and organise a lunchtime tournament for your chosen sport. The purpose of this tournament should be to encourage participation in your chosen sport at your school. Make the tournament open to all grades and ages.
2. Call for nominations before the tournament. When taking nominations, collect data regarding the age, grade and gender of the participants in each team.
3. It may be necessary to employ help from your teacher, and to offer a prize for the winners to run the tournament effectively.

Performance

Run your tournament, distributing any prizes or awards as appropriate.

Data recording

DE 1

1. Retain all data on the age, grade and gender of the participants.
2. Record the results of the tournament.

Tasks

Analyse the data you have recorded and reflect on the success of the tournament in encouraging participation in your chosen sport.

DE 3

1. Which ages, grades and gender engaged most in your tournament? Hypothesise possible reasons for this. What enablers may have encouraged their access to the tournament?
2. Which ages, grades and gender were most successful in your tournament? Hypothesise possible reasons for this. What factors influenced the equity of your tournament?
3. Which ages, grades and gender engaged least in your tournament? Hypothesise possible reasons for this. What barriers may have prevented their access to the tournament?
4. Evaluate the success of your tournament in promoting participation in your chosen sport. What modifications could be made to your tournament in order to promote access and equity in the future?

DE 4

http://mea.digital/qpe12_13

13.3 Devising strategies for participation

As well as reporting on megatrends, *The Future of Australian Sport* gave a set of recommendations for the future. The report presented a five-step approach towards developing strategies to address future changes in the sports sector.

The purpose of this approach is to allow governments, businesses and sports bodies to prepare for future changes in the attitudes, behaviours and choices of Australians with regards to sports and physical activity.

STEP 1	STEP 2	STEP 3	STEP 4	STEP 5
Construct narratives about the future. Identify and describe future change via some type of narrative (e.g. megatrends).	Identify actions. Identify possible actions that will better position your organisation with respect to the important changes, as described in the narrative, likely to occur in the future.	Choose actions. Evaluate and select a portfolio of actions likely to deliver the best outcomes within budgetary and other constraints.	Implement actions. Obtain fiscal, human and other resources to implement the chosen actions.	Monitor and adapt. As new information comes to hand, adjust the portfolio of actions to ensure outcomes are achieved.

Figure 13.9 The ASC's approach to addressing future changes in the sports sector

An access and equity approach

The approach suggested by the ASC and CSIRO focuses on how governments and bodies can take to prepare for future changes, without necessarily outlining what kind of change might be desirable.

It's possible to adapt that approach to make it more directed, and to work towards specific outcomes. For example, it could be applied, with some change in focus, to prepare for future influences on access and equity in sports and physical activity.

STEP 1	STEP 2	STEP 3	STEP 4	STEP 5
Construct narratives Identify and describe possible future changes that may influence access and equity to sports and physical activities.	**Identify barriers and enablers** Identify and describe potential barriers and enablers to sports and physical activities arising from these changes.	**Develop strategies** Develop strategies to minimise the effects of potential barriers and increase the effects of potential enablers arising from these changes.	**Implement strategies** Evaluate the best strategies to promote access and equity and implement them.	**Monitor and adapt** Evaluate the effectiveness of the strategies you have implemented.

Figure 13.10 A five-step approach to addressing future barriers and enablers to access and equity

What next?

What is the future of sport and physical activity in Australia – and the world? Will the 2060 Olympics feature chessboxing, hoverboard racing or zero-gravity gymnastics?

It's impossible to predict the future of sport with any kind of accuracy – changes in technology and society move too fast and in too many directions. However, it may be more possible to predict – or at least prepare for – potential changes to access and equity in physical activity. The five-step approach to addressing future barriers and enablers should hopefully remain valid over time, even if the sports and activities of the future are very different.

CASE STUDY

The future of sports

Sports have drawn people together to cheer for their heroes for as long as there has been a record of human activity. Sports have been seen to rival religion in the power to unify diverse populations, and in some cases have sparked positive social movements that carry over to the worlds of business and government. Sports are timeless, yet with each generation, new technology and social dynamics have changed and intensified how we experience sports. In the past fifty years, we have seen many radical changes – broadcast television and cable, credit cards, salary caps, player unions, integration, globalization of the fanbase, shared revenue agreements, and $100 million player contracts. The changes on the horizon will likely be even more disruptive … Medical advances are allowing us to alter the bodies of athletes. The computing power of smartphones doubles every 18 months. The appetite for sports is nearly insatiable – fans expect all-access passes into the clubhouse and into the boardroom. Change is coming fast. But how these trends intersect, and what our industry [sport and physical activity] will look like as a result, is far from obvious.

