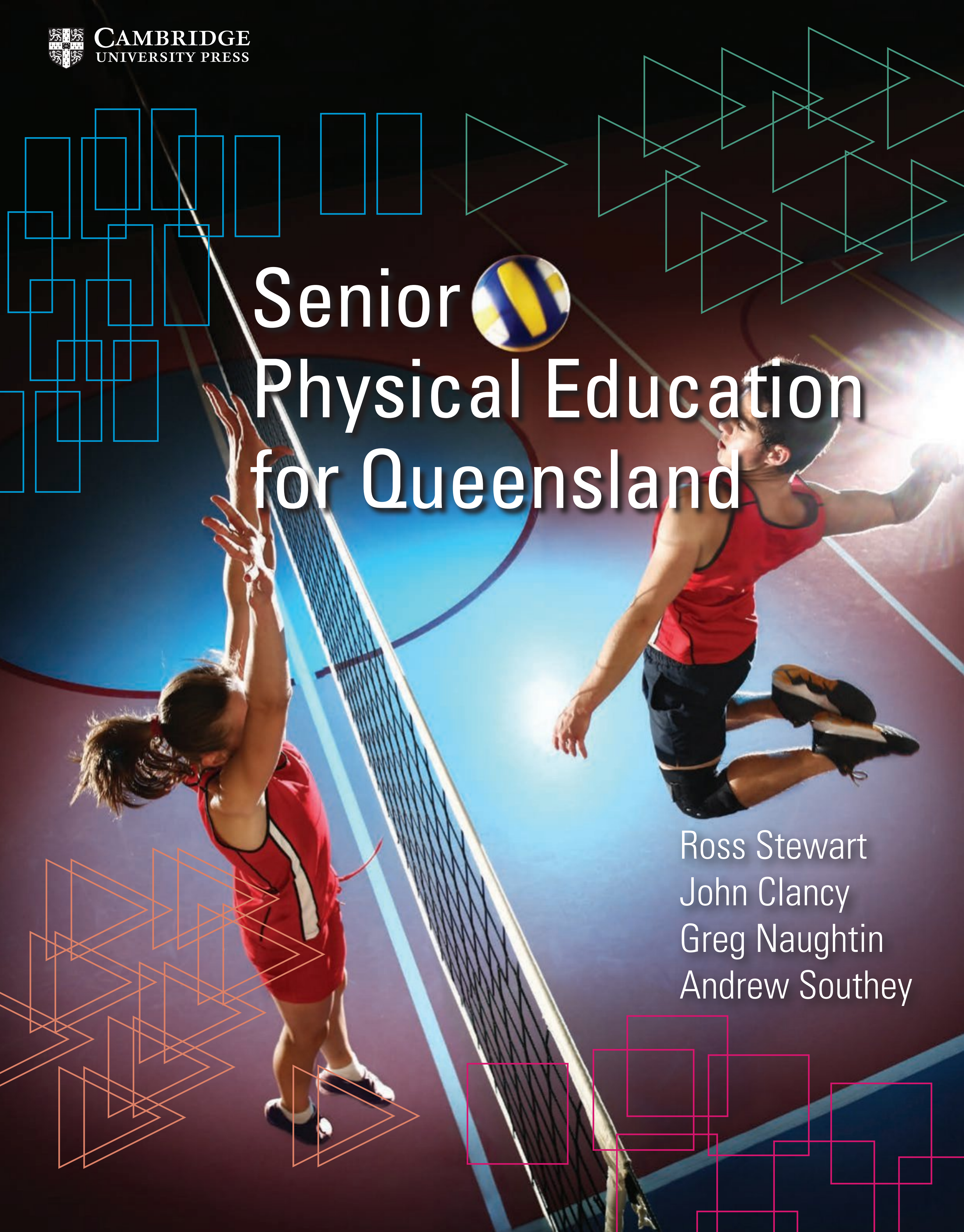

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Senior Physical Education for Queensland

Ross Stewart
John Clancy
Greg Naughtin
Andrew Southey

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About the authors

Ross Stewart

Ross has been teaching PE in Queensland for 20 years, 17 of these as a Head of Department in PE and Sport. He began work with the Queensland Curriculum & Assessment Authority (QCAA, formally the QSA) in 2002 and was appointed the State Review Panel Chair for Senior Physical Education in 2010. Ross has been involved in syllabus writing and reviewing throughout his career and has produced syllabus support materials for the QCAA. He was Chief Assessor for Queensland during the Physical Education trials for Endorsement and was involved with the Senior Physical Education External Examination trial. Ross has presented seminars on syllabus interpretation and implementation and is a published author, having previously written resource materials for PE in Queensland. He teaches Senior PE and Health at Meridan State College on the Sunshine Coast.

John Clancy

John is the Head of Department for PE at Brisbane Grammar School and has taught for over 30 years throughout Queensland from P to 12 through to university. He has presented at state, national and international conferences in relation to physical performance, pedagogy, and assessment and standards. He has fulfilled many roles for the QCAA including Senior Assessor for the trial Senior Physical Education External Examination and Lead Endorser for the trial of Physical Education Endorsement and Assessment. He is District Review Panel Chair for Brisbane Central Chair and was involved in the Syllabus Review and the Rewrite Committee for the new syllabus.

Greg Naughtin

Greg has been a Health and PE teacher for over 35 years and is the Head of Department for Health, PE and Sport at Nambour State College. He has been the District Panel Chair for Physical Education on the Sunshine Coast since 1995. He has been involved in the development of Senior PE in Queensland as a member and as chair of various syllabus writing teams for over 20 years, and has tutored in pedagogy and curriculum at the University of the Sunshine Coast.

Andrew Southey

Andrew is a nationally certified Highly Accomplished Teacher who has been teaching Health and PE for over 14 years. He has been a member of district review panels for both the Sunshine Coast and Far North Queensland regions, was involved in the Syllabus Review and Rewrite Committee for the new Physical Education syllabus and has worked with the QCAA to trial the Endorsement and Assessment of the Senior Physical Education Curriculum. With a background in Sports and Exercise Science, he has extensive knowledge of collecting performance data by integrating ICTs into the Senior Physical Education Curriculum.

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Physical Education and the inquiry approach

This resource is designed to guide Physical Education students through a process of inquiry that helps to process critical content and develops effective problem-solving skills. Specifically, it will assist students to develop the necessary lifelong skills to be active participants in sport and exercise. Ideally, the physically educated student will develop a deep understanding of the complex cause-and-effect relationships that impact engagement in and performance of a variety of physical activities. The inquiry process for Physical Education is unique, as it is designed to facilitate an integration of physical activity with biophysical, sociocultural and psychological concepts and principles. Equal emphasis is placed on an athlete learning new knowledge, and their ability to utilise this knowledge, to develop solutions that foster improvement.

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Throughout this book, students will engage directly with the following key syllabus objectives:

- recognise and explain concepts and principles about movement
- demonstrate specialised movement sequences and movement strategies
- apply concepts to specialised movement sequences and movement strategies
- analyse and synthesise data to devise strategies about movement
- evaluate strategies about and in movement
- justify strategies about and in movement
- make decisions about and use language, conventions and mode-appropriate features for particular purposes and contexts.

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Factors influencing engagement and performance in physical activity

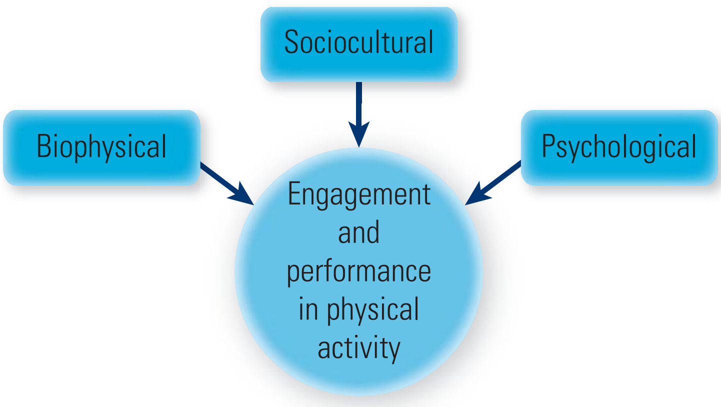

Figure 0.1 Factors influencing engagement and performance in physical activity

The **biophysical bases of Physical Education** involve all the sub-disciplines that affect movement capacities during physical education. Developing a deeper understanding of biophysical concepts will increase the learner's abilities to train more efficiently and refine movement patterns or skills within a range of physical contexts. The biophysical sub-disciplines include:

- functional anatomy
- biomechanics
- exercise physiology
- motor learning.

The **psychological bases of Physical Education** reflect the impact of thoughts and feelings on physical performance and engagement in physical activity. Specifically, the learner will develop the ability to identify how the psychological responses of **individuals and groups** influence and are influenced by engagement and performance. The sub-disciplines explored through psychology include both biophysical and sociocultural influences on thoughts and feelings.

The **sociocultural bases of Physical Education** encompass the influences of social and cultural beliefs and assumptions on engagement in physical activity. In particular, there is a focus on analysing individual and community beliefs about physical activity. The sociocultural factors studied include:

- social-psychological
- pedagogical
- philosophical
- sociocultural
- historical.

Integration of learning

The integrated approach to learning reflects the requirement of the inquiry process to balance the importance of knowledge retention and knowledge utilisation. In particular, a **physically educated student** will learn *about*, *through* and *in* physical activity in order to solve problems relating to the engagement and performance of

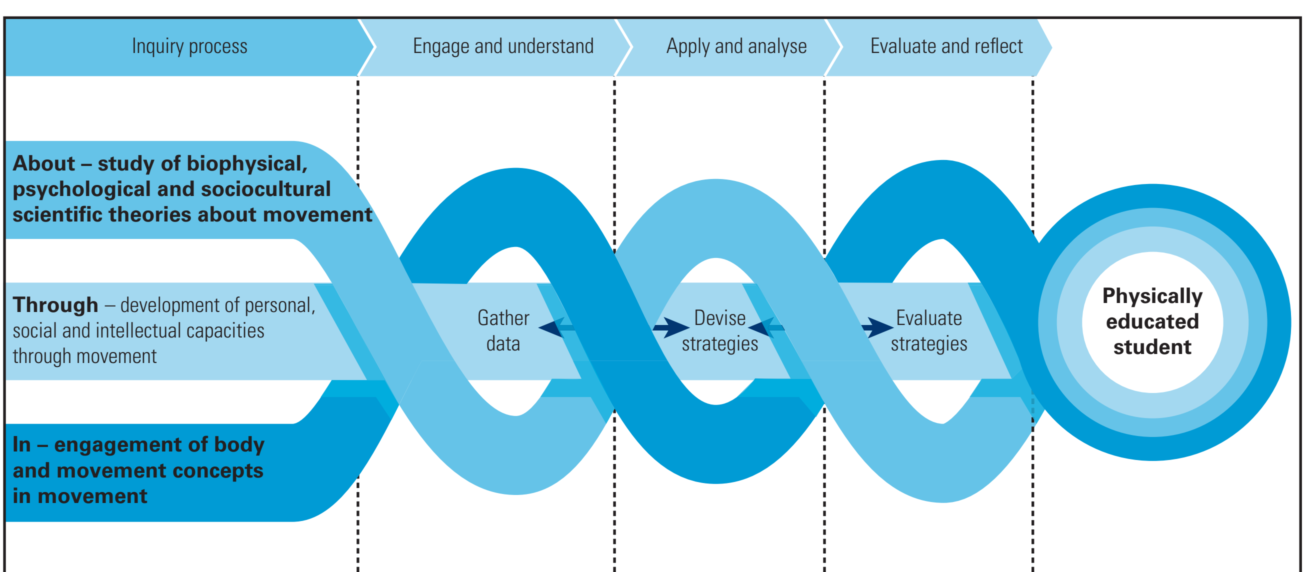

Figure 0.2 The integrated approach to learning Physical Education

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themselves and other athletes. The quality of learning will be dictated by the authenticity of the tasks in which they engage and will allow them to be productive contributors in future sporting landscapes. Specifically, they will develop skills to critique physical responses and social expectations, and also develop the ability to justify reasonable strategies to facilitate change.

Learning about physical activity involves developing deeper knowledge of theoretical concepts and principles related to movement. It will allow students to reflect on and relate personal experience and scenarios to develop conceptual understanding of typical physical and social responses. Furthermore, it allows students to apply the biophysical, sociocultural and psychological concepts to strategies that optimise engagement and performance.

Learning through purposeful engagement in physical activity supports students to develop the critical personal, intellectual and social skills required for sustained participation and improvements in performance. These skills enable students to transform their theoretical knowledge so it can be implemented in a practical environment. They also encourage the ability to work both independently and collaboratively to develop and test strategies for optimising engagement and performance.

Learning in physical activity ensures that athletes become the focal point of the inquiry process. It requires students to explore the physical, emotional and cognitive sensations associated with the movement, which allows students to deepen their knowledge of the biophysical, sociocultural and psychological factors that resonate with their levels of engagement and performance, and will ultimately progress them towards optimal levels.

Stages of inquiry in Physical Education

The inquiry approach to learning within the Physical Education domain progresses through three stages. Students learn about the subject-matter in participating in authentic performance environments, classroom activities, field studies and community events. Key to developing a deep understanding of the concepts and theories is the provision of activities that can be related to the learner's prior knowledge.

Stage 1: Engage and understand

- Engage in authentic learning and collect primary data about persoanl performance.
- Gather secondary data that build upon prior knowledge regarding the biophysical, sociological and psychological factors that influence engagement and performance.

Stage 2: Analyse and apply

- Apply and analyse a range of social and movement concepts, strategies and sequences targeted at optimising physical engagement and performance.
- Identify relationships between primary and secondary data in relation to selected principles and theories.

Stage 3: Evaluate and justify

- Evaluate the effectiveness of social and movement strategies and make decisions about the need to modify or maintain them.
- Justify decisions made in order to optimise engagement and performance using suppportive primary and secondary data.

Figure 0.3 The stages of inquiry in Physical Education

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The first stage involves athletes expanding on prior knowledge by actively engaging in physical activity and interacting with relevant concepts and principles associated with movement. Specifically, they develop a deep understanding of and gather data regarding the relevant concepts underpinning the biophysical, sociocultural and psychologcal domains. The collection of primary data during this phase would include actively engaging in physical activity in order to demonstrate and record physiological, psychological, tactical and strategic responses. Additionally, secondary data collection aims to provide a strong foundation of current theoretical research and assumptions that influence the physical activity being studied.

The second stage of the inquiry process involves the application and analysis of collected data in order to compose and apply new movement sequences in authentic learning environments. Students will analyse the impact of the biophysical, sociocultural and psychological factors on their engagement and performance. Specifically, they will analyse how an athlete's state of mind, quality of movement, body and spatial awareness affect the quality of performance. They will conduct rich investigations and compare the primary and secondary data in order to ascertain relationships between theoretical concepts and principles, and the selected physical activities.

The third and final stage of the inquiry process for physical education involves developing justified evaluations of biophysical, sociocultural and psychological strategies. Students will reflect on the primary and secondary data to appraise the outcomes, implications and limitations of the strategies. This will allow them to make justified decisions about the inclusion, maintenance or modification of their proposed strategies.

Engaging with this resource

Chapter organisation

Throughout this text, students will have the opportunity to test, apply and improve their knowledge of the subject-matter. Each chapter begins by foregrounding the key concepts and terminologies learners will encounter. It also makes specific links back to the key syllabus objectives and outlines the specific inquiry questions of the unit. It provides opportunities for students to develop the skills of a physically educated lifelong learner. To enhance the engagement with the essential subject-matter of each chapter, *Key messages* are included that summarise the main topics presented (see Figure 0.4).

Chapters are divided into two sections, representing the knowledge-development and knowledge-utilisation components of the inquiry approach. The first section of each chapter focuses on stage 1 of the inquiry process and expands on the learner's current knowledge regarding the key theoretical concepts and principles associated with the unit. The second section of each chapter has a specific focus on utilising learners' knowledge in order to apply their understandings. Specifically, this involves the integration of stages 2 and 3 of the inquiry cycle through the completion of targeted inquiry-based tasks. These tasks encourage the use of authentic environments in order to identify social, physical and psychological responses. Furthermore, they provide an organised structure for making comparisons between primary and secondary data in order to produce a critical analysis and justified evaluation of the applications of theoretical concepts to engagement and performance.

Maintaining integrity in sport through ethical strategies is key to ensuring its high value in Australian society.

Ethical strategies include guidelines, policies, frameworks and codes that outline behavioural standards.

Ethical violations reflect poor integrity and lower the cultural and economic value of physical activity.

Figure 0.4 Key messages – used to highlight essential subject-matter insights

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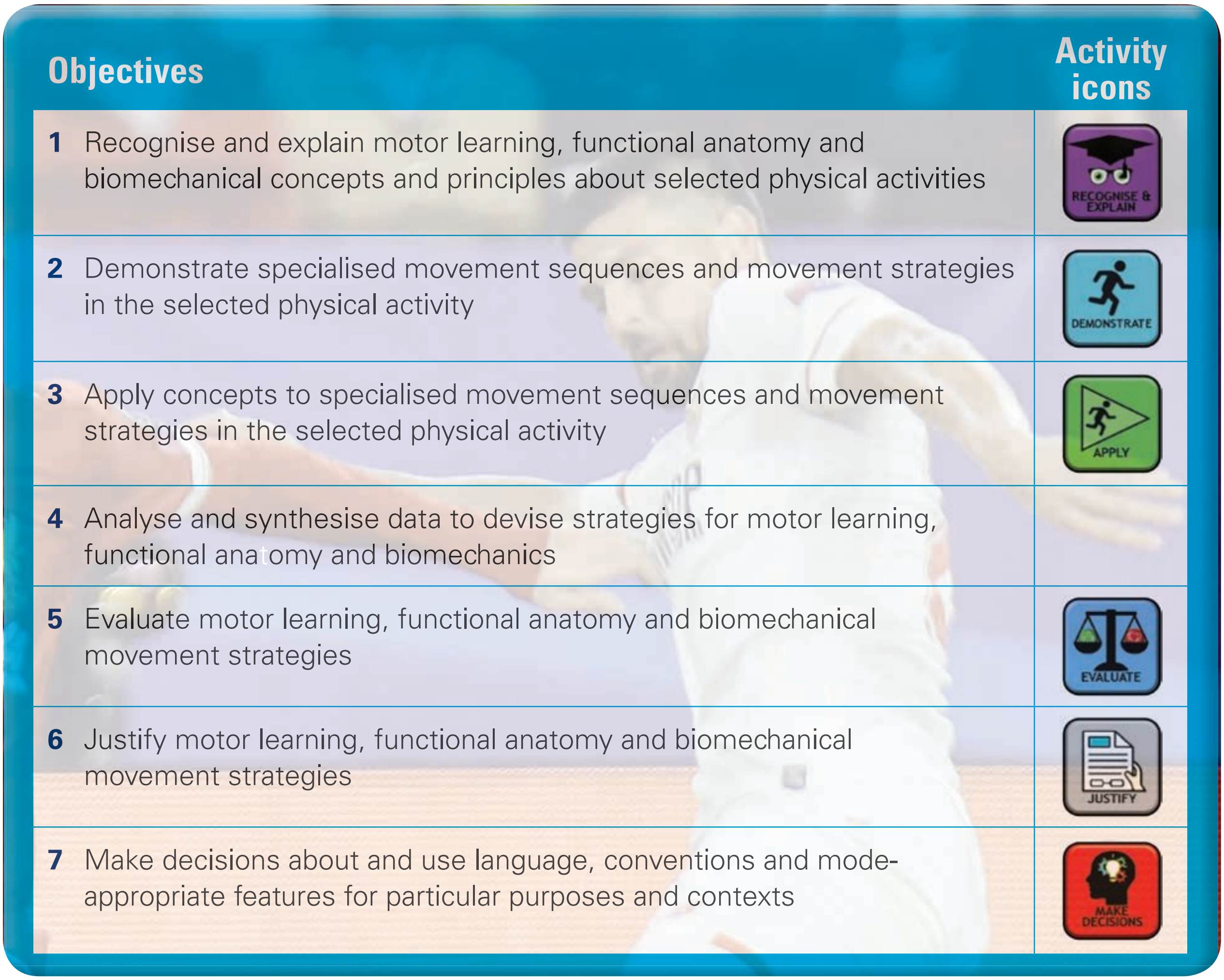
Chapter activities

Throughout each chapter there are traditional-style *Check-in questions* that require students to recall theories, concepts and principles, and utilise their knowledge to respond to scenarios. The syllabus objectives required for each activity are clearly identified at the beginning of the activity with the use of specific icons.

In addition, activities unique to this resource focus on active involvement in the inquiry process in order to facilitate data collection and foster the development of challenging cognitive processes.



Objectives	Activity icons
1 Recognise and explain motor learning, functional anatomy and biomechanical concepts and principles about selected physical activities	RECOGNISE & EXPLAIN
2 Demonstrate specialised movement sequences and movement strategies in the selected physical activity	DEMONSTRATE
3 Apply concepts to specialised movement sequences and movement strategies in the selected physical activity	APPLY
4 Analyse and synthesise data to devise strategies for motor learning, functional anatomy and biomechanics	
5 Evaluate motor learning, functional anatomy and biomechanical movement strategies	EVALUATE
6 Justify motor learning, functional anatomy and biomechanical movement strategies	JUSTIFY
7 Make decisions about and use language, conventions and mode-appropriate features for particular purposes and contexts	MAKE DECISIONS

Figure 0.5 Objectives are outlined at the start of each unit.

Activity 5.5

Check-in

1. Summarise what learning is and how we know it has occurred.
2. Describe what a learning experience using a more cognitive approach to learning would look like.
3. Create a diagrammatical representation of intelligent performance, including a description of the factors that impact it.

Figure 0.6 Example Check-in activity – used to check for understanding

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Engage-in activities expose the learner to segments of the inquiry approach in order to deepen their understanding of a topic, often in isolation from other influences. As the name suggests, they require students to engage in physical tasks or directed research to gather the required data to form a justifiable opinion. As well as indicating the key syllabus objectives, the Engage-in tasks also define the *Key cognitions* required for the successful completion of the task.

Activity 3.2

Engage-in

RECOGNISE & EXPLAIN | ANALYSE & SYNTHESISE

Inquiry question: What factors are impacting your motivation to perform in chosen physical activities?

Engage and understand

1 Prepare the class to participate in a chosen physical activity for the duration of the lesson.

2 Before the lesson, rate your motivation towards participating in this physical activity using the motivation rating scale in Table 3.4.

Apply and analyse

KEY COGNITION

Analyse: Examine or consider something in order to explain and interpret it, for the purpose of finding meaning or relationships and identifying patterns, similarities and differences.

3 Complete the physical activity and rate your motivation again.

4 List all factors that influenced your motivation during the performance.

5 Identify at least two cause-and-effect relationships between your performance and your motivation (e.g. I dropped the ball a lot in the first half (cause), my perceived competence decreased and I stopped trying (effect).

Evaluate and justify

6 Write a sentence justifying which factor (competence, autonomy, relatedness) had the most influence on your motivation.

Figure 0.7 Example Engage-in activity – used to support students to deepen their understanding

Finally, and arguably most importantly, *Active investigations* require the learner to answer inquiry questions through engaging in the whole inquiry process. These are extended investigations that can be pursued over a number of lessons. The key focus of the Active investigations is to collect authentic primary data that can be compared with reputable secondary sources to develop justifiable responses to the inquiry questions.

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Activity 1.20

Active investigation

Inquiry question: How may the two motor learning approaches impact on performance in authentic environments?

1 Perform in and collect digital evidence of your performance in an authentic performance environment.

2 Use the rate limiter hexagon from Activity 1.8 (on p. 16) to identify the major technical and tactical limiter to your performance.

3 Evaluate your level of performance using both Fitts and Posner's, and Newell's stages of learning models.

4 Justify your level in 250 words using primary and secondary data.

Part A

5 Devise two training sessions using the cognitive systems approach. Ensure that these are appropriate for your stage of learning while using the traditional method.

6 Implement the training sessions over two lessons. Collect data from the sessions.

7 Participate back in an authentic environment and collect digital evidence.

8 Identify pre- and post-test data and explain briefly in a table using the following headings: type of practice used; appropriateness to stage of learning; outcomes achieved technically in practice; outcomes achieved tactically in practice; transferability of technical and tactical aspects into the authentic environment.

9 Compare and contrast pre- and post-test data to evaluate the effectiveness of the training strategy.

Part B

10 Devise two training sessions using the dynamic systems approach. Ensure that these are appropriate for your stage of learning while using the constraints-led approach.

11 Implement the training sessions over two lessons. Collect data from the sessions.

12 Participate back in an authentic environment and collect digital evidence.

13 Identify pre- and post-test data and explain briefly in a table using the following headings: type of practice used; appropriateness to stage of learning; outcomes achieved technically in practice; outcomes achieved tactically in practice; transferability of technical and tactical aspects into the authentic environment.

14 Compare and contrast pre- and post-test data to evaluate the effectiveness of the training strategy.

Figure 0.8 Example Active investigation activity – used to guide students through the process of inquiry

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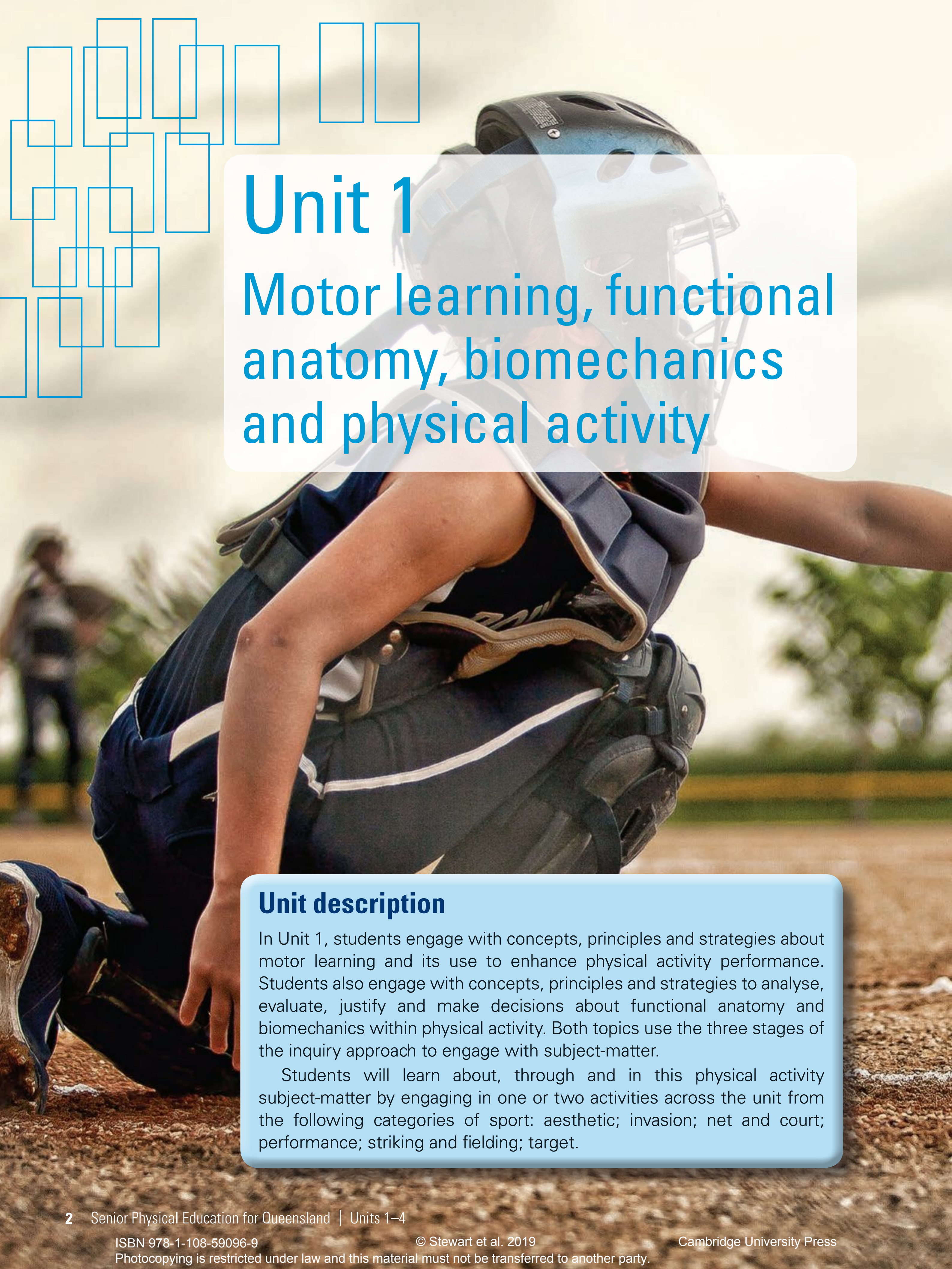

Unit 1

Motor learning, functional anatomy, biomechanics and physical activity

Unit description

In Unit 1, students engage with concepts, principles and strategies about motor learning and its use to enhance physical activity performance. Students also engage with concepts, principles and strategies to analyse, evaluate, justify and make decisions about functional anatomy and biomechanics within physical activity. Both topics use the three stages of the inquiry approach to engage with subject-matter.

Students will learn about, through and in this physical activity subject-matter by engaging in one or two activities across the unit from the following categories of sport: aesthetic; invasion; net and court; performance; striking and fielding; target.

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Unit objectives

Objectives	Activity icons
1 Recognise and explain motor learning, functional anatomy and biomechanical concepts and principles about selected physical activities	RECOGNISE & EXPLAIN
2 Demonstrate specialised movement sequences and movement strategies in the selected physical activity	DEMONSTRATE
3 Apply concepts to specialised movement sequences and movement strategies in the selected physical activity	APPLY
4 Analyse and synthesise data to devise strategies for motor learning, functional anatomy and biomechanics	ANALYSE & SYNTHESISE
5 Evaluate motor learning, functional anatomy and biomechanical movement strategies	EVALUATE
6 Justify motor learning, functional anatomy and biomechanical movement strategies	JUSTIFY
7 Make decisions about and use language, conventions and mode-appropriate features for particular purposes and contexts	MAKE DECISIONS

Chapters in this unit

Chapter
1 Motor learning in physical activity
2 Functional anatomy and biomechanics in physical activity

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Chapter 1

Motor learning in physical activity

Chapter description

In Unit 1, the first stage of inquiry requires students to recognise and explain the concepts and principles about motor learning through purposeful and authentic learning about and in a selected physical activity. In the selected physical activity, students explore body and movement concepts and demonstrate specialised movement sequences and movement strategies.

In the second stage, students apply concepts to specialised movement sequences and movement strategies in authentic performance environments to gather data about their personal application of motor learning concepts. They analyse and synthesise relationships between the motor learning and requirements of the selected physical activity and their personal performance. Students then devise a motor learning strategy to optimise performance in the selected physical activity.

In the final stage, students evaluate the effectiveness of the motor learning and movement strategies and justify using primary and secondary data.

(Extract from Physical Education 2019 v1.1 General Senior Syllabus
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Key inquiry questions

- How do we know motor learning occurs?
- How does motor program analysis assist learning?
- How can motor skills be classified?
- How do different types of practice affect skill development?
- How does effective feedback accelerate motor learning?
- What are the two major approaches to motor learning?
- How can a cognitive systems approach be applied to enhance motor learning?
- How can a dynamic systems approach be applied to enhance motor learning?

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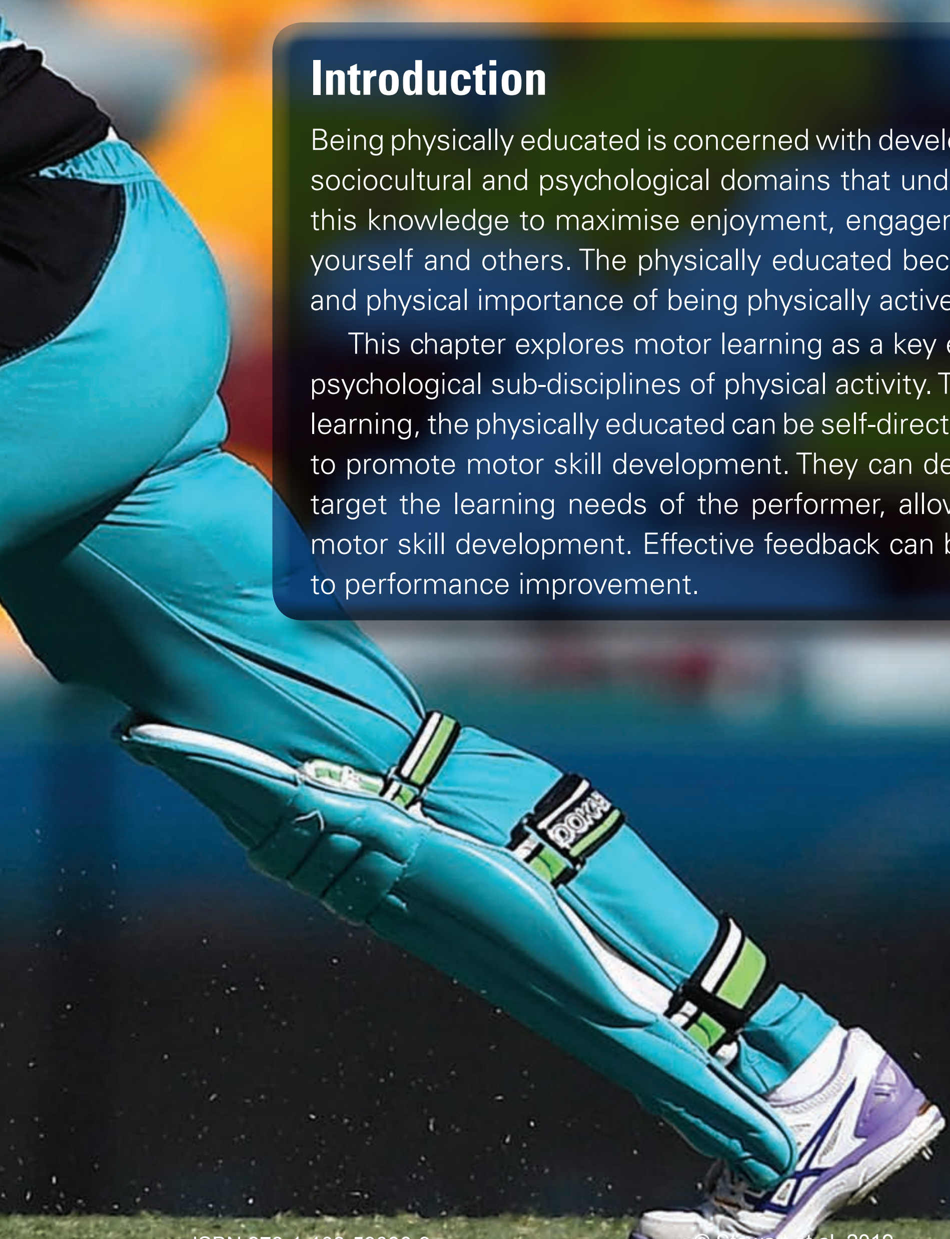

Key terminology

- adaptability
- closed motor skill
- cognitive systems approach
- consistency
- constraints
- continuous motor skill
- decision-making
- discrete motor skill
- dynamic systems approach
- external feedback
- feedback
- fine motor skill
- gross motor skill
- information processing model
- internal feedback
- motor learning
- open motor skill
- perception
- persistence
- rate limiter
- response execution
- serial motor skill
- stability

Introduction

Being physically educated is concerned with developing knowledge in the biophysical, sociocultural and psychological domains that underpin physical activity, and utilising this knowledge to maximise enjoyment, engagement and physical performance for yourself and others. The physically educated become advocates for both the social and physical importance of being physically active.

This chapter explores motor learning as a key element within the biophysical and psychological sub-disciplines of physical activity. Through an understanding of motor learning, the physically educated can be self-directed in establishing learning activities to promote motor skill development. They can design and implement activities that target the learning needs of the performer, allowing for faster and more targeted motor skill development. Effective feedback can be utilised as an important catalyst to performance improvement.

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Inquiry cycle – stage 1: Engage and understand

1.1 What is motor learning?

Learning has many definitions, stages and influences upon it. Generally, however, learning is considered to have occurred when an individual acquires skill, information or knowledge. It should be remembered that learning is non-linear in nature. The learner's ability to use their skill, information or knowledge to achieve a goal is not static, but may vary depending on many factors involving the individual, the task and the environment. Due to this, learning may not be permanent and may fluctuate. This then leads us to the question of what constitutes motor learning.

Motor learning is the ability to learn how to affect the nervous system's reactions. It offers techniques and strategies that work for coaches on a daily basis. Knowing basic concepts takes much of the guesswork out of finding the best instructional sequences and progressions to learn sport skills. According to the *Medical Dictionary for the Health Professions and Nursing* (2012), motor learning is:

motor learning the study of the processes involved in acquiring and refining skills; the field of study concerned with understanding changes in motor control

1 The process of acquiring a skill by which the learner, through practice and assimilation, refines and makes automatic the desired movement.

2 An internal neurologic process that results in the ability to produce a new motor task.

Comparison of these two definitions gives us some insight into the confusion that exists between motor learning and skill acquisition. The following terms are commonly used interchangeably and often refer to the same information: motor learning, motor skill, motor skill acquisition, motor control and motor development.

The debate over the exact nature of motor learning is a result of the many theories that have been proposed over the past hundred years concerning how humans learn. These changing theories can be observed in the field of motor learning, through ongoing changes in training and teaching techniques. They have given rise to a diverse understanding of motor learning with different underpinning concepts. Later in this chapter, both a traditional and a contemporary approach to motor learning will be explored. However, for our purposes, motor learning relates to any process relating to the acquisition, retention and/or refinement of skills. The Physical Education General Senior Syllabus (Queensland) (2019, p. 105) states that motor learning is 'the field of study concerned with understanding changes in motor control'.

Activity 1.1

Check-in

1 In your own words, describe when learning has occurred.

2 Explain how motor learning is displayed when completing a basketball jump shot; include in your response an explanation of how learning can be non-linear.

1.2 What is a motor program?

A motor program is a series of subroutines organised into the correct sequence and timing to perform a movement. Motor programs are used for all movements undertaken by an individual. However, in relation to the learning of movements, motor programs generally refer to the specialised movement sequences needed for a specific activity – the technique or action. When applying a more traditional approach to motor learning, a motor program is stored in memory and retrieved when a skill is required to be performed. Similar to a subroutine in computer programming, it is a sequence of smaller tasks or programs that combine to perform the larger specific movement. For example, to complete a javelin throw in track and field, a number of smaller tasks or programs need to be completed for an effective throw to occur.

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Figure 1.1 Subroutines organised into a correct sequence are necessary to perform a javelin throw effectively.

The subroutines for javelin may be:

- appropriate grip
- initial start position
- velocity of movement and feet position through the sector
- height of body in transition phase
- head, hip and feet position prior to release
- speed of arm
- angle of release
- height of release
- summation of forces during weight transfer and hip drive.

Historically, due to the nature of traditional approaches such as the cognitive systems approach, the concept of subroutines and the classification of skills have played an integral part in understanding motor learning. Breaking down a skill into smaller components is still an important aspect of skill development, particularly where an athlete's personal motor programs can be assisted through biomechanical analysis to enhance the efficacy, accuracy, consistency or speed of the movement.

Activity 1.2

Engage-in

Inquiry question: What is the classification of skills?

Engage and understand

1 Review a video of a motor program in your physical activity at the elite level.

2 Deconstruct the skill into subroutines.

3 Video your execution of the skill.

Apply and analyse

4 View the footage and examine your performance of the subroutines.

Evaluate and justify

Appraise: Evaluate the worth, significance or status of (something); evaluate, judge or consider a text or piece of work.

5 Appraise the similarities and differences between the elite performance and your own to identify strengths and weaknesses of your technical ability in the specific motor program.

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Activity 1.3

Check-in

1. Choose three specific motor programs in your physical activity.
2. Break the motor program down into subroutines.
3. Review critically whether specific motor programs are important for consistency with strong biomechanics or whether your skills need to be adaptable and changing.

1.3 What is the classification of skills?

Skill classification deals with grouping different skills based on the size of muscle movement, the type of movement occurring and the environment in which the skill occurs. This can be useful when developing training activities, as similar skills can often benefit from similar training approaches. Teachers and coaches regularly modify effective training activities designed for one skill in order to apply them to another.

fine motor skills small movements that use the small muscles

gross motor skills bigger movements that use the large muscles

open motor skills occur in environments that are highly unpredictable

closed motor skills occur in highly predictable environments

Fine motor skills are those skills that require small muscle movements. Generally, these are associated with greater dexterity, precision and accuracy, and involve fingers or hands – for example, adjusting the grip on a golf club. **Gross motor skills** are those that require large muscle movement to complete a task. Generally, these require less precision and accuracy – for example, completing a full spin throw in discus or hitting a softball pitch to the outfield.

Open motor skills occur in environments that are highly unpredictable. This may occur due to the variables within the activity. In an invasion game, the completion of the activity may depend on your own position on the field, as well as those of your teammates and your opponents. The timing of the skill is uncertain, as external factors may affect the completion of the task – for example, attacking in a game of touch. **Closed motor skills** occur in highly predictable environments. The performer generally determines the timing of these skills for example, sinking a snooker ball. It is very unusual to find physical activity tasks that are classified as completely open or closed.

Activity 1.4

Engage-in

Inquiry question: What is the classification of skills?

Engage and understand

1. Draw a table including the following tasks in preparation for categorisation of each:
   - tennis serve
   - shot put throw
   - swimming six laps

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- darts throw for bullseye
- adjusting the grip on a cricket ball from off-spin to leg spin
- 3 vs. 3 game of Futsal
- two kicks for a goal in Rugby League
- triple jump
- flying a kite.

2 Perform each task.

Apply and analyse

KEY COGNITION

Categorise: Place in or assign to a particular class or group; arrange or order by classes or categories; classify, sort out, sort, separate (Physical Education 2019 v1.1 General Senior Syllabus © Queensland Curriculum & Assessment Authority).

3 Categorise each task according to the different classifications of skill. For each, explain in your own words why the task matches that classification.

Evaluate and justify

4 Reflect on the following tasks in a game of soccer:

a a penalty shot on goal

b soccer general play.

5 Classify these according to the environment.

6 Explain and justify in no more than 50 words whether soccer is an open or closed skill.

7 Evaluate batting in cricket and complete the following tasks:

a Classify the skill.

b List the subroutines involved.

8 Reflect on former Australian Men's Cricket Captain Steve Smith's ability in relation to the subroutine of batting. Watch the YouTube video *Steve Smith Best Batting* to help you.

a Does Steve Smith demonstrate the perfect model for batting?

b Make a decision regarding whether there is a perfect technical model.