Source: JM Jacobs 2015, *The Future of Sport*, futureof.org

QUESTIONS

1 What are the advantages of sport that the extract identifies?
2 What changes have taken place in sport in the last fifty years, according to the extract?
3 Based on changes in society that the extract mention or that you know about, make three predictions about how sport could change in the next fifty years.

Check your understanding 13.3

1 Identify the five steps outlined in *The Future of Australian Sport's* approach for developing strategies for future changes in sport.

2 Explain how this approach could be modified to help prepare for future changes to access and equity in sports and physical activity.

3 Suggest one possible new sport or physical activity that might be developed in the future, and any barriers and enablers that might be associated with it.

Apply and analyse

Senior Physical Education

LEARNING EXPERIENCE

In 2019, the Queensland Curriculum and Assessment Authority (QCAA) implemented a new senior schooling program in Queensland. One of the most significant changes in senior subjects was in Physical Education – leading to the syllabus that you're studying right now.

In the past, students studying senior Physical Education received half of their marks through physical performance. Significant class time was dedicated to skill and tactical development in four sports throughout the year. Theory and data analysis played a much smaller role in the subject.

The current Physical Education course still requires you to learn about, through and in physical activity. However, instead of focusing on improving performance, physical activity in your course is intended to help you gather primary data about the topics you're studying. These changes made the Physical Education course more aligned with university courses.

Using the steps in Figure 13.10 (p.337):

1 Determine changes to access to sports and physical activity that you and other Physical Education students may experience in the near future.

2 Differentiate changes to equity in sports and physical activity that you and other Physical Education students may experience in the near future.

3 Develop a strategy to enhance enablers or reduce the impact of barriers on access and equity in Physical Education.

Chapter review

[13.1] Our attitudes, behaviours and choices are influenced by a range of personal, social, cultural and environmental factors. Due to the dynamic nature of these factors, our attitudes, behaviours and choices are subject to constant change.

[13.1] Many strategies are already in place to overcome barriers and maximise access and equity in sports and physical activity. These strategies all have potential enablers and barriers that may influence access and equity.

[13.2] *The Future of Australian Sport* documents megatrends that currently influence, and will continue to influence, access and equity in sport. These megatrends influence our attitudes, behaviours and choices with regards to sports and physical activities, and can act as both barriers and enablers.

[13.3] Factors arising from these trends need to be considered when planning for future equity and access to sports and physical activity.

Review questions

Section A: Multiple-choice questions

1 Organised, social physical activity events such as Parkrun act as enablers by:
- **a** providing a social, extrinsically motivating setting for participants to run in.
- **b** providing participants with goals to achieve.
- **c** providing training and instruction for participants.
- **d** promoting competition between participants.

2 The timed-run aspect of Parkrun might act as a barrier to access and equity because it:
- **a** allows for participants to easily set, monitor and achieve goals for continued improvement.
- **b** allows for friendly competition between participants.
- **c** forces participants to compare themselves to other runners.
- **d** may cause less fit and able participants to feel embarrassed or inadequate when comparing themselves to other competitors.

3 An environmental factor that may influence access to increasing participation in sports and physical activity is:
- **a** the cost of participating in many strategies.
- **b** being able to fit regular physical activities into a busy, everyday schedule.
- **c** the fact that many of these strategies are based in capital cities and regional centres.
- **d** the weather might influence when the strategies can be implemented.

4 VicHealth started the Changing the Game program in response to:
- **a** the competition, aggression and physicality often associated with organised sport not being compatible with socially acceptable feminine behaviour.
- **b** women not enjoying many traditional sports.
- **c** women experiencing more health problems than men.
- **d** a variety of sporting bodies asking to fund programs for women and girls in their sports.

5 A potential barrier that may arise from formalised coach education is:
- **a** the reproduction of traditional technique and drill-based coaching that does not cater for individualised learning needs of players.
- **b** many coach education programs are expensive and time-consuming.
- **c** innovative coaching methods are difficult to learn and implement.
- **d** formalised coach education is not generally a method by which sports can identify talented future athletes.

6 The megatrend of ‘A Perfect Fit’ details:
- **a** the emergence of individual sports and physical activities.
- **b** the increasing personalisation of sports and physical activities.
- **c** the increase in fitness-tracking devices and social media.
- **d** the increase in popularity of personal trainers.