9 Evaluate how the knowledge of subroutines and classification of skills may affect the design of training and learning environments.

Figure 1.2 Former Australian Men's Cricket Captain Steve Smith prepares for a shot

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Activity 1.5

Check-in

1 Watch the YouTube video *9 Lowest Paid 'GOD LEVEL' Skilled Workers Caught on Tape!!*
2 List five skills that you enjoyed watching.
3 Identify the common characteristics that would enable the skilled performances to occur.
4 Consider what was required for this level of skilled performance to be achieved.

Discrete motor skills have a distinct start and finish – for example, hitting a golf ball. **Continuous motor skills** do not have a definite finish or end, but rather are repetitive in nature – for example, running. **Serial skills** are those where a number of discrete motor skills are linked together – for example, triple jump.

Typically, learning is demonstrated as the number of successful attempts increases for the learner. Several factors can be used to ascertain the success of motor skills. Factors include **consistency**, **stability**, **persistence** and **adaptability**. Consistency relates to the ability to replicate a skill and produce the same outcome. Stability speaks of the ability to negate external forces on performance. The learner in repetition of tasks demonstrates persistence. Adaptability relates to the ability to change the skill based on external factors. Practice is integral to facilitating the improvement of these characteristics.

discrete motor skills have a distinct start and finish

continuous motor skills do not have a defined end, but are repetitive in nature and may continue for an unspecified length of time

serial skills those where a number of discrete motor skills are linked together

consistency the degree to which the performance varies

stability the state of being stable and resistant to change

persistence lasting for a long time, the act of being persistent

adaptability ability or willingness to change

Activity 1.6

Engage-in

Inquiry question: What types of practice impact motor learning?

Engage and understand

1 Review the following YouTube videos:
   - *I Learned to Play Piano with My Balls!*
   - *Brickies Labourer in Bangladesh*.
2 Identify what was needed for each individual's motor development. Consider the qualities of consistency, stability, persistence and adaptability; how does each affect the motor control required to complete the tasks observed?
3 Complete a juggling task in relation to recognising the effect of practice on performance and to identify different training styles.

   Aim: Juggle the ball 30 times

   Equipment: 2 balls per pair

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Organisation

4 Students are to work with a partner. One is student A; the other is student B.

5 Each pair of students requires four tennis balls.

6 No practice is allowed.

Task

7 Draft a table using the following format, but for 20 attempts.

Initial	Dominant hand: Completion		Non-dominant hand: Completion		Post practice	Dominant hand: Completion		Non-dominant hand: Completion	
	Student A	Student B	Student A	Student B		Student A	Student B	Student A	Student B
1					1				
2					2				
3					3				

8 Student A is to attempt to juggle two balls in one hand up to a maximum of 30 catches. At any stage, if the ball is dropped the count stops. Student A has 20 attempts on their dominant hand and 20 attempts on their non-dominant hand. Student B counts and records the number of successful catches for each attempt.

9 Reverse the roles of student A and student B to collect further primary data and ensure all trials are recorded in the table.

10 Both students now undertake further practice for this task. Student A undertakes 30 practices for each hand. If they reach 30 catches, they stop and start again. In between each practice attempt, student A must bounce the ball in one hand 20 times. At the end of 30 practices using each hand, student A sits and has no further practice. At the same time, student B has 10 minutes' continuous practice using each hand. There is no limit on catches.

11 Repeat step 8 to collect post-practice data and observe improvement.

Apply and analyse

12 Categorise the skills involved in the task.

13 Examine the data and consider which practice had the biggest impact on you and your partner.

14 Organise class data into one table.

15 Examine the data and identify which practice had the biggest impact on the class.

16 Evaluate what effect practice had on the performance of the juggling task.

Evaluate and justify

Synthesise: Combine different parts or elements (e.g. information, ideas, components) into a whole, in order to create new understanding.

17 In a 100-word statement, synthesise what you have discovered in this laboratory with what you already know about practice to hypothesise the impact practice has on motor learning.

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What types of practice are available to enhance motor learning?

Within motor learning, there are many types of practice that can be used to optimise performance (see Table 1.1).

Different approaches to motor learning generally tend to require different types of practice to stimulate learning, due to the different underlying assumptions in each model. Two major, yet different, approaches to skill acquisition will be explored later in this chapter and extensively in Chapter 5. These will call upon the practice types in very different ways. The traditional cognitive systems approach relies heavily on practice types 1 to 9 in Table 1.1. The more modern approach of dynamic systems theory relies more on the characteristics of problem-solving, specificity and variability practice, as these are the key elements of a non-linear constraints-led approach to motor learning.

1 Massed practice. This involves continual repetition of a specific skill with no or limited intervals between. This is completed in a closed environment. According to the *Psychology Dictionary*, 'massed practice is considered less effective than a distributed practice'. An example is 50 passes between two Futsal players.	**2 Distributed practice.** This involves short intervals focused on a specific skill with frequent intervals between – for example, 5 × 10 free throws in basketball with 5 lengths of the court dribbling of the ball, followed by 5 × 10 free throws.
3 Whole practice. This involves practice of the specific skill in total – for example, completing a golf shot.	**4 Part practice.** This involves breaking the skill down into separate sections or subroutines – for example, ball toss in tennis serve, racquet swing down back.
Many practitioners use a whole–part–whole approach to skill practice.	
5 Blocked practice. This involves chunked periods of time practising a single skill of a multitask activity – for example, in volleyball, 10 set passes followed by 10 dig passes, practised for 15 minutes.	**6 Random practice.** This involves the repetition of several skills simultaneously – for example, in basketball, shooting practice alternating between a three-point shot, free throw and lay-up.
The *Medical Dictionary* states that, 'Research shows that while blocked practice is superior at improving immediate performance, it is not as effective as other approaches, such as random practice, for retained learning.'	
7 Constant practice. This involves the repetition of a specific skill without variation – for example, passing a ball over 10 m.	**8 Varied practice.** This involves the repetition of a skill with minor variations – for example, passing a ball over 10 m, 15 m and 20 m.

Table 1.1 Types of practice

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9 Drills. This involves the repetition of a skill. It generally occurs in a closed environment with direct instruction by the teacher/coach. Limited, if any, external factors are involved as the player is aware of the direction of reception and the selected technique to be used. Another term that can be interchangeable with 'drills' is 'grids'. This generally is an extension of the original drill activity into a secondary drill. This is the same repetition of the skill in a closed environment with more players involved in a square or grid.	**10 Problem-solving.** This type of practice requires the player to use some decision-making to complete the task.
11 Specificity. This involves representative practice task designs that faithfully replicate performance environments during practice. This is important, as the perception and action are tightly coupled – for example, cricket batting practice using a bowler rather than a bowling machine.	**12 Variability of practice.** This involves different options to complete a specific task or goal – for example, training for touch football with a tennis ball.

Table 1.1 *(continued)*

Figure 1.3 A swimming coach explaining strokes to students during practice

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Activity 1.7

Engage-in

Inquiry question: How do you perform in authentic environments?

Engage and understand

1 Capture digital evidence of your performance in a variety of modified game and match situations. Consider 1 vs. 1, 2 vs. 2 and 3 vs. 3 situations as appropriate for your physical activity of study. Ensure digital evidence is stored in at least two locations for review, comparison and contrast later in the unit, and in preparation for assessment.

Apply and analyse

Critique: Review (e.g. a theory, practice, performance) in a detailed, analytical and critical way.

2 Critique the digital data and identify two strengths and weaknesses of your play.

1.4 What factors affect motor learning progress?

To develop appropriate learning activities for an athlete, it is essential to have a clear understanding of their current ability. In this way, teachers, coaches and the athlete can target areas that will bring about improved performance through specifically designed training strategies. A key to improved learning, therefore, is understanding what is currently limiting performance and improvement.

One skill-acquisition researcher, Newell, suggests that any aspect that reduces the rate at which learning progresses can be termed a **rate limiter**. Rate limiters are numerous, and vary from athlete to athlete; however, they can be classified as technical, perceptual, tactical, psychological, physical and physiological. This indicates that aspects from any category may be acting as rate limiters, hampering development in other areas and the overall development of the motor skill.

rate limiter constraint that holds back or slows the emergence of a motor skill

> The slow development of one sub-system can act as a rate limiter, meaning that skills may only emerge when all the relevant sub-systems have reached a critical level of development (Thelen, 1995). For example, in child development, muscle strength is a rate limiter for the emergence of walking (Haywood & Getchell, 2005).
>
> *Source: Renshaw et al. (2007, p. 549).*

Technical factors

These relate to the specialised movement sequences required for the specific sport or activity – for example, in tennis, forehand or backhand.

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Perceptual factors

According to Wortham and Reifel these relate to:

> the child's developing ability to interact with the environment, combining use of the senses and motor skills. The developmental process of use of perceptual or sensory skills and motor skills is viewed as a combined process. Perceptual-motor development results from the interaction between sensory perception and motor actions in increasingly complex and skillful behaviors (Jambor, 1990; Mullen, 1984; Puckett & Black, 2005). More specifically, visual, auditory, and tactile sensory abilities are combined with emerging motor skills to develop perceptual-motor abilities.
>
> Perceptual-motor skills include body awareness, spatial awareness, directional awareness, and temporal awareness. Body awareness means the child's developing capacity to understand body parts, what the body parts can do, and how to make the body more efficient. Spatial awareness refers to knowledge of how much space the body occupies and how to use the body in space. Directional awareness includes understanding of location and direction of the body in space, which extends to understanding directionality and objects in space. Temporal awareness is the development of awareness of the relationship between movement and time. Skills involving temporal awareness include rhythm and sequence. The sequence of events using a form of rhythm or pattern reflects temporal awareness (Frost, 1992; Gallahue, 1989; Jambor, 1990).
>
> *Source: Wortham and Reifel (2008, pp. 126–7).*

Tactical factors

These relate to 'the decisions and actions of players in the contest to gain an advantage over the opposing team or players' (Martens, p. 170). This may occur through the manipulation of oneself, the goal to be achieved or the environment.

In Chapter 5, the concept of intelligent performance is explored and likened to tactical awareness. Intelligent performance occurs through the athlete's capacity to manipulate the:

- rules
- time
- scoring
- principles of play
- affordances – technical and tactical, individual plus team
- limitations – technical and tactical, individual plus team.

Psychological factors

These relate to the mental and emotional state of the person and how this may be impacting learning progress negatively. Psychological issues include motivation, confidence, arousal levels, self-confidence, concentration and focus.

Physical factors

These relate to the physical capabilities of the learner, where the athlete's components of fitness or energy systems may be restricting potential improvement – for example, is the strength of the muscular system limiting the learning of a complex movement in a sport aerobics routine?

Physiological aspects

These relate to the genetic make-up of body systems. Here, the individual's body composition elements – such as height, weight or arm span – may be preventing further improvement from occurring.

Additional external factors affecting motor learning progress

In addition to rate limiters within the performance of an athlete, several other external factors may affect motor learning. These include the environmental, sociocultural and instructional conditions that surround the learning of the individual.

Environmental conditions are obviously external factors that impact on motor learning. Why does Queensland have a large number of elite swimmers

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Activity 1.8

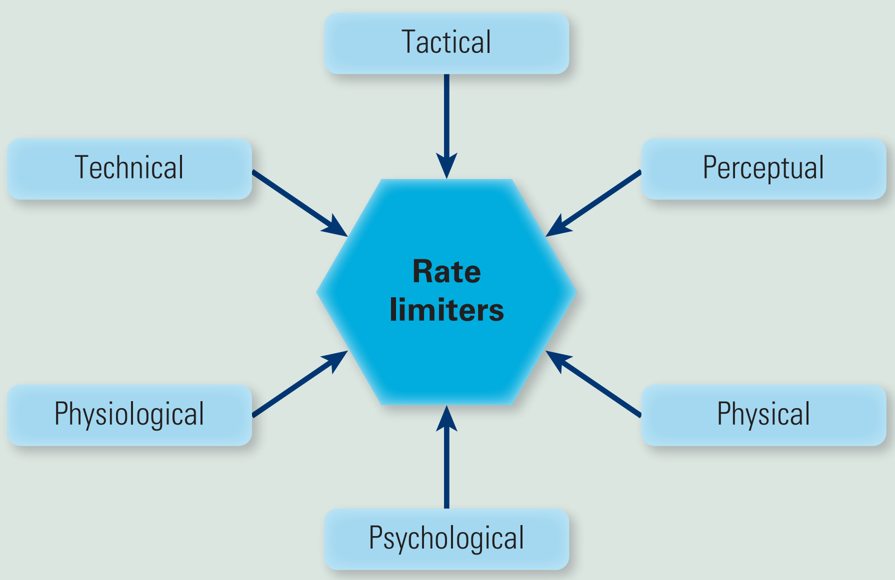
Engage-in

Inquiry question: What types of training and limiting factors affect motor learning?

Engage and understand

1 In the rate limiter hexagon graphic organiser, categorise five aspects from each section that may limit performance in the physical activity being studied.

Rate-limiter hexagon



2 Order the limiters in each section by highlighting the top three limiting factors on your performance in the current physical activity. Remember to consider how each might be affecting your consistency, stability, persistence and adaptability.

Apply and analyse

Analyse: Examine or consider something in order to explain and interpret it, for the purpose of finding meaning or relationships and identifying patterns, similarities and differences.

3 Decide which is the most significant rate limiter in each section for your performance in the current physical activity.

4 Analyse the most significant rate limiter for your performance in the current physical activity.

5 For the most significant limiting factor in each section, devise a session using a specific type of training to enhance your performance.

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yet a limited number of elite downhill skiers? The geographical location in which the athlete lives and dominant weather patterns may affect initial physical activity selection and then the opportunities afforded to practise and develop skills.

Sociocultural factors will have an impact on skill acquisition. Family background, education, religion, culture, individual and family financial situation will all influence access to the resources required to learn. The quality and amount of facilities, equipment and instructors all greatly impact the level of skill acquisition that can be achieved.

Finally, the instructional conditions will affect skill acquisition. Here, the quality of interactions between the learner and the teacher or coach will enhance or restrict learning. Skill acquisition may be linked to psychological aspects such as motivation, confidence and arousal, and how the practitioner can work with these to enable the learner most effectively. However, other factors may include the pedagogical approach of the practitioner, the quality of the instruction, or activities given and types of feedback provided.

1.5 What is feedback and how does it affect motor learning?

Feedback is an essential part of motor learning, as it enables learners to reflect upon performance, identify positive and negative behaviours, and plan to maximise future outcomes.

The two major types of feedback involved in motor learning are internal feedback and external feedback. *Internal feedback* is when the body receives information during the performance. This occurs through the body senses, or proprioceptors. These senses help to develop a kinesthetic sense for a movement and allow the athlete to differentiate between effective skill execution and error. Internal feedback can be 'knowledge of performance' where the athlete is attuned to the senses and body movement in the performance. For example, in cricket batting, the athlete may identify that they feel they were reaching too far forward to hit the ball. In high jump, they may feel the arch was not held for long enough.

External feedback or augmented feedback comes from outside of the body. This can occur in several different formats. Verbal feedback can occur from an observer. Written feedback is obviously in writing. This may be in the form of notes, a long article or annotations on a checklist. Both verbal and written feedback can come from a number of sources – for example, a coach, peer, teammate, opponent, commentator or spectator. Knowledge of results is also a part of external feedback and 'can include scores, times, and distances (Mononen et al., 2003).' (Roulier, 2014).

A 'feedback loop' refers to a continual cycle of information in a traditional approach. Firstly, it relates to the input of information. This occurs though the identification of information from the individual, the task and the environment. Our bodies are constantly receiving messages through internal feedback (body, position, balance, fatigue) and external feedback from the environment about what is occurring around us and the positioning of key factors in the games like the opposition, our teammates and the weather. This information is processed, and output or the action occurs. From the output or action, further information is able to be gathered – for example, success of the action. This ongoing feedback allows for constant decisions to be made about what to do and when to do it – and also what might need to be adapted about the skill in order for it to suit the current situation … this is all facilitated through a feedback loop.

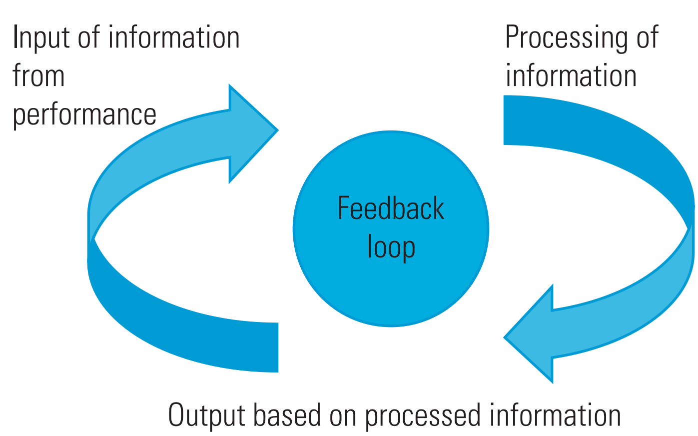

Figure 1.4 A feedback loop

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1.6 What are the characteristics of good and bad feedback?

External feedback that comes from a practitioner can be a powerful catalyst in the learning process. The quality of feedback given by a teacher or coach can enhance or restrict motor learning, and therefore it is essential to be aware of what constitutes effective external feedback.

Effective feedback should be:

- **positive rather than negative** – feedback can be either positive information, which is affirming, or negative feedback, which produces an adverse effect. Even when errors occur, describing what can be done, rather than what was performed incorrectly, will be more beneficial.
- **timely** – occurring as soon as possible after completion of the task
- **pertinent and relevant** – it should not overload the learner with information, but rather be specific to the current situation
- **directed**, so that learners solve problems.

It is worth noting that the amount of external feedback that is actually taken in and actioned by a learner has been questioned. Less 'white noise' is better – keep feedback short, targeted and specific for the learner to develop from the feedback given. When looking at feedback, you will notice that much of the information relating to feedback is coach-centred. However, for greater depth of learning to occur, it is far more beneficial for feedback to be learner-centred. Enhanced learning will occur if the individual is able to self-organise and to identify personal rate limiters.

To assist the learner to develop this self-reflective skill, the practitioner must use strategic questioning as an important part of the feedback process. Closed questions with a correct response would be directed at the learner in relation to a technical aspect. For example, 'What type of shot should you have played?' Open questions allow for multiple responses and are usually directed at learners to solve problems. This may be a technical problem – for example, 'What did you need to do in that situation so as to pass the ball accurately to the spiker?' Greater height, accuracy of pass, proximity to the net and/or timing of the pass would be the possible responses. However, open questions are usually used to solve more complex tactical problems, such as, 'What options did you have in attack so to enhance your scoring opportunity?' By teachers and coaches modelling effective questioning throughout the learning process, athletes learn to ask these questions of themselves and in turn to formulate successful future performances, without the need for an external person to 'tell them what to improve'.

Figure 1.5 A basketball team discussing tactics

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Activity 1.9

Engage-in

Inquiry question: How is feedback effective?

RECOGNISE & EXPLAIN
APPLY
DEMONSTRATE
ANALYSE & SYNTHESISE

Engage and understand

1. During game play in your next performance lesson, find a partner with whom you can share immediate feedback.
2. Identify specific times in your performance when constructive advice could be delivered immediately – for example, after a point, after a try, a change of ends or a break in play.
3. Engage in the physical activity, taking it in turns with your partner to play or provide feedback. If possible, take notes on the feedback you give, so that your partner may review your advice after the lesson.

Apply and analyse

KEY COGNITION

Explain: Give a detailed account, including reasons or causes, and make the relationships between things evident; make (an idea or situation) plain or clear by describing it in more detail or revealing relevant facts; provide additional information that demonstrates understanding of reasoning and/or application.

4. At the completion of the performance, give your partner an overall summary of their performance by identifying the successful aspects you observed. Also give them one area to improve by focusing on how to develop a specific technique or an area of skill selection.

1.7 What are the two major approaches to motor learning?

As an understanding of learning has developed over time, two major approaches to investigating motor learning have developed. Each approach has a number of different learning models associated with it, and each of these two major approaches is underpinned by different assumptions about how performers learn motor skills. More traditional approaches to motor learning generally take a **cognitive systems approach** to learning, while more contemporary motor learning models tend to reflect a **dynamic systems approach**. Each approach works to explain the learning process and to highlight effective teaching and coaching pedagogies to enhance the learning of motor skills.

Cognitive systems approach to motor learning

The cognitive systems approach is a more traditional approach to motor learning, whereby improvement occurs as the result of feedback following a process of input, information processing and output. That is, the body is viewed as a computer with the brain being the central processing unit. Input of information occurs from the environment (ascertaining what is occurring), processing of the information occurs by the brain (deciding what movement is required and selection of a motor program) and an output results (executing the movement).

cognitive systems approach acquisition of information-processing abilities

dynamic systems approach the theory that movement behaviour is the result of complex interactions between many different factors, such as the environment and the task at hand

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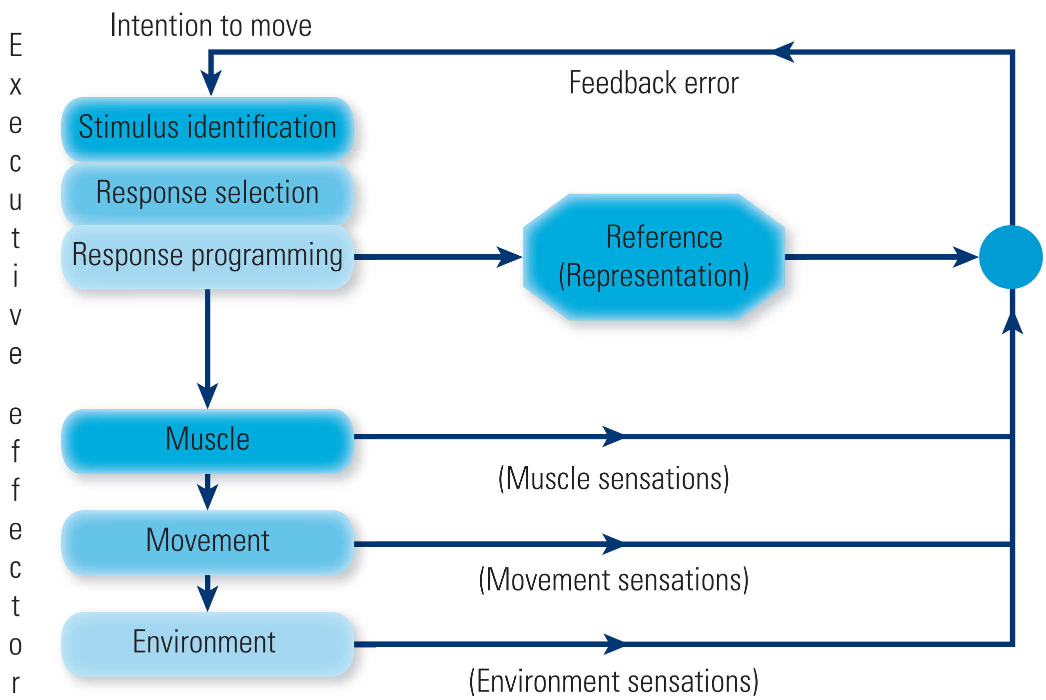

Source: Davids et al. (2008, p. 10).

Figure 1.6 Information processing occurs in the central nervous system through a series of discrete cognitive stages involving perception, decision-making and response execution.

A well-known cognitive systems approach is the *information processing model*. In this learning model, outlined by Welford (1968) and later Whiting (1969), the notion of input, processing and output are described as the phases of perception, decision-making and response execution. *Perception* occurs as the athlete's senses pass onto the short-term memory relevant data about the current circumstances surrounding the performance. **Decision-making** occurs through comparison with similar previous experiences stored in the long-term memory in order to select a motor program. **Response execution** occurs when the decision is passed to the relevant body parts and the selected motor plan is enacted. Learning occurs as **feedback** about the success of this process is retained so that future performances in similar situations can be refined.

decision-making (information processing) selecting a motor program in response to the current situation

response execution occurs when the decision is passed to the relevant body parts and the selected motor plan is enacted

feedback (in motor learning) any information received during or after a performance about the movement itself or the level of success achieved by the movement in that situation

In addition to information processing, Fitts and Posner (1967) propose that learning changes for an individual as their ability to process information develops. Under a cognitive systems approach, Fitts and Posner proposed three stages in his stages of learning model. Under staged learning, an individual progresses from beginner to expert as they enhance different aspects associated with information processing.

Fitts and Posner's stages of learning model describes skill acquisition as a gradual process, whereby the learner moves through three learning stages in a linear progression. The *beginner or cognitive stage* sees the learner concerned largely with gathering information along with formulating basic motor programs. This stage is characterised by large gains in skill development; however, inconsistent performance is common, as motor programs are put together and stored. The *associative stage* involves the process of putting actions together in more coordinated ways and becoming increasingly familiar with the situations in which the skills can be used successfully. The associative phase is characterised by small gains, with a focus on refining performance through conscious reflection on performance feedback. Given enough time and practice, the athlete may advance to the final stage of motor learning, the *autonomous stage*. This stage is characterised by performances that seem unconscious, automatic and smooth. The motor programs involved are well learned and are now ingrained in long-term memory.

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Activity 1.10

Check-in

1 Draft a table labelled ‘Fitts and Posner’s stages of learning model’. In the table, do the following:

   a Identify each stage of learning in a row.

   b Assign a column each to perception, decision-making and response execution.

2 Complete the table by identifying characteristics for each stage under the ‘Information Processing’ heading.

Activity 1.11

Engage-in

Inquiry question: How do we develop motor learning?

Engage and understand

Option A: Striking and fielding games

Participate in Drills 1 and 2.

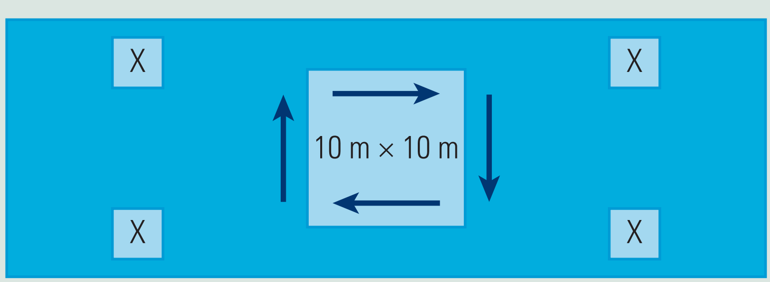
Aim: Develop motor learning in softball

Equipment: 1 ball, 4 markers

Space: Drill 1 – 10 m, Drill 2 – 10 m x 10 m

Drill 1: Complete 60 stationary passes in pairs.

Drill 2: Pass the ball around the square, again completing 60 passes.



(continued)

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1 Design a mind map with developing softball technique in an authentic environment as the central theme.
2 Identify in branches off the central theme the sub-headings of type of skill undertaken and the type of practice.
3 Identify the type of skill and the type of practice undertaken in Drills 1 and 2.

Apply and analyse

4 Consider and explain in branches off the sub-headings, characteristics that are pertinent to the classification of the type of skill and type of practice.
5 Identify what was needed to complete the drills successfully.
6 Identify what differences there are in the drills depending on the game environment – for example, tracking of ball, tracking of team member, tracking of opponent.
7 Critically review how closely aligned the drills were to the game environment.

Evaluate and justify

Judge: Form an opinion or conclusion about; apply both procedural and deliberative operations to make a determination.

8 Judge whether motor learning of softball was developed in each drill.
9 Consider other factors that may be involved in completing a skill in a game environment. How do these other factors affect the successful completion of the skill?

Engage and understand

Option B: Net and court games

Participate in Drills 1 and 2.

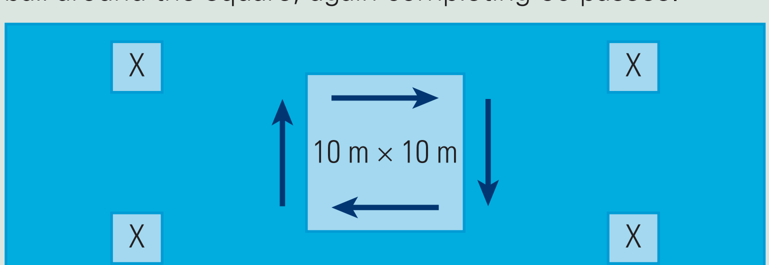
Aim: Develop motor learning in volleyball

Equipment: 1 ball, 4 markers

Space: Drill 1 – 10 m, Drill 2 – 10 m x 10 m

Drill 1: Complete 60 stationary passes in pairs.

Drill 2: Pass the ball around the square, again completing 60 passes.



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10 Design a mind map with developing motor learning as the central theme.

11 Identify in branches off the central theme the sub-headings of type of skill undertaken and the type of practice.

12 Identify the type of skill and the type of practice undertaken in Drills 1 and 2.

Apply and analyse

13 Consider and explain in branches off the sub-headings characteristics that are pertinent to the classification of the type of skill and type of practice.

14 Identify what was needed to complete the drills successfully.

15 Identify what differences there were in the drills depending on the game environment – for example, tracking of ball, tracking of team member, tracking of opponent.

16 Critically review how closely aligned the tasks were to the game environment.

Evaluate and justify

KEY COGNITION

Judge: Form an opinion or conclusion about; apply both procedural and deliberative operations to make a determination.

17 Judge whether motor learning in volleyball was developed in each drill.

18 Consider other factors that may be involved in completing a skill in a game environment. How do these other factors affect the successful completion of the skill?

The cognitive systems approach and Fitts and Posner's stages of learning are considered a traditional theory of motor learning. Several approaches considered traditional theories have common characteristics. These include a belief that learning involves constructing internal models of the world and of movements that facilitate interactions with the environment. These motor program memories are stored in the brain and are used to guide future actions. Davids and colleagues (2008, p. 17) state that:

> Traditional theories assume that the coordination and control of movement requires some kind of ordered prescription or representation for action (Anson, Elliott & Davids, 2005; Newell, 2003). Traditional cognitive approaches deal with this requirement by invoking a central controlling mechanism that resides in the brain.
>
> *Source: Davids et al. (2008, p. 17).*

The traditional cognitive style approaches have more recently been questioned due to their inability to explain or develop intelligent performers. The following are some of the issues that have emerged.

- **The amount of storage required in the brain to store motor programs.** Remembering the earlier analogy of skill execution under a cognitive approach being like a computer processor, the more motor programs developed and used in an ever-increasing number of circumstances, the more the brain would become cluttered with information, which in turn would slow performance – just like a computer reaching its processing capacity. In reality, we know this is not true, as a performer with more experience is able to perform faster and more efficiently.
- **Reliance on a hierarchical system that controls movement.** The issue with this traditional concept in motor learning is that for skill acquisition to occur, 'increasingly elaborate cognitive processes to coordinate increasingly skillful movement patterns' are required (Davids et al., 2010, p. 21). That is, situations become increasingly complex and successful performance is not as simple as recognising cues and enacting a set response. Under a cognitive approach, variability is considered

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unhelpful and practice is spent refining a motor program to an ordered and structured set of refined subroutines. However, an 'intelligent performer' is able to adapt and manipulate their responses in the moment during performance to succeed in highly complex and dynamic performance environments. A traditional approach to learning struggles to account for this type of variation in performance.

- **The cause-and-effect outlook.** Traditional approaches to learning struggle with the complex nature of humans and movement. Therefore, the cognitive systems approach and movement through the stages of learning (cognitive→associative→autonomous) have been questioned due to factors that affect skilled performance and the ideal of linear learning. This system lends itself to practised rehearsal of a set motor program, which is very controlled in relation to input (start point/direction/skill selection) and output (skill execution), such as a drill. This has led many practitioners to use massed repetitive practice to develop skills; however, results indicate this is not the most effective way to develop many skills.
- **The use of part-practice to minimise 'background noise' dealt with by the central nervous system and in deciding on an output.** Learning part of a task individually will then enable the transfer or linking of these sub-tasks later to create a whole performance. The expectation is that transfer will occur between the learned skill or subroutine and the new skill, such as performing the skill with external factors such as defenders. However, the reality is that the learner must adapt an existing motor pattern to the new constraints. More modern scientific theories question this, and see that the interrelationship and coordination between all constraints – learner, task/goal and the environment – are needed for performance.
- **Decomposition of task.** Using drill or part-practice and progressing to a whole or authentic environment would cognitively mean that a new motor pattern needs to be learned and stored in long-term and short-term memory to be effective. That is, the new skill in the authentic environment would need to be learned in full, from the beginning.
- **Feedback considered crucial.** Part of the feedback relates to instruction where an idealistic movement is prescribed. Augmented feedback is relied upon through a visual demonstration of the ideal model of movement. However, approaches that are more modern question this concept and promote the learner seeking and identifying an appropriate movement pattern that provides a solution to the task. Davids and colleagues (2010, p. 98) found that:

> Research has shown, however, that even in highly stable skills such as rifle shooting or golf putting, common optimal coordination patterns do not exist (Brisson & Alain, 1996; Ball, Best, & Wrigley, 2003; Fairweather, Button, & Rae, 2002). This is because each time a skill is performed, it must be adapted to subtle differences in initial conditions (e.g. changes in body sway, physiological status, or psychological factors) and in the environment (e.g. a slight breeze, different temperatures, different surfaces).
>
> *Source: Davids et al. (2010, p. 98).*

Some major issues therefore remain in relation to a cognitive systems approach developing intelligent performers with the ability to apply flexible adaptable programs to open scenarios. Davids and colleagues (2010, p. 99) reinforce that studies on developing intelligent performance through modern approaches have 'strong implications for a learner model' and suggest that 'the emphasis during learning should be on encouraging change and adaptation rather than achieving some hypothetical, idealized state'.

Figure 1.7 Even a highly stable skill, such as a golf putt, requires adjustments to the movement patterns each time it is implemented to account for the subtle differences in circumstances.

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Activity 1.12

Check-in

1. How effective are the cognitive systems and traditional teaching approaches for enabling flexibility or variation of a skilled performance to solve an issue at a particular point in time?
2. In the chaos of an invasion game, use an example to explain how likely it is that a set motor program will be used.

Dynamic systems approach to motor learning

Contemporary motor learning theories tend to be more holistic in their approach to motor skill acquisition. Rather than simply looking at the acquisition, refinement and application of motor programs, a dynamic systems approach explores the interconnected aspects of the individual, the task and the environment. Learning occurs as the performer knows where in an environment to search for affordances that will allow them to achieve a goal and has the ability to implement a plan to successfully complete that goal. This is important, as individuals aim to demonstrate intelligent performance through the manipulation of their technical and tactical ability. The dynamic systems theory is a more modern approach whereby the athlete is viewed as 'a complex, biological system composed of many independent but interacting systems' (Davids et al., 2008, p. 30).

The *dynamic systems approach* views an athlete as a complex system with many interacting components impacting it. This enables learners to adapt to variations in the task, themselves and the environment to provide different multiple solutions to problems or challenges. In this theory, motor learning is not considered linear in nature; rather, learning is non-linear as an individual's performance progresses and regresses as a stable pattern of performance occurs and erodes based on the learner, the task/goal and the environment. Progression of learning shifts up and down through Newell's stages of learning.

The first stage of Newell's stages of learning model is *assembling a coordination pattern*. In this stage, learners aim to establish a basic relationship among the key components of the task, environment and themselves. This is characterised by limited movements while assembling appropriate body actions to complete the task. The learner may seek many alternative movement actions as they seek to achieve a particular task or aim. Due to the exploration of many different movements, a pattern may emerge to complete the task; however, it may become destabilised or erode as readjustment to variables occurs. A learner seeking consistency or accuracy may seize upon a movement pattern with limited **degrees of freedom** to accomplish this – for example, serving in tennis.

degrees of freedom factors affecting the directions in which independent motion can occur

The second stage of the model is *gaining control of a coordination structure*. In this stage, a tighter fit occurs between the assembled co-coordinative structure and the performance environment. Subtle and refined deviations in the movement patterns occur in order to experiment with adaptability in different situations. This is crucial for flexibility of performance, as Davids and colleagues (2008, p. 87) state: 'theorists advocate that movement variability can play a functional role in helping humans adapt to novel surroundings and learn new skills'. That is, an attempt is made to improve motor patterns, which are functional under different conditions.

Furthermore, Davids and colleagues state that:

> movement systems do not have fixed coordination patterns which are somehow stored in their memories or physical structure. Instead, they exhibit coordination tendencies as parts come together long enough to form a functional movement pattern that can achieve a performance goal under specific environmental circumstances.
>
> *Source: Davids et al. (2008, p. 88).*

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Due to this, the learner is able to adapt to slight variations in conditions and can vary movements to accommodate this – for example, adjusting to a first serve in tennis on a windy court.

The final stage is *skilled optimisation of control*, which is where the athlete is more flexible and open to exploiting environmental information sources, thus enhancing efficiency and control. Athletes are able to exploit their own and team members' positions based on their opponent's position and manipulate task execution based on own strength and weakness for optimal, adaptable actions. This infers that energy use is at the most appropriate level while not expending excess energy. Davids and colleagues state that:

> Even at the stage of optimal skill performance, discovery learning plays an important role as people search for creative task solutions or patterns that are even more energy efficient. At all stages of learning, performers are searching for the most functional solutions for satisfying the constraints placed upon them.
>
> *Source: Davids et al. (2008, p. 93).*

Activity 1.13

Active investigation

Inquiry question: What are the approaches to motor learning and what is my stage of learning?

Engage and understand

1. Capture digital evidence of your performance in a variety of modified game and match situations. Consider 1 vs. 1, 2 vs. 2, 3 vs. 3 type situations as appropriate for your physical activity of study. Ensure digital evidence is stored in at least two locations for review, comparison and contrast later in the unit and in preparation for assessment.
2. Using the rate limiters listed in Activity 1.8 (on p. 16), identify from the captured evidence the most significant limiting factor in each section and overall for your performance.

Apply and analyse

3. Draft a graphic organiser with stages of learning as the central theme, as demonstrated on the following page. From the central theme, list Fitts and Posner on one side and Newell on the other side. From these, list the characteristics of the stages of learning in each model.

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Stages of learning

Fitts and Posner (1967)
Characteristics of stages
1.
2.
3.

Newell (1991)
Characteristics of stages
1.
2.
3.

4 Examine the primary data that you captured in step 1 and analyse your performance using the headings in the table below. Provide examples.

Has motor learning occurred?
Complete the sections below by commenting on your performance and giving examples

Improvement	Consistency	Stability	Persistence	Adaptability

Evaluate and justify

Justify: Give reasons or evidence to support an answer, response or conclusion; show or prove how an argument, statement or conclusion is right or reasonable.

5 Evaluate your level of performance according to Fitts and Posner's, and Newell's stages of learning models.

6 Justify your stage of learning using primary and secondary data.

The dynamic systems approach promotes a holistic approach to learning where dynamic interactions through activities can produce rich responses through self-organisation within a complex system. This system is non-linear in nature and embraces chaos where the learner responds to constraints to form a stable motor pattern. **Constraints** enable the emergence of movement behaviours or affordances. Constraints are the many different variables that affect the successful completion of a task

constraints
boundaries that shape a learner's self-organising movement patterns, cognitions and decision-making processes

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within an authentic game environment. For example, weather conditions will affect the speed of the green in lawn bowls. Constraints can both enable performance (e.g. tall height of player in completing a spike) and limit performance (e.g. short player attempting to dunk in basketball). Constraints can be organised into those that involve the learner, the task or the environment. To maximise skill acquisition, training activities must be designed to reflect the constraints found in game situations so that skills and tactical implementations can be improved. It is now widely accepted that training activities that reflect constraints and a dynamic systems approach will produce greater learning gains than the application of a linear cognitive approach.

Athletes therefore perceive – for example, through vision – and coordinate actions with their environment. Performance is characterised as functional under different conditions through the manipulation of movement patterns after variable repeated practice.

As learners are non-linear dynamic systems, according to modern theories and models, it is logical that practice should mirror this. Practice should therefore be non-linear in nature, where learning activities utilise constraints concerning the learner, the task or the environment to highlight specific affordances that will promote learning and overcome targeted rate limiters. Learning activities should be game-like and require the learner to solve problems about performance to learn, rather than involve repetitive use of motor programs in isolation from game situations. Such practice activities develop self-organisation of the learner and the variability and adaptability of performance required to demonstrate learning. From this knowledge, a modern framework for the pedagogy of motor learning developed, known as the constraints-led approach (CLA); it will be explored in more detail in Chapter 5.

Figure 1.8 Acquiring a skilled topspin forehand involves both the development of an effective technique and the capacity for it to be used tactically within a rally to win points.

1.8 What is skill?

As we have seen, there are essentially two competing versions of motor learning theory: the traditional cognitive systems approach and the more contemporary dynamic systems approach. Each has a set of underlying assumptions about how people acquire skills. However, even the term 'skill' can be defined differently under each approach, and this can cause further confusion.

Traditionally, 'skill' has referred to the refinement and successful application of specialised movement sequences. A skilful performance is concerned with demonstrating technical proficiency within a game situation. Therefore, under a cognitive systems approach, individuals developed 'skills' – the specific movements required for the activity and practice focused on the refinement of an ideal motor program.

In a modern dynamic systems approach, 'skill' is more focused on what produces a successful outcome for the individual given the specific situation. In this way, refining a 'perfect technique' is not as important as finding the right thing to do that will be successful. Therefore, a modern view of skill incorporates two key components:

- **technical proficiency of specialised movement sequences** – this includes developing motor programs that are consistent, accurate and, where required, demonstrate speed, but can also be adapted and modified in many ways to suit the task or the environment
- **tactical awareness** – knowing what is happening in the environment and what options are available, and selecting a motor sequence that will be successful.

Modern dynamic systems approaches tend to view skill as holistic, rather than as individual 'skills'. That is, an athlete will develop 'touch skill' as they learn the game, rather than viewing individual components of pass, dump or ruck. This is an important distinction when applying a dynamic systems approach, as modern coaching pedagogy tends to endorse the development of both technical proficiency and tactical awareness simultaneously for enhanced motor learning. This notion will be explored further in Chapter 5.

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Activity 1.14

Active investigation

Inquiry question: What motor learning outcomes do the different practice types produce?

Engage and understand

1 In small groups of two, four, six or nine, select one of the clustered types of practices from the list below:

- **a** massed practice and distributed practice
- **b** whole practice and part practice
- **c** blocked practice and random practice
- **d** constant practice and varied practice
- **e** drills and problem-solving
- **f** specificity and variability of practice.

2 Identify the characteristics of the two different types of practice selected.

3 Recall your major technical rate limiter in Activity 1.8 (on p. 16).

Apply and analyse

Consider: Think deliberately or carefully about something, typically before making a decision; take something into account when making a judgment; view attentively or scrutinise; reflect on.

4 Conduct some secondary research to design a training session targeting your major technical rate limiter using the two different types of practice you selected.

5 In groups, share and examine the designed practice session and critically review its appropriateness for developing motor learning and, if required, refine tasks.