7 The megatrend of 'From Extreme to Mainstream' examines the increasing popularity of:
   a extreme sports.
   b lifestyle, adventure and extreme sports.
   c mainstream sports.
   d dangerous sports.

8 The megatrend of 'More than Sport' identifies that:
   a sport is a microcosm of society.
   b sport is a means for financial gain.
   c sport can be used to maintain political popularity.
   d sport can be used as a means to achieving health and community goals.

9 The megatrend of 'Everybody's Game' suggests that:
   a increasing diversity influences the rate of participation in different sports.
   b traditional sports have been adopted by immigrants.
   c the influence of an increasingly diverse population will continue to change the sports that are culturally significant in our society.
   d there are now more people than ever playing sport.

10 The first step in *The Future of Australian Sport's* five-step approach for the future is to:
   a develop strategies.
   b identify actions.
   c construct narratives.
   d improve enablers.

Section B: Short-response questions (150–250 words)

The information below is taken from the AusPlay survey. This was a nationwide survey undertaken by the Australian Sports Commission in 2017 to study participation trends in sport.

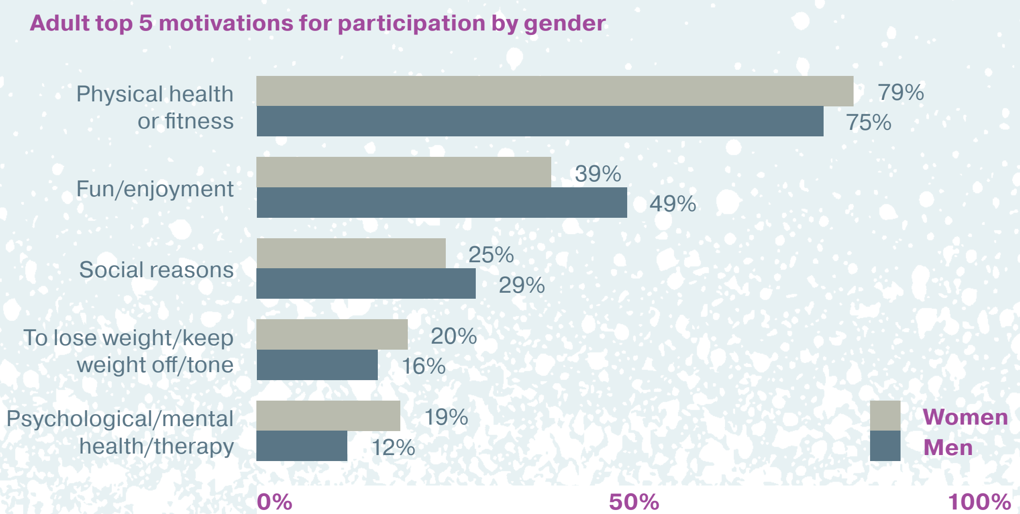


Figure 13.11
Participation trends in Australian sport

1 Consider the motivations of women for participating in sport or physical activity presented above. Explain how the megatrend of ‘A Perfect Fit’ relates to the motivations of women to participate in sport and physical activity.

2 Social media acts as a powerful agent of socialisation. Considering multiple possible motivations for participation, explain how social media might act as both an enabler and a barrier for women’s access to sports and physical activities

Section C: Extended response to stimulus (400 words)

Several schools in Australia have recently adopted programs in which students wear fitness trackers. The fitness trackers record the numbers of steps, heart rates and minutes of exercise for the children at the school each day. The data is made available to the children and their parents in an attempt to make them more aware of their levels of physical activity.

However, questions have been raised about the ethics of these programs. The data the fitness trackers provide can become points of comparison for the children at these schools. While schools don’t make the data public, schoolyard discussions enable students to compare each other’s fitness data.

Apply the adapted five-step approach to analyse barriers and enablers that may arise from a school fitness-tracker program. Develop strategies to promote access and equity in sport for students participating in such a program.

Figure 13.12
What barriers and enables might arise from this fitness-tracker program?