6 Investigate the success of tasks by implementing all the groups' practice sessions. Collect evidence of performance. This may be notes on successful trials, accuracy of technique or video evidence.

Evaluate and justify

7 Evaluate the effectiveness of the practice for your performance.

8 Determine whether the practice would have an effect on the performance of your rate limiter in the authentic performance environment. Justify your argument using primary and secondary data.

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Activity 1.15

Active investigation

Inquiry question: What is the effect of motor learning theories on performance in authentic environments?

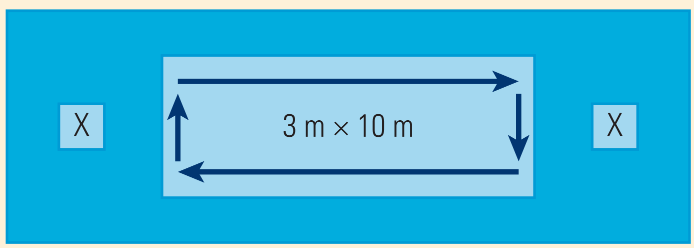
Aim: To improve motor patterns in Gaelic Football

Equipment: 15 Gaelic footballs. If not available, volleyballs/soccer balls/Australian Rules footballs/tennis balls

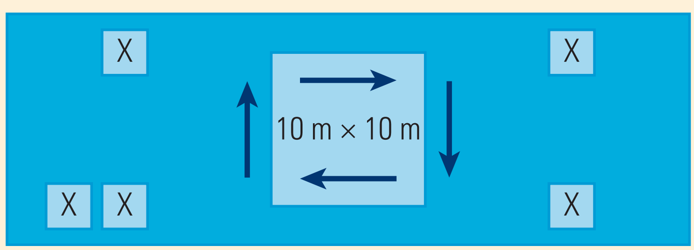
Space: Drill 1 – 3 m × 10 m, Drill 2 – 10 m × 10 m

Engage and understand

Drill 1: Complete 60 stationary passes in pairs.



Drill 2: In groups of five, complete passing around grid 30 times.



Apply and analyse

Analyse: Examine or consider something in order to explain and interpret it, for the purpose of finding meaning or relationships and identifying patterns, similarities and differences.

1 Analyse what has been learned and its ability to be transferred to a game.

Engage and understand

2 Participate in a small-sided game (5 vs. 5) of 'End Ball'.

Aim: To improve motor patterns in Gaelic Football

Equipment: 3 Gaelic footballs. If not available, volleyballs/soccer balls/Australian Rules footballs/tennis balls

Space: 3 × (20 m × 40 m)

Rules: initial rules are:

a Ball must be passed on the full.

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b If ball is knocked down by an opponent, you maintain possession.
c If your team drops the ball, the opponents receive possession.
d When you catch the ball, you must stand still but may pivot on the spot.
e Defenders cannot make contact with the player in possession and must be 1 m away.

Apply and analyse

3 Analyse what has been learned and its ability to be transferred to a game.

4 Consider your answer to task 1 and reflect on this in relation to principles of play within invasion games:

a maintain possession – catch, pass
b use of space – maintaining space through face and space movement, maintaining space as attack option or support play in plus-1 situations.
c creating space – supporting the ball carrier: width, back door, V-formation attack, team/partner plays
d defending space – use of field and time, using person-on-person or zone option
e the rules of Gaelic Football
f safety aspects of game play.

Engage and understand

5 Participate in a possession game. The aim is to make 10 passes in a row inside the 10 m × 10 m grid. The same rules as for 'End Ball' listed previously apply.

Apply and analyse

6 Analyse what has been learned and its ability to be transferred to a game.

Engage and understand

7 Participate in a small-sided game (5 vs. 5) of 'End Ball'. The same rules as previously listed apply. Additional rules added as game progresses:

a allowed to take four steps
b allowed to bounce the ball once after four steps and take another four steps
c foot pass – a kick is allowed
d ball allowed to hit the ground
e player disposed by one-handed knock out of the ball.

Apply and analyse

Examine: Investigate, inspect or scrutinise carefully; inquire or search into; consider or discuss.

8 Analyse what has been learned and its ability to be transferred to a game.
9 Examine and identify the types of practice undertaken in Drills 1 and 2.
10 Examine and identify the types of practice undertaken in task 7.

Evaluate and justify

11 Evaluate the effectiveness of the various types of practice on your performance.
12 Determine whether the practice would have an effect on the performance of your rate limiter in the authentic performance environment. Justify your argument using primary and secondary data collected.

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Activity 1.16

Engage-in

Inquiry question: How can representative practice improve motor learning?

Engage and understand

1 Read the following extract.

Although physical education is a well-established profession with a sound tradition of formal training and established pedagogical practices, there has been some criticism that practice is often not based on a theoretical model of how learners actually learn (Newell & Rovegno, 1990). The need to base pedagogical practice on a sound theoretical model of the learner and of the learning process has previously been emphasized (Renshaw et al. under review).

The aim of this paper is to show how key principles of ecological psychology and dynamical systems theory might underpin a philosophy of coaching practice based on nonlinear pedagogical principles.

Nonlinear pedagogy

In simple terms, nonlinear pedagogy is 'application of the concepts and tools of nonlinear dynamics' to coaching practice, (Chow et al., 2006, p.72). Nonlinear pedagogy is predicated on a view of the learner as a human movement system which is inherently nonlinear in character … An important task is to identify key constraints that impinge on any specialized nonlinear dynamical system in nature in order to understand emergent properties of such systems (Newell, 1986). In nature, different nonlinear dynamical systems satisfy a range of constraints as behaviour emerges from them (Davids et al., 2008). The basis of nonlinear pedagogy, therefore, involves the manipulation of key (personal, task and environmental) constraints impinging on learners leading them to satisfy these interacting constraints. In this way, constraints manipulation facilitates the emergence of functional movement patterns and decision-making behaviours in different sports and physical activities.

Source: Renshaw et al. (2009, pp. 540–602).

Summarise: Give a brief statement of a general theme or major point(s); present ideas and information in fewer words and in sequence.

2 Summarise and understand the following key points:

a What is non-linear pedagogy?

b What are constraints?

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3 Read the following extract.

The mutuality of the performer and the environment

One of the established tenets of ecological psychology is the mutuality of the individual and environment: one cannot be considered without careful reference to the other … In team sports, the environment consists of team mates and opponents, as well as playing surfaces and inanimate objects that define specific performance contexts (such as an ice rink in skating, a bicycle in the triathlon, parallel bars in gymnastics or goalposts and pitch markings in the football codes). For an individual to engage effectively with other individuals, events, surfaces and objects in the performance environment their affordances for action need to be detected. An affordance refers to a property of the environment which can be detected as information to support an action, and which is related to an individual's ability to use it (Gibson & Pick, 2000). For example, an unmarked team mate affords the option for a pass for a player with the ball in team sports, while the surface of the ice in a rink affords sliding across on the blades of a skate … Although these affordances are always available for actions by any individual athlete, the detection and learning of affordances is not an automatic process. The role of the learner is to learn to pick up the affordances that these specific environments offers them (Gibson & Pick, 2000). Some affordances will require significant periods of exploration, practice and time to enable detection for action (Gibson & Pick, 2000) … This finding implies that affordances are specific to each individual and relate to his/her action capabilities. In athletes, these capabilities may change as a result of growth and development of body sub-systems across the lifespan or by the application of principled training programmes that develop movement system variables such as strength, speed or range of flexibility.

The importance of exploratory behaviour for facilitating perceptual learning has important implications for coaches attempting to develop athletic performance. It highlights the need to accurately identify the key perceptual information sources in the performance environment (Davids et al., 2006) so that practice opportunities can enable learners to become attuned to specifying information sources available in specific performance environments (Beek, Jacobs, Daffertshoffer, & Huys, 2003).

In sports, performers may initially use non-specifying information when they are not attuned to specifying information sources. For example, skilled cricket batters determine differences between a wristspin bowler's standard legspinner (clockwise spin) from the googly (anti-clockwise spin) by picking up specifying information from the hand position at ball release. Less skilled batters learn that the trajectory of a ball aimed outside off-stump will be a googly while a ball aimed at leg stump will be a legspinner (Philpott, 1995). Although this information may have some saliency it is based on non-specifying (less useful) information and the learner will often make incorrect decisions. With experience batters become attuned to the bowler's action and he/she learns to differentiate between the two ball types by using the specifying information that is available from observing the bowler's action (Renshaw & Fairweather, 2000) …

To help athletes pick up specifying information, it is important for coaches to understand whether practice sessions are representative of the performance environment … For coaches experimental settings equate to practice environments, implying that they need to accurately sample the environmental conditions of practice to ensure congruence with the performance environment in which the movements will be implemented (Davids et al., 2007). Designing representative practice tasks requires the coach to have an understanding of the interaction between key individual, task and environmental constraints of specific sports performances.

Source: Renshaw et al. (2009, pp. 540–602).

(continued)

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4 Summarise and understand the following key points:
   a What is the importance of linking the performer and the environment?
   b What is an affordance?
   c To whom are affordances specific?
   d What are representative practice tasks?

Apply and analyse

Implement: Put something into effect – for example, a plan or proposal.

5 Provide one example from the text and one from your experience in the current physical activity of the link between the performer and the environment.

6 Review physical activities completed during this unit in Engage-in and Active investigation inquiries. Categorise whether or not they are representative tasks. Explain why.

Task	Representative	Non-representative	Explanation
Active investigation Task 1 Task 1 and 2: Drills		Non-representative practice	No defender in task. Always know where the ball is coming from and selection of skills; know where to pass it to. No external pressure/ defender.
Active investigation Activity 1.15: Task 2 Task 4: End Ball	Representative		Similar to the game. Where, when, who and how to pass the ball are involved.

7 Review four separate physical activities completed in class time and categorise them as representative tasks or not. Explain why.

Evaluate and justify

8 Evaluate how representative practice may be beneficial to the athlete in authentic game environments.

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Activity 1.17

Engage-in

Inquiry question: How can perception and action coupling improve motor learning?

Engage and understand

1 Read the following extract.

Perception and action are coupled

In ecological psychology the theory of direct perception signifies the tight coupling of perception and action systems in individuals (Savelsbergh, Davids, Van Der Kamp & Bennett, 2003). In essence, information drives movements, but movements also influence what information can be picked up by performers/learners. This principle has meaningful implications for the design of coaching practice. Athletes need to be provided with opportunities to learn to perceive the key specifying information sources to enable the emergence of functional movement solutions. This point can be illustrated by observing what happens under practice conditions that do not include specifying information sources. In a study of cricket batting, we demonstrated that batting against bowling machines compared to real bowlers led to a re-organisation of the timing and co-ordination of a forward defensive shot (Renshaw, Oldham, Davids, & Golds, 2007). The former task constraints did not facilitate opportunities for batters to pick up specifying information from the bowler's actions – a key component of expert batting performance (Müller, Abernethy, & Farrow, 2006). These findings support the principle of perception-action coupling and suggest that coaches should design practice tasks that keep specifying information sources and actions together … In this regard it is important for coaches to use a strategy of 'task simplification' rather than 'task decomposition' when designing practice sessions (Davids et al., 2007). Task simplification signifies that information-movement couplings utilised during performance are preserved by requiring learners to practice in simulated performance conditions. In task simplification key performance variables such as velocity of balls and opponents, number of players in the game and size of playing areas are maintained and managed to simplify the task … This approach contrasts with the traditional strategy of breaking up actions into arbitrary units by reducing skills to practice in static drill activities that are not relevant to game situations. In summary, the key point of task simplification is that it enables learners to practice in a managed environment with all key information sources present.

Source: Renshaw et al (2009, pp. 540–602).

2 Summarise and understand the following key points:

a What is perception and action coupling?

b What is task simplification and task decomposition?

c How does this approach differ from traditional approaches?

(continued)

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Apply and analyse

3 Recall a perception and action coupling demonstrated in the text and identify one within your selected physical activity.

4 Identify and explain a task in your physical activity where a traditional approach of task decomposition occurs for a technical skill.

5 Design, implement and explain a task in your physical activity where a task simplification occurs for a technical skill.

Evaluate and justify

Appraise: Evaluate the worth, significance or status of something; judge or consider a text or piece of work.

6 Appraise the effectiveness of the tasks you chose in tasks 4 and 5 for developing motor learning in an authentic environment.

Activity 1.18

Active investigation

Inquiry question: How may creativity of performance be developed in authentic environments?

1 Read the following extract.

Encouraging creativity in learning and performance

Extensive practice is essential to realise performance potential in any domain (Ericcson, Krampe & Tesch-Römer, 1993). Ericsson et al. (1993) built their 'expert-performance approach' on the concept of deliberate practice, defined as engagement in relevant activities that require great effort, lots of repetition and opportunities to acquire feedback and is not inherently enjoyable (Ericsson, 2003; Ward, Hodges, Williams, & Starkes, 2004). Even in later work, Ericsson (2007) described practice as deliberate 'when individuals engage in a practice activity (usually designed by their teachers), with full concentration on improving some aspect of performance' (p. 14). This view of practice proposed by Ericsson might be interpreted as emphasizing the need for early specialisation and the need to practise using highly repetitive drills – the concept of perfect practice. However, given the importance of developing performers with adaptive variability, it could be argued (as Ericsson did in later work (Ericsson, 2003)) that this type of practice is far from perfect and can lead to performance that lacks flexibility to adapt in the ways demonstrated by highly skilled individuals.

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In contrast to deliberate practice, nonlinear pedagogy advocates the need for practice that adopts the principle of 'repetition without repetition' (Bernstein, 1967). In this approach, coaches design representative practice tasks that allow individuals time and space to explore and discover co-ordination patterns and make decisions that are most appropriate for their unique constraints (Davids et al., 2008). In contrast to the deliberate practice framework, coaching based on a nonlinear pedagogy would not reject unstructured learning environments and would promote informal learning opportunities, including having children design their own games and activities (Chappell, 2004; Kidman, 2001, 2005).

In summary, providing opportunities to learn by playing modified tasks or games that are inherently enjoyable and intrinsically motivating for the performer will have the dual effect of helping to create 'love' for the sport while at the same time developing the integrated physical, technical, tactical and psychological skills needed for competitive success (Bloom, 1985; Chappell, 2004; Côté et al., 2007; Ericsson, 2007; Jannelle & Hillman, 2003).

Source: Renshaw et al. (2009, pp. 540–602).

2 Draft a table that summarises the key points of the following and provide a specific example of each:

- **a** the characteristics of deliberate practice
- **b** issues that may arise from using deliberate practice
- **c** alternative approaches to deliberate practice
- **d** the benefits of a non-linear approach using small-sided or modified games with variability.

Identify: Distinguish; locate, recognise and name; establish or indicate who or what someone or something is; provide an answer from a number of possibilities; recognise and state a distinguishing factor or feature.

3 Identify and recall your involvement in an activity using deliberate practice.

4 Consider the effectiveness of the task in the following table.

Task description:

Rate the task according to the table headings using the rankings: 5 – very good, 4 – good, 3 – average, 2 – poor, 1 – very poor.

Enjoyable	**Intrinsically motivating**	**Develop technical abilities in authentic environment**	**Develop tactical abilities in authentic environment**	**Develop psychological abilities in authentic environment**

(continued)

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Explain ranking				

a Design and implement a small-sided or modified game using non-linear pedagogy.

b At the conclusion of your small-sided or modified game, consider the effectiveness of the task in the above table.

Evaluate and justify

Synthesise: Combine different parts or elements (e.g. information, ideas, components) into a whole, in order to create new understanding.

5 Evaluate the success of the small-sided or modified game in developing creativity of performance in an authentic environment.

Activity 1.19

Engage-in

Inquiry question: Why is variability of practice important in motor learning?

Engage and understand

1 Read the following extract.

> **Coaching is a balance between maintaining stability versus creating instabilities**
> Coaching is a balance between protecting the confidence of athletes by providing environments that enable them to be successful and risking the loss of existing confidence levels by exposing them to more demanding practice tasks.

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Variability is an essential component of performance development.
Variability within individual movement patterns has traditionally been viewed negatively, since a common goal for many coaches is the acquisition of an 'ideal' technique as a template for performance success. In fact, much traditional practice is based around the need for performers to have acquired a 'correct' technique before being exposed to the real game. However, there is now a large body of research that demonstrates that individual learners can achieve similar task outcomes by using different co-ordination patterns and that experts often display more variability within their movement patterns than less skilled individuals (Bootsma, Houbiers, Whiting, & van Wieringham, 1991; Brisson & Alain, 1996; Davids et al., 2006; Davids, Button et al, 2007; Renshaw & Davids, 2004; Schöllhorn & Bauer, 1998) ...

Despite this many coaches require athletes to practice in sterile conditions and undertake decomposed practice tasks such as run-throughs in order to provide what they believe is the best chance for their athletes to standardise their run-up. However, it is now well established that Olympic standard long jumpers are not capable of placing their feet in the same place for every run-up and actually adjust their step patterns as they approach the take-off board (Hay, 1988; Montagne, Cornus, Glize, Quaine, & Laurent, 2000). During a competition the jumper may need to make adjustments for changes in individual constraints such as fatigue and psychological stress as well as changes in environmental conditions such as run-up surfaces and changes in wind speed or direction. The implication is that while maintaining the essential specifying information for actions, rather than reduce variability, the coach might seek to increase variability in practice conditions so that the athlete develops adaptability and flexibility to cope with changing task constraints (Davids et al., 2007).

Source: Renshaw et al. (2009, pp. 540–602).

Apply and analyse

2 Identify the key components of the article by completing the table below in relation to a perceived positive or negative influence on player confidence and the outcome during an authentic performance environment.

	Positive	Negative
Stability rather than instability in practice		
Variability of practice in a traditional approach		
Variability of practice in a modern approach		
Variability in authentic performance environment		

Evaluate and justify

3 Evaluate whether variability of practice is important in motor learning.

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Activity 1.20

Active investigation

Inquiry question: How may the two motor learning approaches impact on performance in authentic environments?

1 Perform in and collect digital evidence of your performance in an authentic performance environment.
2 Use the rate limiter hexagon from Activity 1.8 (on p. 16) to identify the major technical and tactical limiter to your performance.
3 Evaluate your level of performance using both Fitts and Posner's, and Newell's stages of learning models.
4 Justify your level in 250 words using primary and secondary data.

Part A

5 Devise two training sessions using the cognitive systems approach. Ensure that these are appropriate for your stage of learning while using the traditional method.
6 Implement the training sessions over two lessons. Collect data from the sessions.
7 Participate back in an authentic environment and collect digital evidence.
8 Identify pre- and post-test data and explain briefly in a table using the following headings: type of practice used; appropriateness to stage of learning; outcomes achieved technically in practice; outcomes achieved tactically in practice; transferability of technical and tactical aspects into the authentic environment.
9 Compare and contrast pre- and post-test data to evaluate the effectiveness of the training strategy.

Part B

10 Devise two training sessions using the dynamic systems approach. Ensure that these are appropriate for your stage of learning while using the constraints-led approach.
11 Implement the training sessions over two lessons. Collect data from the sessions.
12 Participate back in an authentic environment and collect digital evidence.
13 Identify pre- and post-test data and explain briefly in a table using the following headings: type of practice used; appropriateness to stage of learning; outcomes achieved technically in practice; outcomes achieved tactically in practice; transferability of technical and tactical aspects into the authentic environment.
14 Compare and contrast pre- and post-test data to evaluate the effectiveness of the training strategy.

The use and understanding of the non-linear constraints-led approach with dynamic systems theory and ecological psychology supporting the pedagogical approach may see more learner-centred development in the future. As students, teachers and coaches reflect upon and recognise that decision-making behaviours emerge from interactions between the task/goal and the player and the environment,

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the resulting learning/coaching scenarios may be better suited to developing individuals and teams. This may lead to less massed drill practice and more open-ended student-centred approaches.

Renshaw and Moy's 2017 article 'A Constraint-Led Approach to Coaching & Teaching Games: Can Going Back to the Future Solve the "They Need the Basics Before They Can Play a Game" Argument?' mentions several factors, including those in the following extract:

Low uptake by teachers and high use of teacher prescribed drills
Traditional teacher-centred methods of teaching and coaching assume a gradual, linear process of learning, with teaching methods often characterized by blocked practice drills with augmented teacher instruction and feedback designed to help students develop sound technique or idealized motor patterns. Curtner-Smith et al. (2001) presented compelling evidence that PE teachers spend most of their time (up to 78%) engaging in such teaching strategies. Somewhat ironically, such strategies can limit the amount of time that learners are actually engaged in physical practice.

However, the value of drills in enabling the emergence of functional techniques is questionable. For example, how does dribbling around cones, where the focus of attention is at the feet, enable a young player to travel with the ball in the game where there is a need to scan the environment to guide actions that take into account moving defenders? How can receiving a pass with no pressure from an opponent develop the ability to control the ball close to the body or perhaps more importantly away from the pressure of an oncoming defender?

A key limitation of traditional pedagogical styles then is that they tend to prevent individual learners from exploring and discovering their own functional movement solutions to a games problem, a more appropriate characterisation of learning in play (Davids et al., 2013).

The decomposition of tasks in traditional games teaching also brings into question the 'transferability' of movement patterns developed in drills to games. A number of studies across a range of games and sports have shown that these unrepresentative practice tasks do not facilitate the emergence of movement patterns that exhibit fidelity with those seen in performance environments (e.g. Pinder et al., 2012; Dicks, Button & Davids, 2010).'

Source: Renshaw and Moy (2017).