GLOSSARY

acceleration the rate at which an object changes its velocity

access the opportunity to participate

affirmation a short statement designed to repeat to yourself in order to enhance your self-belief and self-confidence

agent of socialization a significant other that acts as a catalyst for compliance with social norms

agonist the prime mover, providing major force to lead a muscle action

amotivation a lack of motivation to act

angular momentum the rotational equivalent of momentum (mass × velocity)

antagonist muscles that work in opposition to the agonist to reverse a movement

anterior situated to the front; in front of

anthropometric relating to the size and proportions of the human body

anxiety a subjective feeling of apprehension, accompanied by a heightened state of arousal

appendicular relating to the limbs

Archimedes' principle a body wholly or partly submerged in a fluid is buoyed up by a force equal to the weight of the displaced fluid

arid dry, hot and inhospitable

arousal a heightened sense of physical and mental alertness or activation

attention your awareness of the environment and acknowledgement of cognitive processes

attentional focus the combination of width and direction in regards to concentration

attitude a thought or feeling towards a particular thing

autonomous able to function independently

axial relating to the head, neck and trunk

axis of rotation a pivot line about which rotation occurs

behaviour the way in a person acts in response to a particular stimulus or situation

Bernoulli principle air moving at low velocity under a wing generates a higher pressure than high-velocity air moving over the wing

biological stemming from the scientific make-up of an organism

blocked practice the repeated practice of one skill in a block of time

buoyancy the tendency of an object to float in water

buoyant force an upward force against the underside of an object in water

capital something that holds value within a society

centre of gravity the point on a body at which Earth's gravitational pull is concentrated

centre of percussion the 'sweet spot' on an implement where the hands experience no jarring effect during a collision

choice a conscious decision between a range of alternative options

choking a process of increasing anxiety due to the perceived importance of an event

climate the common atmospheric or weather conditions of a region

closed motor skill movement performed in a highly predictable, stationary environment

coefficient of restitution measure of an item's elasticity

cognition the mental process by which knowledge is acquired through perception, thinking and learning

cognitive anxiety negative thought patterns towards a person's own performance

cognitive psychology a branch of psychology that proposes that the behaviours of individuals are a function of their internal mental processes

commodification treating services, ideas or people as commodities or objects of trade

concentric contraction a muscle contracting under load and shortening to produce tension

concentric force a force applied through the centre of gravity of an object

conservation of momentum the preservation of energy or momentum in a moving body or in a collision between two objects

constant practice repetitive practice of one variation of a skill in one context

constraint a boundary that shapes each learner's movement by limiting the number of available actions

continuous motor skill a movement with no clear beginning and end points

continuum a continuous sequence of progression from one extreme to another

coronal plane divides the body into front and back halves

cultural capital desirable assets that a person possesses, which can be used for sociocultural gains

demographic a specific portion of the wider population with common characteristics

discipline training people to obey rules or a code of behaviour

discrete motor skill a movement with clearly defined beginning and end points

discrimination unjust treatment of individuals or groups based on differences

distal away from the attached end of a limb or the origin of the structure

distributed practice a practice schedule with relatively long rest periods between trials

divided attention a simultaneous focus on more than one sensory stimulus

drill repetitive practice of the same technique to the same problem in a predictable environment

dual task a task that combines a cognitive task with a motor task

dynamic involving constant change and activity

eccentric contraction a muscle contracting under load and lengthening to produce tension

eccentric force a force applied to one side of the centre of gravity, causing the object to rotate

ecological psychology a branch of psychology that proposes that behaviours are a function of the interactions between an entity and their environment

ectomorph body type tending towards slenderness with a low component of body fat

effective mass the way in which increased mass or bracing can result in a more effective collision

endomorph body type tending towards low muscle tone with a high component of body fat

endorphin hormone secreted within the brain and nervous system that activates the body's opiate receptors

equity giving value to and celebrating personal, social and cultural differences within society

external distractor an irrelevant external cue that diverts attention from the present task

external focus instruction an instruction that directs your attention to the outcome of your movement

external perspective imagery viewing and rehearsing the whole body performing the movement, as if watching a video of yourself.

extremity a limb and/or the end part of a limb

extrinsic feedback information about movement performance received from an external source

extrinsic motivation being engaged by external rewards, punishments or outcomes

extroverted a personality type tending to be outgoing, loud and socially confident

feminine qualities socioculturally associated with being female

fine motor skill movement requiring the small muscles of the body

fixator muscles involved in movement that assist to stabilise joints

flow a state of mind in which a performer feels as though they are 'in the zone'

force an action that is applied to an object to start, stop or cause changes in movement

fundamental movement skill a basic skill upon which movement sequences and strategies are created

gamesmanship using ploys and tactics to gain a psychological advantage in a competition

gender the constructed state of being masculine, feminine or other

generation a group of people born in the same time frame.