It is clear that decision-making processes need to be implemented at the start of learning so that relearning is not required. These concepts will be revisited in Chapter 5 in relation to developing tactical awareness.

Figure 1.9 Coach instructing adaptive basketball players

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Activity 1.21

Active investigation

Inquiry question: How do you perform in authentic environments?

Engage and understand

1. Capture digital evidence in the performance domain.
2. Complete in 1 vs. 1, 2 vs. 2, 3 vs. 3, 5 vs. 5 and/or 10 vs. 10 game scenarios, focusing on both technical and tactical components.
3. Participate in a full field/court game.
4. Ensure digital evidence is stored in at least two locations for review, comparison and contrast later on in the unit and in preparation for assessment.

Apply and analyse

5. Examine and identify key limiters and strengths in relation to your performance.
6. Analyse and explain your stage of learning.

Evaluate and justify

7. Evaluate and synthesise primary and secondary data about the influence of motor learning concepts and principles on personal performance of specialised movement sequences and movement strategies in authentic performance environments.
8. Hypothesise how you would manipulate a training program in the future to ensure optimisation of your own performance in an authentic performance environment.

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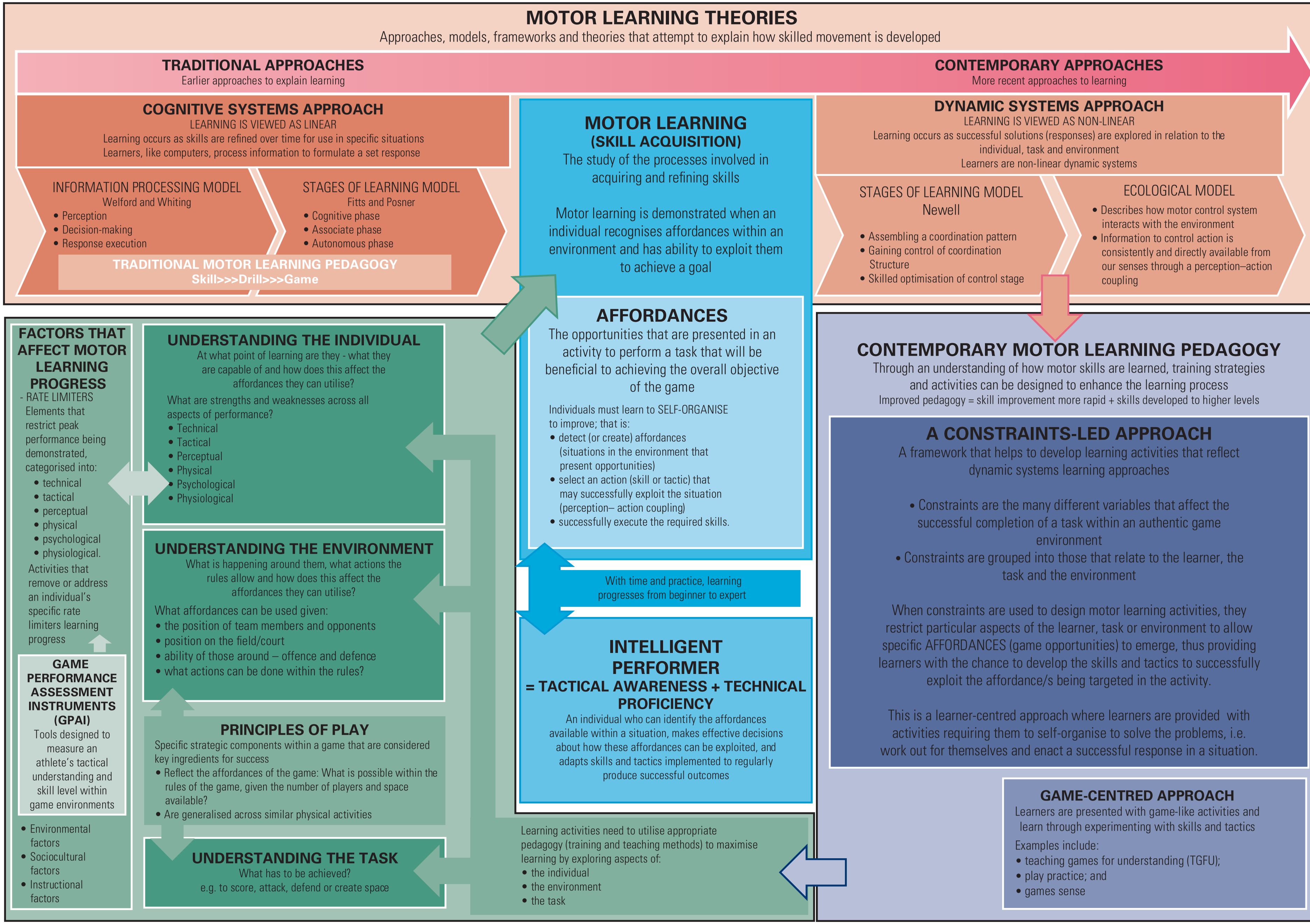

Figure 1.10 Motor learning theories

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Chapter summary

In this chapter, students have explored how an understanding of motor learning concepts and principles can assist to optimise individual or team performance. The students engaged in and explored body and movement concepts, and demonstrated specialised movement sequences and movement strategies.

Areas covered

- What is motor learning?
- When has learning occurred?
- Types of skills:
  - fine and gross
  - open and closed
  - discrete, serial and continuous.
- Types of practice:
  - massed and distributed
  - whole and part
  - blocked and random
  - constant and varied
  - drills and problem-solving.
- Factors affecting motor learning:
  - technical
  - tactical
  - perceptual
  - psychological
  - physical
  - physiological.
- Rate limiters
- Feedback:
  - internal and external
  - feedback loop.
- Cognitive system approach to motor learning:
  - Fitts and Posner's stages of learning
  - characteristics: drills–skill–game
  - limitations.
- Dynamic system approach to motor learning:
  - Newell's stages of learning
  - characteristic constraints – task, learning, environment
  - constraints-led approach.
- What is a skill?
- Skill vs. skilled vs. skilled performer

The motor learning information was implemented to evaluate individual and team performance and to explore ways of developing body movement concepts and specialised movement sequences and movement strategies.

Chapter review

Multiple-choice questions

1 Motor learning is:

A a term used in car racing.
B a process of acquiring and refining skills.
C completely separate from motor skill, motor skill acquisition, motor control and motor development.
D a process to provide feedback.

2 Playing a grand piano is considered to be completion of:

A a gross motor skill due to the size of the piano.
B an open motor skill due to the environment in which it is played.
C a continuous and closed skill due to limited external influences.
D a fine motor skill due to the movement of the fingers.

3 Massed practice is:

A implemented to ensure task representation occurs.
B repetitive in nature.
C a Catholic ritual.
D identical to part practice.

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4 Feedback can only be given:
   A by an expert coach.
   B after video analysis has occurred.
   C by reviewing the subroutines involved in each task.
   D by none of the above.
5 The cognitive systems approach involves:
   A input of information to the brain, processing of information followed by execution of movement.
   B close alignment with Fitts and Posner's stages of learning.
   C a more traditional approach.
   D all of the above.
6 The dynamic systems approach involves:
   A only skills completed in an open environment.
   B alignment with Fitts and Posner's stages of learning model.
   C a modern approach aligned with Newell's stages of learning model.
   D the construction of tasks only for elite performers.
7 The stages in Newell's stages of learning model are:
   A stage 1 – assembling a coordinated pattern; stage 2 – gaining control of a coordinated structure; and stage 3 – skilled optimisation of control.
   B stage 1 – gaining control of a coordinated structure; stage 2 – assembling a coordinated pattern; and stage 3 – skilled optimisation of control.
   C stage 1 – cognitive; stage 2 – associative; and stage 3 – autonomous.
   D stage 1 – autonomous; stage 2 – cognitive; and stage 3 – associative.
8 Non-linear pedagogy is:
   A antiquated and out of date.
   B only applicable to invasion games where a change of direction is necessary.
   C able to challenge learners to develop flexible, adaptable solutions to problems.
   D useful only when needing to manipulate psychological constraints.
9 When developing small-sided games so that the learner can develop affordance, the focus on manipulating constraints should:
   A involve deconstruction of tasks.
   B involve massed practice to ensure skills are learned first.
   C be teacher/coach-centred.
   D be representative of the authentic environment.
10 The use of deliberate practice to develop performance in an authentic environment is:
   A supported by research carried out by Ericsson in 2007.
   B not integral to non-linear pedagogy approaches.
   C only appropriate when the learner can take time to think about what should occur.
   D effective when a session is planned in advance and equipment has been sourced.

Short-answer questions

1 List the three stages of Fitts and Posner's, and Newell's learning models.
2 Give three examples of different categories of rate limiters and explain how they may affect performance.
3 How might improvement, consistency, stability, persistence and adaptability be used to ascertain if learning has occurred?
4 Identify and explain three different types of practice used in the traditional approach to motor learning.
5 Evaluate how the use of small-sided or modified games may be beneficial to motor learning.

Extended-response questions

1 Make a decision regarding your stage of learning using Newell's learning model and justify your reasoning.
2 Decide and justify whether the use of traditional or non-linear pedagogy would influence your motor learning and performance in an authentic environment.

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Chapter 2
Functional anatomy and biomechanics in physical activity

Chapter description

In Unit 1, the first stage of inquiry requires students to recognise and explain concepts and principles of functional anatomy and biomechanics through purposeful and authentic learning about and in a selected physical activity. In the selected physical activity, students explore body and movement concepts and demonstrate specialised movement sequences and movement strategies.

In the second stage, students apply concepts to specialised movement sequences and movement strategies in authentic performance environments to gather data about their personal application of biomechanical and body and movement concepts. They analyse and synthesise relationships between the biomechanical requirements of the selected physical activity and their personal performance. Students then devise a biomechanical strategy to optimise performance in the selected physical activity.

In the final stage, students evaluate the effectiveness of the biomechanical and movement strategies and justify using primary data and secondary data.

(Physical Education 2019 v1.1 General Senior Syllabus © Queensland Curriculum & Assessment Authority)

Key inquiry questions

- How can a knowledge of the functional anatomy of the skeletal and muscular systems assist in the analysis of specialised movement sequences?
- What are the anatomical and biomechanical requirements of specialised movement sequences required by various physical activities?
- How can biomechanical analysis contribute to developing strategies to optimise performance in physical activity?
- How can biomechanical data contribute to personal decisions to maintain or modify specialised movement sequences?

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Key terminology

abduction
acceleration
adduction
agonist
anatomical position
angular motion
antagonist
appendicular skeleton
axial skeleton
balance
Bernoulli's principle
centre of gravity
circumduction
contact force
displacement
dorsiflexion
dynamic balance
eversion
extension
flexion
force
force summation
hyperextension
impulse
inertia
inversion
levers
Magnus force
moment of inertia
momentum
motion
motor unit
Newton's laws of motion
planes of motion
plantar flexion
projectile motion
pronation
properties of force
qualitative analysis
quantitative analysis
rectilinear motion
rotation
skeletal muscles
speed
static balance
summation of forces
supination
synovial joints
velocity

Introduction

Being physically educated means being concerned with developing knowledge in the biophysical, sociocultural and psychological domains that underpins physical activity and utilising this knowledge to maximise enjoyment, engagement and physical performance for yourself and others.

This chapter explores functional anatomy and biomechanics as key elements within the biophysical sub-discipline of physical activity. Through an understanding of functional anatomy and biomechanics, the physically educated can use a common anatomical language to describe specialised movement sequences in various physical activities. They can use biomechanical analysis to determine the efficiency of movement sequences and, from such analysis, make justified recommendations to optimise skilled performance.

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Inquiry cycle – stage 1: Engage and understand

2.1 Functional anatomy, biomechanics and optimising performance

The human body can produce a wide range of complex movements, using hundreds of synchronised muscular movements simultaneously. Functional anatomy relates (in this chapter) to the study of the functions of muscles and bones. This anatomical understanding allows athletes, coaches and sports scientists to use a common language to describe human movements and the muscles involved in producing specialised movement sequences. In an effort to optimise the efficiency of specialised movement sequences in various sports, scientists and coaches began to apply the laws of physics to the analysis of human movements. This study is known as biomechanics: *bio*, meaning living organisms, and *mechanics*, the study of the action of forces in producing movement. This application of mechanics to human movement has resulted in enhanced performances, not only through improvements in skills and techniques, but also through advances in sporting equipment materials and designs.

For example, biomechanical research has provided tennis coaches with data indicating that the most efficient tennis serve has a ball toss at 150 per cent of the player's height and a racquet angle to the court of 92 degrees at impact. The coach and player can use this data to perfect serving technique. Tennis equipment has been influenced greatly by biomechanical research in recent times. Racquets, for instance, have a larger 'sweet spot' and vibration on impact has been reduced by a broader, stronger frame. Biomechanical research has also significantly improved performances through the development of training techniques and skill modifications that reduce the likelihood of injury. Running styles, for example, can be modified through biomechanical analysis in order to prevent over-use injuries.

The use of biomechanical principles is not confined to sports laboratories and sports scientists. Coaches and athletes who understand the mechanical bases of a physical skill, and can analyse movement in terms of mechanical principles, will be better able to help performers to learn skills in a way that produces the optimum result while minimising the risk of injury. This chapter outlines the biomechanical bases of physical activity that can be applied to understanding and analysing the application of force during performances in any physical activity.

Human movement and muscular force

In order for an object to change its motion or shape, it must be acted upon by a **force**. A force can simply be described as a push or pull. When a force is applied to an object, it may cause the object to increase in velocity, decrease in velocity, start spinning, change direction, change shape or a combination of these.

force a push or pull in a given direction

The forces that produce motion in physical activities can be described as being either internal

Figure 2.1 A tennis ball changes in shape, begins to spin and moves forward as a result of the force applied by the racquet.

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forces or external forces. Internal forces are produced within the body by muscles. External forces are forces such as gravity, friction, wind and forces exerted by other persons, which may all have an effect on motion. External forces can be classified further into **contact forces** (resulting from contact with other objects, fluids or surfaces) and **non-contact forces** (resulting from gravity). The resultant motion produced in physical activities is caused by the interplay of external and internal forces. For instance, a javelin accelerates up to the point of release due to the internal forces generated by the thrower's muscles. After release, external forces act on the javelin. It slows slightly due to friction with the air, begins to fall due to gravity and stops upon striking the ground.

contact force a force applied through direct contact with objects, fluids or surfaces

non-contact force a force that acts on an object without physical contact such as the force of gravity

Human movement occurs through the internal force generated by the action of muscles pulling on tendons attached to the skeleton.

The skeletal framework

The human body has 206 bones, of which 124 are devoted to the production of movement (Figure 2.2). These bones are collectively referred to as the appendicular skeleton, as opposed to the bones of the axial skeleton, which serve mainly to protect vital organs in the human body and to provide a structure to which the appendicular skeleton can attach and move around. Certain bones in the axial skeleton, such as the ribs and vertebrae, are important areas for muscle attachment and, in conjunction with the bones of the appendicular skeleton, are essential to the production of human movement.

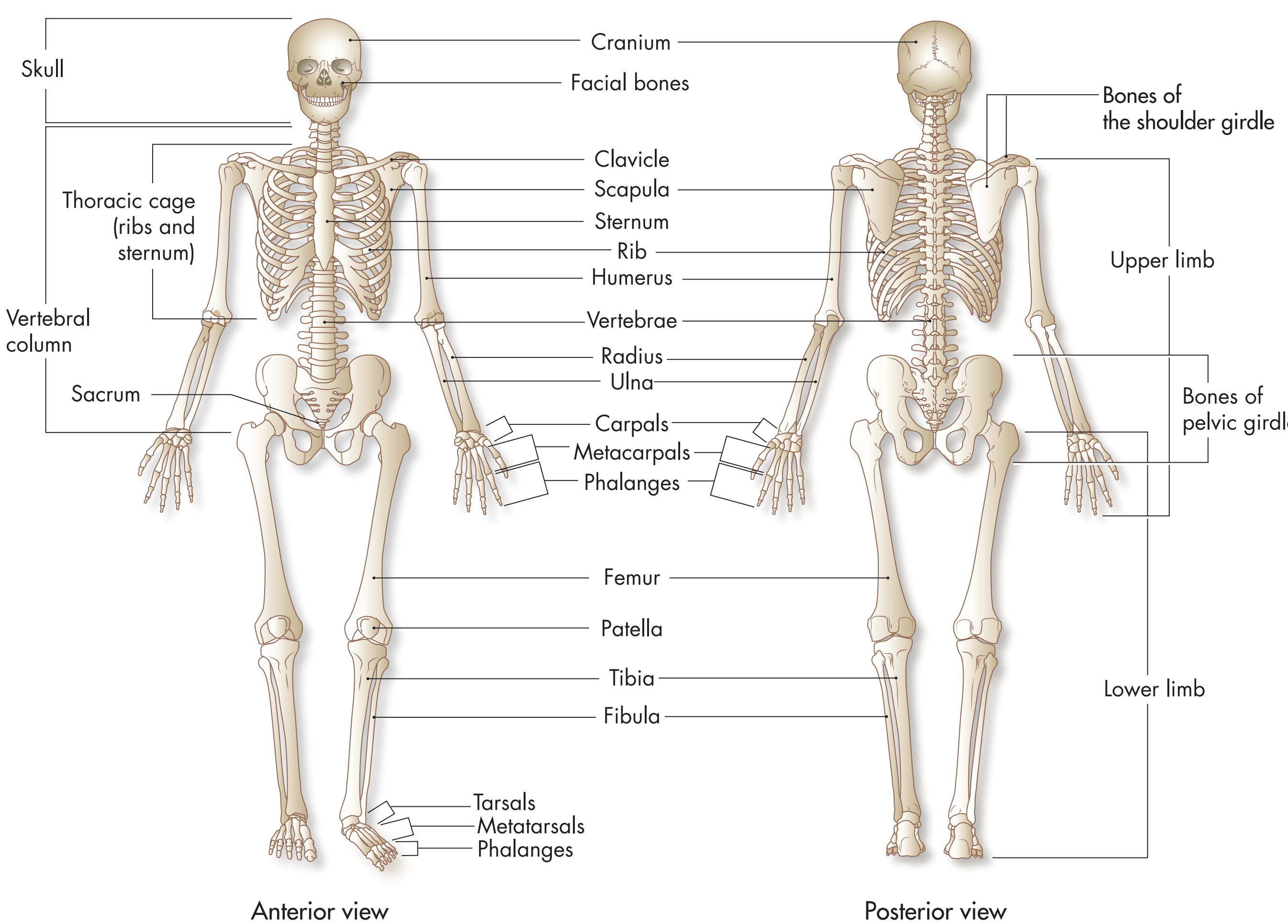

Figure 2.2 Major bones of the human skeleton

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Activity 2.1

Check-in

1 Consider the shape of the bones of the shoulder and pelvic girdles. What functions of these structures are related to their shape?

2 Knowledge of anatomical terminology and the names of bones, muscles and joints allows athletes, coaches and sports scientists to use a common language in describing human movements. Therefore, it is important to be able to name, locate and correctly spell the bones in the human skeleton. Numerous apps, online quizzes and interactive tools can be used to help us learn and recall the names and locations of bones. Locate and use one or more of these resources to help your recall of skeletal anatomy.

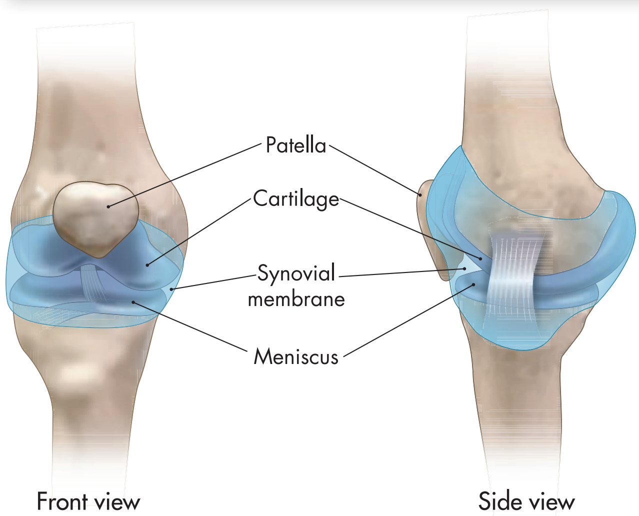

Figure 2.3 Structure of a synovial joint

Allowing for movement

All movements of the skeleton occur where two or more bones intersect. There are several different types of joints in the human body, including fibrous joints, cartilaginous joints and synovial joints. Synovial joints, or freely moveable joints, are responsible for allowing movement of the skeleton. These joints are anatomically designed to drastically reduce the amount of friction between bones when they move. Figure 2.3 illustrates the typical structure of a synovial joint. First, the ends of articulating bones are covered by smooth cartilage that prevents them from rubbing together. Similarly, menisci are small pieces of cartilage that sit between the bones to act to cushion the joint. Finally, the area between the bones is enclosed with synovial fluid. This fluid functions to further cushion the end of the bones and acts as a lubricant when movement occurs.

There are six categories of synovial joints:

- **Ball-and-socket joints.** These joints produce the greatest range of movement (ROM). As the name suggests, the end of one of the bones that make up the joint is shaped like a ball and this sits inside the cup or 'socket'-shaped end of the other bone. Examples of ball-and-socket joints are the hip joint and the shoulder joint. It is essential that these two joints provide a large ROM, as they are the sites where the axial and appendicular skeletons meet.
- **Hinge joints:** The hinge joints typically only allow a back-and-forth movement, similar to the opening and closing of a door. An example of this is the knee joint. Acting like a hinge, the knee can only allow the leg to bend and straighten back to its original position. Any movements outside this range can lead to damage to the connective tissues supporting the joint. Other examples of hinge joints include the elbow joint, the ankle joint and the joints between the phalanges in the fingers.
- **Pivot joints.** These are joints that allow a **rotation** movement around a central point. The best example of this involves the top two vertebrae of the spine – the atlas and axis. When shaking the head, the atlas, which is the uppermost vertebra, spins or rotates around a fixed point on the axis, the second vertebra. Another example of a pivot joint is the radio-ulnar joint near the elbow that produces pronation and supination of the forearm.
- **Gliding joints.** Gliding joints occur when the joint between bones is a flat or nearly flat surface. This flat surface allows for bones to slide past each

rotation the turning of a limb or the spine along its axis

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other. Unlike other synovial joints, movement at gliding joints does not greatly change the angle between the two bones, but alters their position relative to each other. One common example of the gliding joint is the carpal bones in the wrist. When waving the hand from side to side, the small, irregularly shaped carpal bones glide past each other to allow for the movement. Other locations where gliding joints can be found include between the scapula and clavicle, and between the sternum and clavicle.

- **Saddle joints.** These involve one bone fitting over the end of another that is shaped like a saddle. This type of joint allows side-to-side and back-and-forth movements. The joint between the thumb metacarpal and the trapezium (one of the carpal bones in the wrist) is a saddle joint.
- **Ellipsoidal joints.** This joint is formed between one bone with an oval-shaped end that fits into an elliptical (oval-shaped) bowl on the end of another bone. Like a saddle joint, this type of joint allows side-to-side and back-and-forth movements. The wrist joint is an example of an ellipsoidal joint.

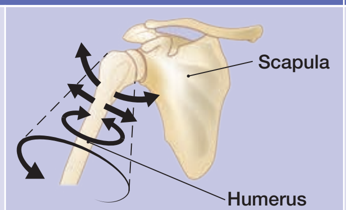
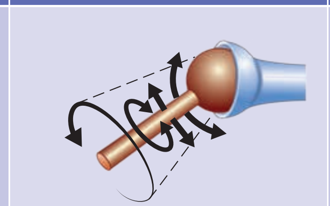
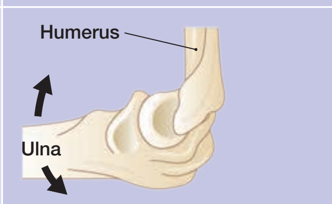
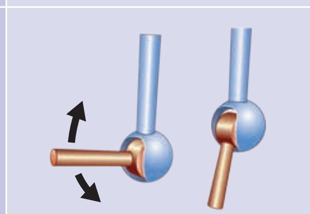
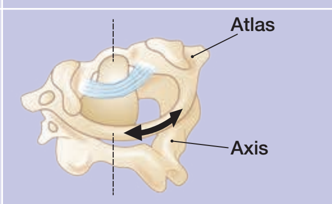
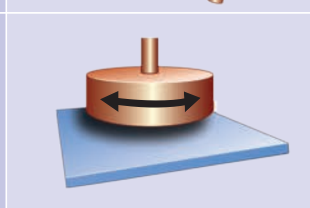
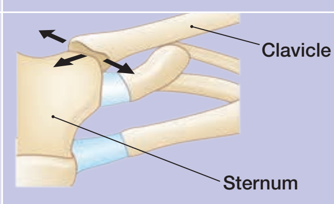
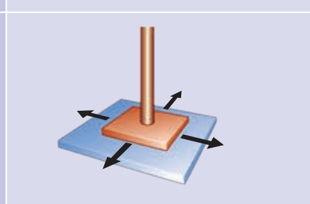
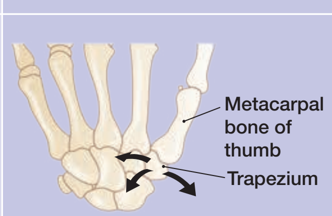
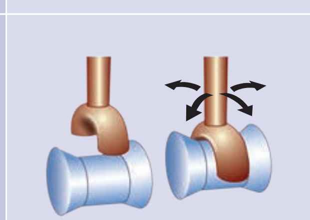
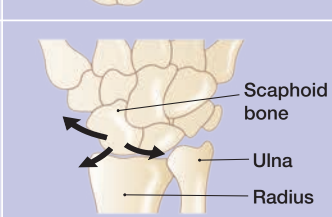
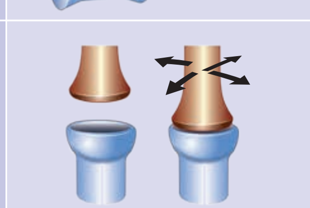
Types of synovial joints		Models of joint movements	Examples
Ball-and-socket joint			• Shoulder joints • Hip joints
Hinge joint			• Elbow joints • Knee joints • Ankle joints • Interphalangeal joints (between the bones of the fingers and toes)
Pivot joint			• Atlas/axis • Radio-ulnar joints
Gliding joint			Joints between: • Clavicle and sternum • Clavicle and scapular • Carpal bones • Vertebrae and ribs
Saddle joint			• Joint at the base of the thumb
Ellipsoidal joint			• Wrist joint • Joints between the fingers and the hand • Joints between the toes and the foot

Table 2.1 Classification of synovial joints

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Activity 2.2

Check-in

1 The hip and shoulder joints have a large range of movement.
   a What type of joints are these?
   b What is similar about the location of these two joints and the bones they connect?
   c What structural difference allows the shoulder to move more freely than the hip?
2 The knee and elbow are hinge joints. Make a list of the movement sequences associated with the physical activity that is the focus of your study this term, which involve movements at these two joints.

KEY MESSAGE: The skeleton provides a framework that allows the body to move and provides attachments for tendons and muscles.

KEY MESSAGE: Synovial joints are freely moveable and allow a range of movement to occur.

KEY MESSAGE: Synovial joints are classified into six different categories based on the shape and structure of the joint.

Planes of motion

All movements produced by the body occur in one or more of the three planes of motion. As seen in Figure 2.4, the frontal plane, the sagittal plane and the transverse plane are imaginary flat surfaces that divide the body equally in two.

The *frontal plane* (also known as the coronal plane) divides the body into front (anterior) and back (posterior) halves. Movements that involve moving

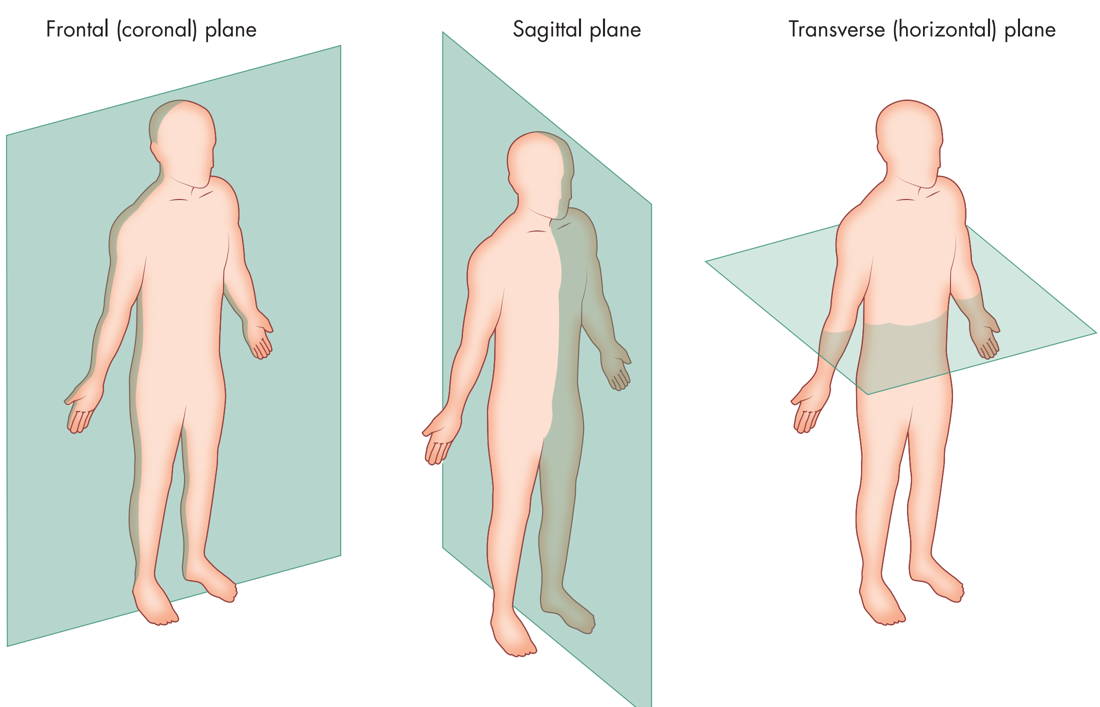

Figure 2.4 The three planes of motion

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parts of the body side to side occur in the frontal plane. A clear example of this would be the star jump, as both the arms and legs are moving in the frontal plane away from and back towards the body.

The *sagittal plane* (also known as the median plane) divides the body into left and right halves. Movements in this plane involve forwards and backwards motion. Running is a good example of movement in the sagittal plane, as both arms and legs are experiencing forwards and backwards motion.

Finally, the *transverse plane* (also known as the axial plane) divides the body into superior (top) and inferior (bottom) halves. Rotational or twisting movements of the body occur in this plane. Passing a rugby ball across the body is an example of such movement.

Describing movement

When describing the components of the human body and the vast range of movements it can produce, *anatomical position* is always used as a reference point. The body is said to be in anatomical position when:

- it is upright and facing forward
- the arms are held by the side
- the hands are open with palms facing forward.

The movements that are produced by muscles occur at the joints. Each movement that can be produced at a joint has been given a name to describe the movement. Using this naming system allows athletes, sports scientists, coaches and physical education students to refer to particular movements in a consistent way that can be universally understood.

Flexion and extension

Flexion and extension are joint movements that occur in the sagittal (front and back) plane. **Flexion** occurs when the angle of the joint decreases, whereas **extension** occurs when the angle joint increases. In some cases, the joint can extend beyond anatomical position; this is called **hyperextension**. An example of flexion and extension can be seen when spiking a volleyball. During the preparation phase (Figure 2.6), the bicep muscle contracts and bends the arm at the elbow, causing

flexion occurs when the angle of the joint decreases

extension occurs when the angle of the joint increases

hyperextension occurs when the joint extends beyond anatomical position

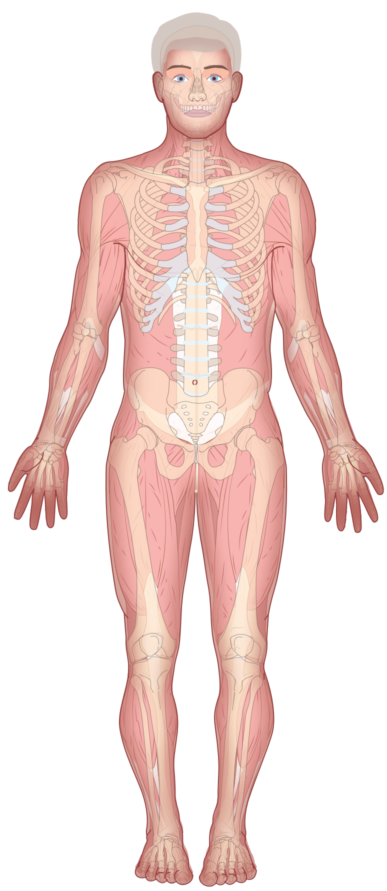

Figure 2.5 The body in anatomical position

Figure 2.6 Elbow flexion in preparation to spike

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Figure 2.7 Elbow extension during spike execution

a decrease in the angle (flexion). During the action phase of the spike (Figure 2.7), the triceps brachii muscle straightens the arm and increases the angle (extension).

Other examples of flexion and extension in the sagittal plane include the extension of the knee joint when jumping, the extension of the shoulder joint when raising the bow hand in archery and the flexion of the hip joint when kicking a ball.

Plantar flexion and dorsiflexion

Flexion and extension of the foot at the ankle joint is known as **plantar flexion** and **dorsiflexion**. A soccer player uses plantar flexion when pointing the toes before kicking the ball. Dorsiflexion is an important movement when running, as it prepares the foot to generate maximum force when striking the ground. When using starting blocks, sprinters begin with their ankle dorsiflexed so they can push off with great force.

Abduction and adduction

Abduction and **adduction** are the terms used to describe the movements that occur in the frontal (side to side) plane in reference to the midline of the body. Abduction occurs when movement occurs away from the midline of the body, whereas adduction occurs when movement is returning towards the midline of the body. When a gymnast performs the crucifix position on the rings apparatus, the shoulders are being held in an abducted position (Figure 2.10). Adduction is occurring when the arms are returned

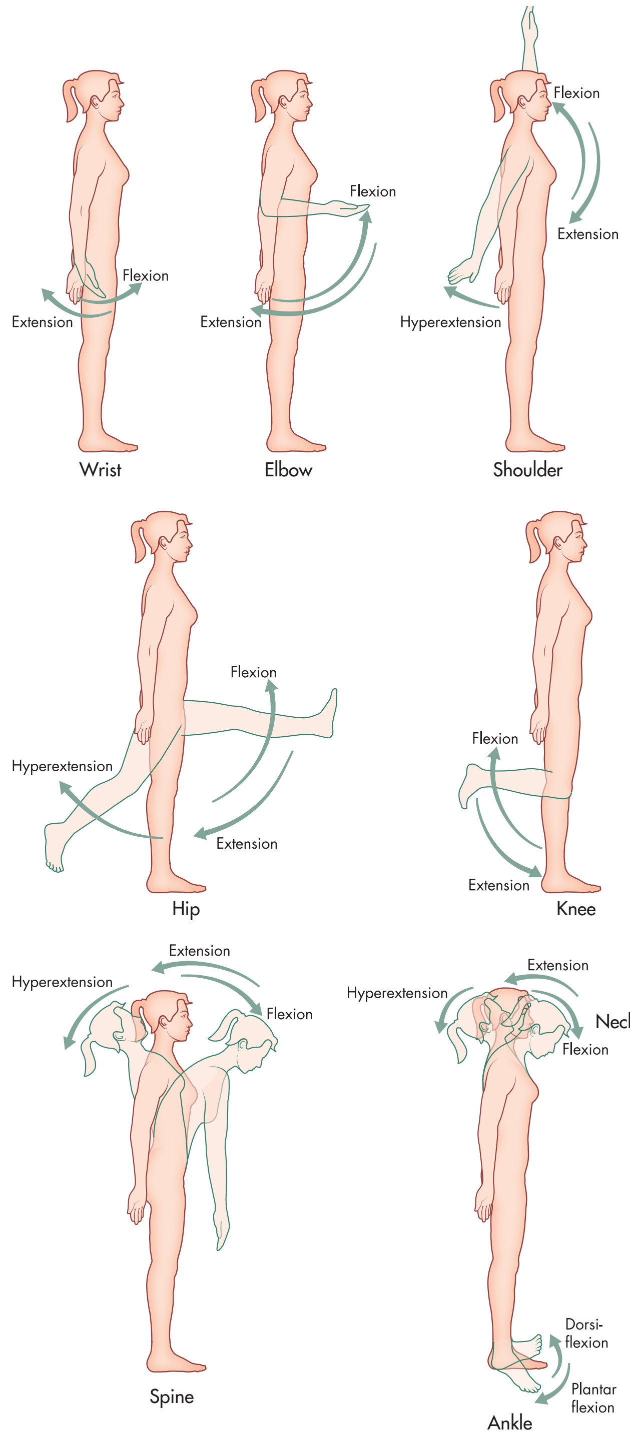

Figure 2.8 Examples of flexion, extension and hyperextension

plantar flexion the action of extending the ankle joint downwards, pointing the toes

dorsiflexion the action of flexing the ankle joint upwards, raising the toes

abduction the movement of a part of the body away from the central part of the body or away from another body part

adduction the movement of a part of the body towards the middle of the body or towards another body part

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Figure 2.9 Plantar flexion of the right ankle in preparation to kick

Figure 2.10 A gymnast demonstrates strength and control, holding the shoulders in an abducted position

to the side of the body, as the movement is towards the midline of the body.

The downswing motion used by golfers is an example of adduction of the rear shoulder, as it moves the arm back towards the midline of the body.

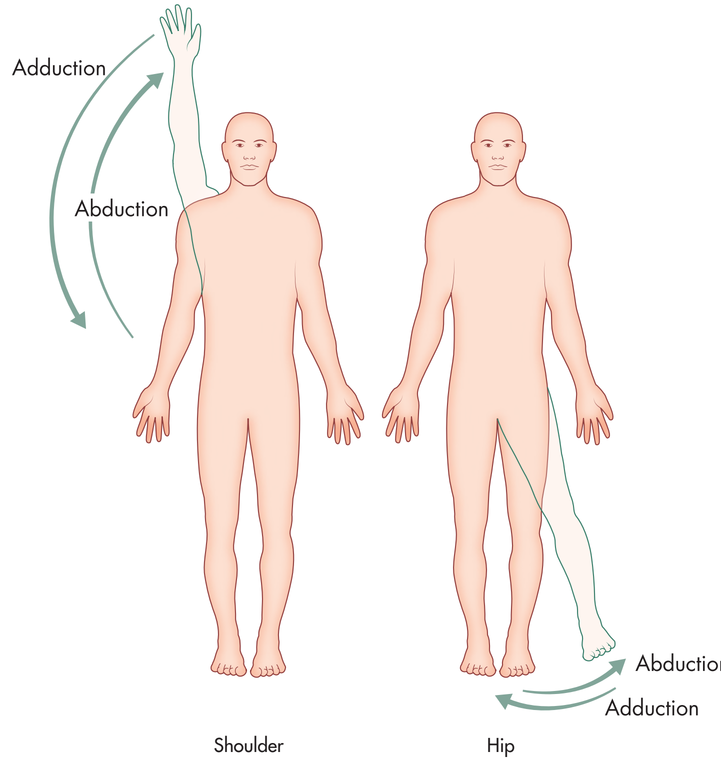

Figure 2.11 Examples of abduction and adduction

In soccer, abduction of the hips is evident when someone is performing a quick change of direction, whereas passing a ball across the body would require adduction.

Circumduction and rotation

Circumduction is the rotation of a limb in a circular motion. Circumduction actually involves a combination of flexion, extension, adduction and abduction. When swimming freestyle, circumduction is the action used by the shoulder joint. This action is also used in the bowling motion of cricket. In both cases, the far end of the limb is making a wider circular motions than the end closest to the midline of the body. Rotation, on the other hand, is the turning of a limb or the spine along its axis. A soccer player turning their leg outward in order to kick with the inside of their foot is a good example of rotation. In contrast to circumduction, the rotation of the leg along its long axis results in the entire limb turning uniformly. Inward rotation is when a body part is rotated towards the midline of the body, whereas outward rotation is when the limb is rotated away from the body.

circumduction the movement of a joint in a circular motion

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Figure 2.12 Kicking a soccer ball with the inside of the foot requires rotation of the hip.

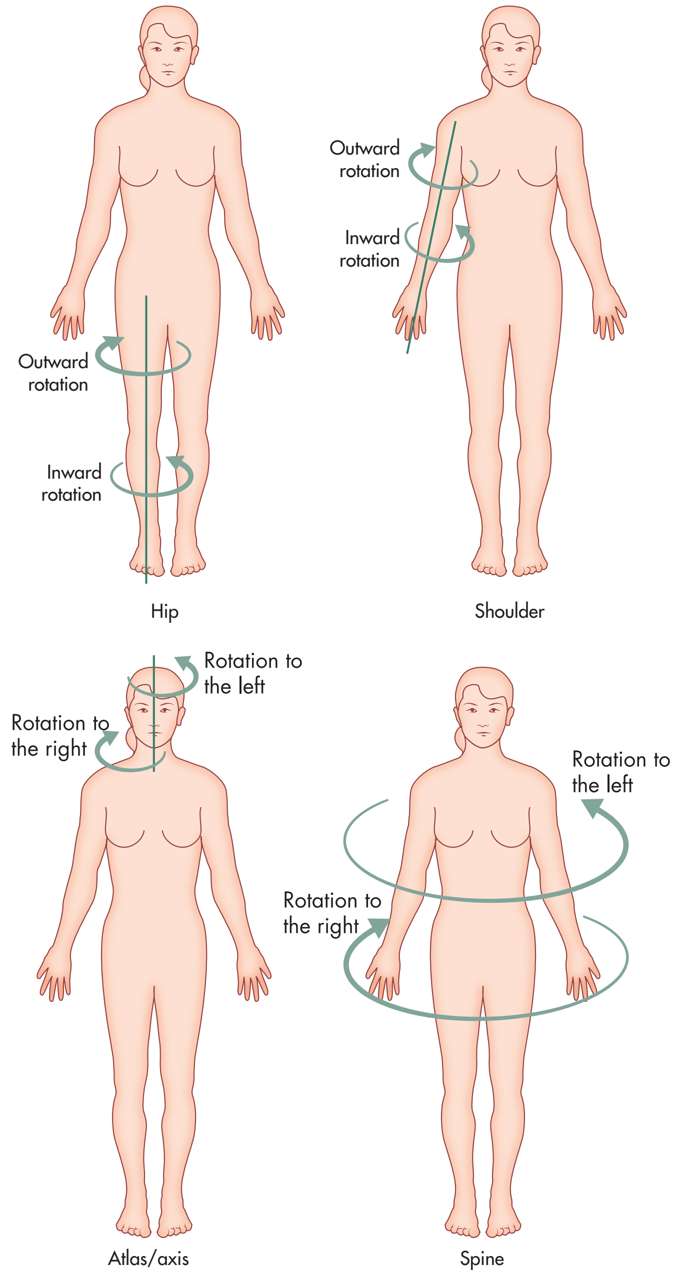

Figure 2.13 Examples of rotation

Pronation and supination

Pronation and **supination** are specialised rotation movements of the radio-ulnar joints. Pronation is the turning movement that results in the palm facing down, whereas supination is the reverse, which causes the palm to face up. Sports that involve the use of a striking implement such as a bat or racquet often use pronation and supination to change grips and produce various shots. Tennis players pronate and supinate the forearm in changing grips from forehand to backhand. In order to apply backspin, pronation would be used when playing a backhand slice. When playing a horizontal bat shot in cricket, a skilled player can control whether a ball is hit in the air or along the ground by using supination and pronation.

pronation rotation of the palm of the hand so the palm faces down

supination the act of turning the palms of the hands upwards

eversion occurs when the ankle turns laterally so the sole of the foot faces outwards

inversion occurs when the ankle turns medially so the sole of the foot is facing inwards

Eversion and inversion

Eversion and **inversion** are actions associated with turning the ankle joint. Inversion occurs when the ankle turns the foot medially so the sole of the foot is facing inwards. Alternatively, eversion occurs when the ankle turns the foot laterally resulting in the sole of the foot facing outwards. Sports that involve

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Figure 2.14 Pronation of the forearm is required to produce a backhand slice in tennis.