genetic predisposition an increased likelihood of developing a particular trait or characteristic

goal setting a means by which individuals and teams direct their focus.

green space land that is covered with grass, trees or other vegetation, either natural or planted

gross motor skill movement requiring the large muscles of the body

identity the characteristics or qualities that define an individual

imagery a form of mental rehearsal that involves using all of the senses to re-create or create an experience in the mind

implicit learning subconscious learning in an incidental manner, without awareness

impulse change in momentum that occurs when force is applied over a given time

inertia the degree of difficulty in getting an object to move or to stop

inferior situated below; away from the head

inherent self-talk unplanned or reactive dialogue

insertion the moveable attachment of a muscle

institutionalised made normal through regular and common practices

instructional self-talk dialogue that focuses on how to execute the movement

internal distractor a thought or feeling that diverts attention from the present attentional cues

internal focus instruction an instruction that directs your attention to the movement of your body

internal perspective imagery viewing and rehearsing the movement from the athlete's eyes

intrinsic feedback information about movement naturally received from sensory systems

intrinsic motivation being engaged by the inherent pleasure of experiencing an activity

introverted a personality type tending to be shy, quiet and socially awkward

inverted-U hypothesis theory that performance increases with physiological or mental arousal, but only up to a point

isotonic constant muscle contraction at a given joint angle and load

joint a point of articulation where two bones or segments join to allow movement

lateral away from the midline of the body, towards the outer side

learning a relatively permanent change in performance as a result of practice and experience

lever a rigid rod or body segment that rotates around an axis

lift force the propelling force when swimming created by high pressure under the hand and low pressure above it

linear momentum the product of mass and velocity of an object travelling in a straight line

Magnus force application of the Bernoulli principle causing a spinning ball to deviate in flight, or a ball with a seam to swerve in flight

masculine qualities socioculturally associated with being male

mass a physical body's resistance to acceleration when a net force is applied

massed practice a practice schedule with short or no rest periods between trials

medial towards the midline of the body, on the inner side

megatrend a combination of economic, social and environmental trends that together change attitudes, behaviours and choices in everyday life

mesomorph body type tending towards muscularity, with high muscle and low body fat components

microcosm a representation of something on a smaller scale

mindfulness a mental state achieved by focusing one's awareness on the present moment

moment arm the shortest distance from the line of force application to the axis of rotation

moment of force the force applied to an object multiplied by the moment arm

momentum the force of a body in motion

motivation the direction and intensity of effort

motor development the change in the performance of a motor skill as a result of maturation or physiological training

motor learning the process and study of how we learn (or acquire) motor skills

motor program a movement plan that contains all the commands for the muscles to execute a motor skill

motor skill an activity that require voluntary muscular movement to achieve a goal or task

movement strategy an approach that helps an individual or team successfully achieve a movement outcome or goal

musculoskeletal relating to the muscles and skeleton

myofibril long contractile thread found in skeletal muscle cells

negative self-talk critical and unhelpful dialogue that you say to yourself

neurological related to the brain and nervous system

neutral self-talk dialogue that is not directly linked to own performance or situation

Newton's Second Law of Acceleration any change in motion is directly proportional to the applied force and is made in the line of the force

Newton's Third Law for every action there is an equal and opposite reaction force

norm a set of structured rules that govern the way a group is organised and maintained

novice a beginner or inexperienced learner

open motor skill a movement performed in a highly unpredictable, moving environment

optimal level of arousal the level at which an athlete performs at their best

optimum the best or most favourable amount

origin the attachment of a muscle that remains relatively fixed during muscular contraction

outcome goal a goal that focuses on the result of a particular event

parabola curved pathway travelled by an object where the angle of take-off is identical to the angle of landing

part practice repetitive practice of parts or components of a motor skill

pedagogy the methods that a teacher uses to facilitate learning

peer someone who shares common characteristics, such as age, with one another person

perceived competence the ability and skills you think you have

perception–action coupling the link between what you do (action) and what you see (perception)

perception what you become aware of directly through your senses, especially sight or hearing

perfectly elastic collision a collision in which no energy is lost

perfectly inelastic collision a collision in which all energy is lost

performance the act of executing a motor skill

performance goal a goal based on comparing current performance with previous performance

performance-related feedback information an athlete receives about their performance of a motor skill

performance routine a routine established by the athlete in order to maintain focus.

pivot point the point in space around which an object rotates

positive self-talk encouraging dialogue that you say to yourself

posterior situated to the rear; behind

pressure a feeling of great stress, of not being in control

principle of play a fundamental movement strategy used to adapt to tactical situations in authentic performance environments

process goal a goal that focuses on the technique rather than the performance result

profile drag the resistive force in water caused by the size and shape of a body, together with its speed and orientation

progressive muscle relaxation tensing and then releasing muscles in order to identify and achieve a relaxed state

projectile an object propelled into the air or water by an external force

proprioception an awareness of body position through sensory receptors within muscles, ligaments, tendons and joints

proximal toward the attached end of a limb or the origin of the structure

psychology the study of the human mind and mental states

psychoneuromuscular theory theory that imagining the performance of a skill uses the same neural pathways as performing the skill

pump propulsion the propelling force created by a pressure gradient pumping water down the arm, forming a low pressure area at the back of the hand

random practice the practice of two or more skills in a random order

range of movement the extent of movement able to be demonstrated in a joint

rate limiter a factor that influences how an individual learns and potentially restricts their performance in a specific context

reciprocal inhibition process in which muscles located on one side of a joint relax to accommodate muscle contraction on the other side

representative practice an unpredictable and variable practice environment that contains key elements from the performance environment

resilience the ability to withstand and overcome hardship

role a set of expected behaviours specific to a person and/or position

rotational inertia a body's resistance to change due to its mass and its radius of rotation

sagittal plane divides the body into left and right halves

selective attention a deliberate focus on relevant information, ignoring irrelevant information

self-belief confidence in oneself and one's ability

self-concept the way in which you view yourself as an entire person

self-confidence a feeling of trust in one's abilities, qualities, and judgement

self-determination theory human motivation theory that focuses on the degree to which an individual's behaviour is self-motivated and self-determined

self-efficacy the strength of one's belief in one's own ability to complete tasks and reach goals

self-esteem how you feel about your self-concept, the feelings you have about yourself

sensory information cues within the environment that can be accessed using one or more of the senses

serial motor skill a movement involving a series of discrete movements with clearly defined beginning and end points

sex the anatomy of an individual's reproductive system, and secondary sex characteristics

simulation training training that mimics the competition environment as closely as possible

skeletal muscle muscle tissue involved in movement

skin friction the resistive force caused by water flowing backwards along the surface of a body moving forwards

social cohesion how much team members like each other or enjoy each other's company

social institution a group that governs the behaviour and expectations of individuals

social norm a form of behaviour that is usually accepted as correct by the majority of society

socialisation the process of learning to behave in a way that is acceptable in your society

sociocultural a combination of social and cultural factors

socio-economic status level in society based on social and economic factors such as education, location, income and wealth

sociologist person who studies societies, how they are arranged and how they operate

sociology the study of the influence of relationships and structures within society, and their influence on individuals

somatic anxiety the physiological symptoms of anxiety

somatotype the different body shapes that humans have

specialised movement sequence a combination of specialised fundamental movement skills and sequences relative to the position or event in a selected physical activity

sport psychology the study of the psychological and mental factors that influence and are influenced by participation and performance in sport, exercise and physical activity

stabilisation the setting of the base of support as a foundation for the summing of momentum

stakeholder someone that has an interest in a team and can affect or be affected by its actions

stereotype a commonly held, simplified belief about a group within society

stereotypical relating to a simplified perception based on an observable characteristic of a person or group

strategic self-talk planned dialogue or specific cues used to enhance performance in specific situations

superior situated above; toward the head

synovial joint a freely moveable joint

task cohesion a team's ability to work together to achieve a goal

task constraint a boundary applied to a game or activity that shapes movement (e.g. rules, playing dimensions)

temperament a person's nature, affecting their behaviour

temperate mild or moderate

tendon cord of dense, fibrous tissue that attaches muscle to bone

time-poor not having enough time to do things

transactional leadership a leader who uses external rewards or punishments to motivate others

transfer of learning the influence of a skill you already have on the learning of a new skill

transformational leadership a leader who puts the best interest of others ahead of their own

transverse plane divides the body into upper and lower halves

trend a general change or development in ways

varied practice practice of several variations of a skill in several different contexts

wave drag the resistive force caused by a body moving along through or near the water surface

whole practice practice of a motor skill in its entirety

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OTHER MATERIAL

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