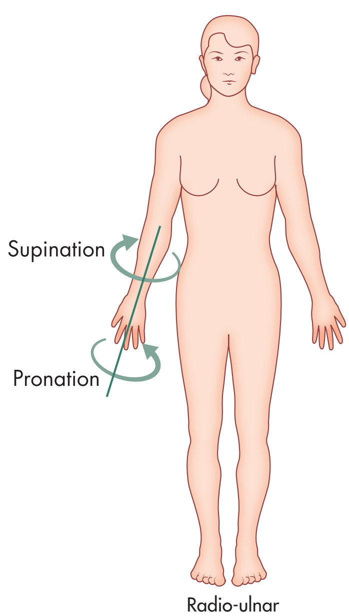

Figure 2.15 Pronation and supination

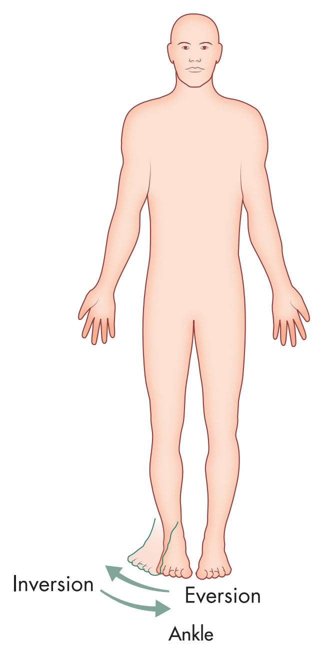

Figure 2.16 Inversion and eversion

changing direction while running at speed utilise these movements. Sudden or forced inversion or eversion of the ankle joint is a common cause of ankle injury.

Table 2.2 on the following page provides a summary of the major terms used in describing joint movements and the joints at which they occur.

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Movement	Description	Joints at which the movement can occur
Flexion	Decreases the angle at a joint in the forward–backward plane.	Shoulder, elbow, wrist, fingers, head, spine, hip and knee
Extension	Increases the angle of a joint from a flexed position back to normal (opposite of flexion).	Shoulder, elbow, wrist, fingers, head, spine, hip and knee
Abduction	Moves a body part away from the midline of the body.	Shoulder, hip, wrist, head and spine
Adduction	Returns a body part towards the midline of the body from an abducted position (opposite of abduction).	Shoulder, hip, wrist, head and spine
Rotation	Rotates a bone around a central axis. Rotation can be described as outward or inward rotation.	Shoulder, hip, head, spine and knee (while the knee is flexed)
Plantar flexion	Extends the ankle in order to point the toes downwards towards the ground.	Ankle
Dorsiflexion	Flexes the ankle joint in order to point the toes upwards towards the knees (opposite of plantar flexion).	Ankle
Pronation	Rolls the forearm and hand to be facing palm down.	Radio-ulnar joint
Supination	Rolls the forearm and hand to be facing palm up (opposite of pronation).	Radio-ulnar joint
Inversion	Turns the sole of the foot inwards.	Ankle
Eversion	Turns the sole of the foot outwards (opposite of inversion).	Ankle

Table 2.2 Summary of terms used to describe joint movements

Activity 2.3

Check-in

1 List an example of a sporting action that requires each of the movements summarised in Table 2.2. Your examples must be different from those used earlier in the text to illustrate each movement. You must be specific, naming not only the movement, but also the joint at which it occurs. For example, the up phase of a push-up is an example of elbow extension.
2 Create a table to record your responses.

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Activity 2.4

Engage-in

Inquiry question: What movement types are involved in a range of common training and exercise activities?

Engage and understand

1 Working in pairs, one student replicates or mimics the movements listed in the following table while the other observes. Swap roles so both have the opportunity to observe the movement.

2 Take note of the movements that occur at the listed joints.

Physical movement	Joints involved	Movement type	Plane of movement
Bicep curl	Elbow	Flexion and extension	Sagittal plane
Sit-up	Spine Hips		
Star jump	Hips Shoulders		
Squat	Ankles Knees Hips		
Chin-up	Elbows Shoulders		
Walking on a treadmill	Ankles Knees Hips Shoulders		
Riding an exercise bike	Hips Knees Ankles		
Rowing on a machine	Ankles Knees Hips Spine Shoulders Elbows		

(continued)

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Apply and analyse

Analyse: Examine or consider something in order to explain and interpret it, for the purpose of finding meaning or relationships and identifying patterns, similarities and differences.

3 Analyse each of the moments by completing the table. List the movement types and plane of movement involved during the *effort phase* of each movement.

Activity 2.5

Engage-in

Inquiry question: What movement types are involved in a number of common sporting actions?

Engage and understand

1 Collect video footage of yourself completing the following skills:

- shooting a basketball free throw
- kicking a soccer ball with the inside of your foot
- passing a touch football.

Apply and analyse

Analyse: Examine or consider something in order to explain and interpret it, for the purpose of finding meaning or relationships and identifying patterns, similarities and differences.

2 Analyse the movements involved in each of the actions using the following tables.

Movement	Joints involved	Joint action		Plane of movement
		Preparation phase	Action phase	
Shooting a basketball free throw	Ankle	Plantar flexion	Dorsiflexion	Sagittal
	Knee	Flexion	Extension	Sagittal
	Hip			
	Shoulder			
	Elbow			
	Wrist			

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Movement	Joints involved	Joint action		Plane of movement
		Preparation phase	Action phase	
Kicking a soccer ball (with the inside of your foot)				

Movement	Joints involved	Joint action		Plane of movement
		Preparation phase	Action phase	
Passing a touch football				

3 In groups, discuss the findings of your analysis. Reach a group consensus regarding the movements involved in each action.

Production of force by skeletal muscles

Skeletal muscles (those attached to the skeleton) produce the force required to produce movement. Muscles consist of many hundreds of muscle fibres that are grouped in bundles along the length of the muscle. Each muscle fibre contains many contracting units called *myofibrils*. Myofibrils contain two types of protein filaments (myosin and actin) that, when stimulated by a nerve impulse from the brain, can produce contraction in the length of the muscle fibre.

A single nerve cell (or neuron) does not stimulate the whole muscle to contract. A great many neurons carry signals from the brain to each muscle, and each neuron will stimulate only a number of muscle fibres. A single neuron and the muscle fibres it stimulates is called a *motor unit*. The number of muscle fibres

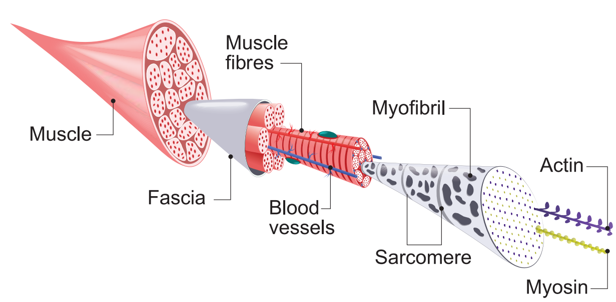

Figure 2.17 The basic structure of skeletal muscle

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in each motor unit depends on the precision of the movement the muscle is required to produce. For example, the muscles of the eye contain motor units with only a few fibres for every neuron, whereas a large, powerful muscle group such as the hamstrings may have hundreds of fibres per neuron. Depending on the amount of force required, the brain can stimulate the whole muscle or merely sections of the muscle to contract. The more motor units that are stimulated by nerve impulses from the brain, the greater the force of the contraction. Therefore, physical tasks that require small amounts of force will only require the contraction of a small percentage of motor units. If more force is required, the brain stimulates more motor units.

Muscles are attached to the skeleton by tendons, and by contracting they pull on the bones to produce **angular motion** at the joints. Muscle fibres can contract with force, but cannot lengthen with force, and therefore are arranged in pairs or groups in order to produce opposite movements. These pairs of muscles are known as *agonist and antagonist muscles*. These are muscles that typically produce opposing movements but commonly work together to allow a joint to move efficiently through its full range of motion. The muscle that produces the most force during a muscular contraction is known as an agonist muscle, or the 'prime mover'. The antagonist muscle is the opposing muscle that must relax for the joint to move. For example, when flexing the elbow, the biceps brachii is the agonist muscle and the triceps brachii is the antagonist. When the biceps brachii is contracted during this movement, the muscle feels tense, whereas the triceps brachii is lengthened and relaxed. This process of muscles on one side of the joint relaxing to accommodate muscle contraction on the other side of the joint is known as *reciprocal inhibition*.

angular motion
movement around a fixed point or axis of rotation

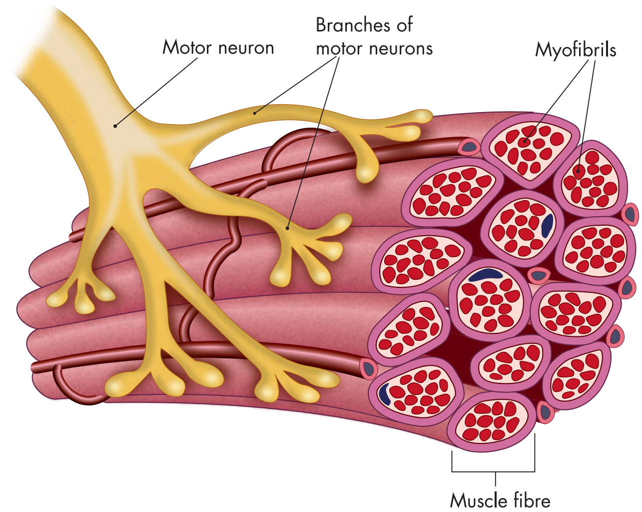

Figure 2.18 Motor unit consisting of a motor neuron and a bundle of muscle fibres

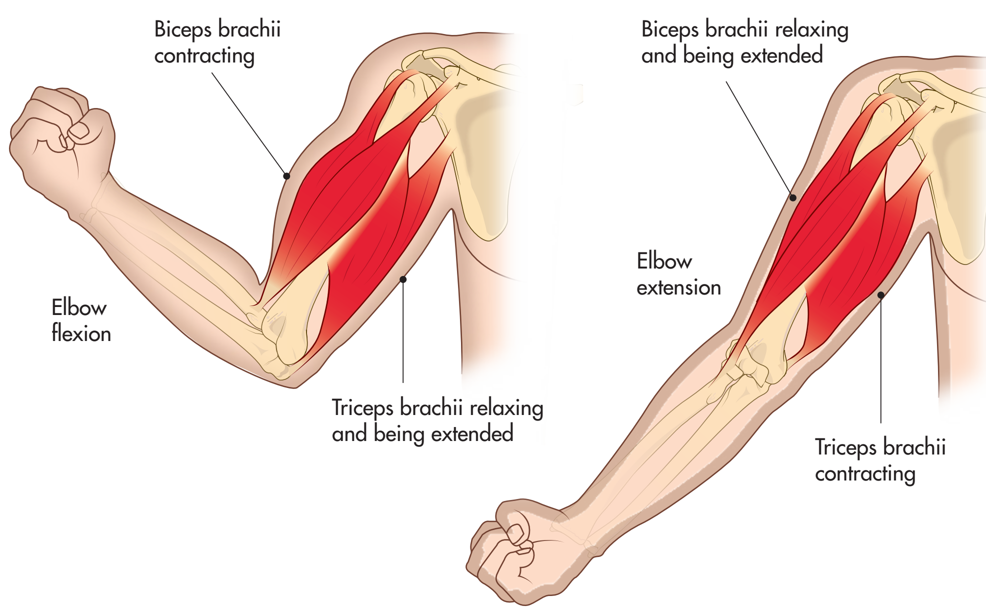

Figure 2.19 Action of the biceps brachii and triceps brachii in producing elbow flexion and elbow extension

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With hundreds of individual muscles attached to the skeleton, each with thousands of individually controlled motor units, the coordination of seemingly simple movements such as walking is actually incredibly complex.

Types of muscular contraction

Muscles don't just contract in order to assist in the production of movement. Muscular contractions can be classified into three basic types according to the movement of the muscle during the period of muscular tension: isotonic contractions, isometric contractions and isokinetic contractions.

Isotonic muscle contractions occur when the muscle shortens or lengthens to produce movement. Isotonic contractions can be either concentric or eccentric.

Concentric muscle contractions are produced when a muscle shortens under tension. This type of contraction is used mainly in producing motion against a resistance. For example, the upward action in producing a chin-up utilises a concentric contraction of the biceps brachii. *Eccentric muscle contractions* are produced when a muscle lengthens in a controlled way under tension due to an external force. Eccentric contractions are commonly used in absorbing or controlling external force – particularly the force of gravity. In the downward action of a chin-up, the elbow is extended – an action usually produced by the triceps brachii, but because the action involves lowering the body with gravity, the movement is produced in this case by the controlled lengthening of the biceps brachii. This type of contraction also occurs in absorbing the force of hitting the ground while running.

Isometric muscle contractions (also called static contractions) are produced when a muscle is producing tension, but remains the same length.

Figure 2.20 A chin-up involves concentric, eccentric and isometric contractions of the biceps brachii.

Static contractions are used in stabilising a part of the body in order to resist a force. If a chin-up were held stationary in the halfway position, the biceps brachii would be producing a isometric contraction.

Isokinetic muscle contractions, like isometric contractions, produce movement at a joint. The difference is that isokinetic muscle contractions produce movement at a constant *rate*. The advantages of isokinetic contractions are that the muscle gains strength evenly throughout the whole range of motion, and it is therefore the most efficient method of gaining strength. A disadvantage of this type of contraction is that it requires the use of machines called isokinetic dynamometers, which are too expensive for most gyms and sporting clubs. It is also rare to see these types of contractions in sport.

Major muscle groups

Figure 2.21 on the following page illustrates the major skeletal muscle groups used in producing the wide range of movements possible in the human body.

KEY MESSAGE

Muscle fibres are arranged into motor units that consist of a bundle of muscle fibres and the nerve cell (neuron) that controls it.

KEY MESSAGE

Muscular contractions can be classified as isotonic, isometric or isokinetic.

KEY MESSAGE

Isotonic muscle contractions can be classified as concentric or eccentric.

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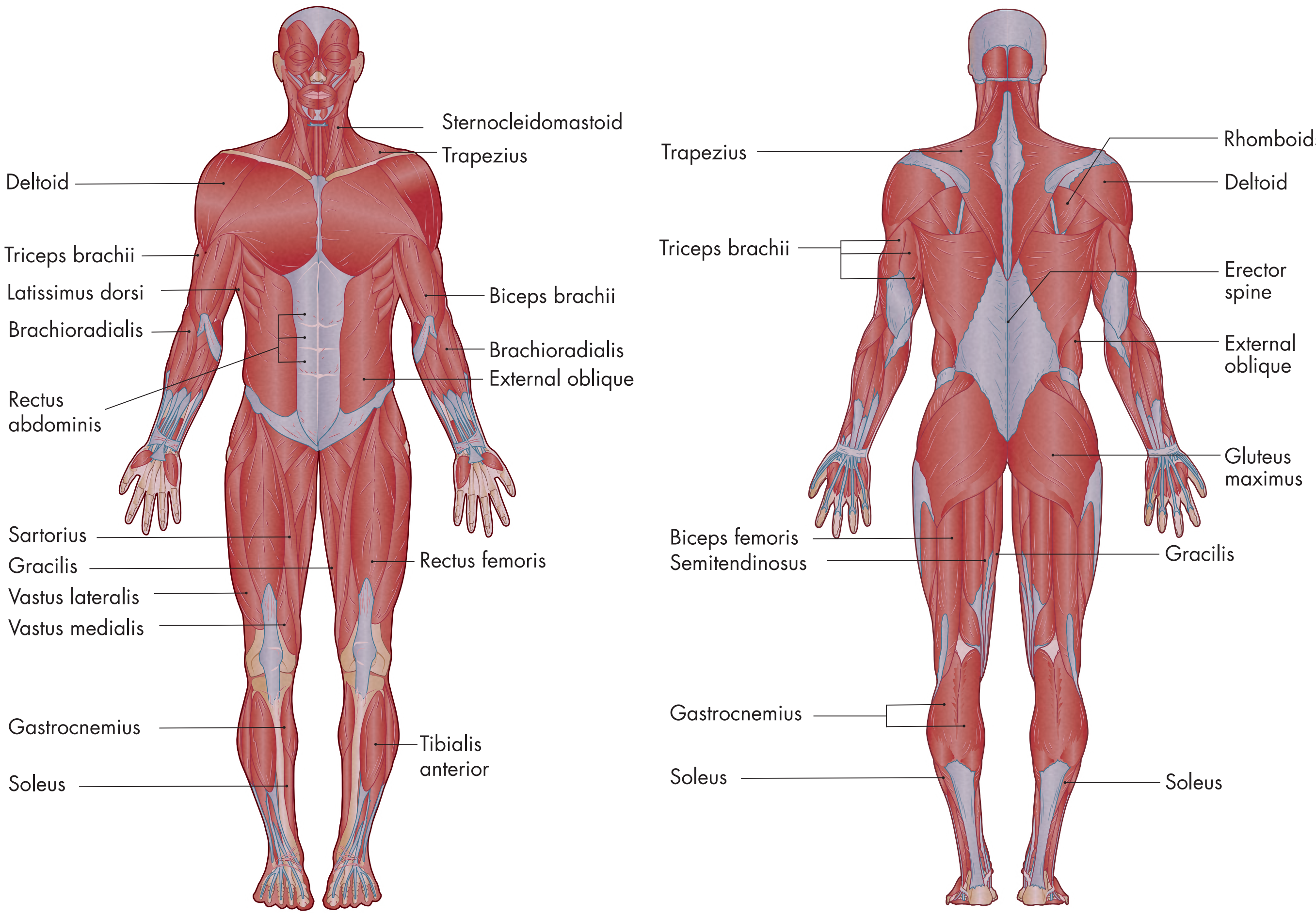

Figure 2.21 Major muscle groups

Activity 2.6

Check-in

1. Some major muscles are grouped together because they produce similar actions or share insertion points. Using research, list the muscles that make up the groups known as the hamstrings, the quadriceps and the abdominals.
2. Consider the types of muscular contractions:
   a. What are three activities of daily living that use concentric contractions?
   b. What are three activities of daily living that use eccentric contractions?
   c. What are three activities of daily living that use isometric contractions?
3. Knowledge of anatomical terminology and the names of bones, muscles and joints allows athletes, coaches and sports scientists to use a common language to describe human movements. It is therefore important to be able to name, locate and correctly spell the major skeletal muscles. Numerous apps, online quizzes and interactive tools (including 3D views of individual muscles) can be used to help learn and recall the names and locations of the major muscle groups. Locate and use one or more of these resources to help your recall of muscular anatomy.

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Table 2.3 lists specific joint actions, their involvement in a range of physical activities and the major muscles responsible for producing the action. It should be noted that some muscles, because they stretch over more than one joint, can be involved in producing movement at more than one joint. The biceps brachii is an example of this, as it produces movement at both the elbow and shoulder joints.

Action	Examples of movements in various physical activities	Muscle(s)
Closing fingers to grasp (finger flexion)	Sports that involve holding onto an opponent, teammate or piece of equipment, such as a softball bat	Flexor digitorum profundus Flexor digitorum superficialis
Flexing thumb to grasp (thumb flexion)	Gripping a bat	Flexor pollicis longus
Flexing wrist towards palm (palmar flexion)	Chest pass in netball, throwing a cricket ball, overhead serve in volleyball	Palmaris longus Flexor carpi ulnaris Flexor carpi radialis
Extending the wrist towards the back of the hand (dorsiflexion)	Backhand shot in squash and badminton, backhand top spin shot in table tennis, throwing a frisbee	Extensor carpi ulnaris Extensor carpi radialis Extensor carpi brevis Extensor carpi longus
Pronation of the forearm	Top spin forehand in tennis, spin-passing a touch ball, action of top forearm in controlling a pull shot to the ground in cricket	Pronator teres
Supination of the forearm	Bowling off spin in cricket, throwing a cricket ball, pitching in softball	Supinator
Elbow flexion	Maintaining tight grips in a rugby scrum, rock climbing, drawing the bow in archery, kayaking	Biceps brachii Brachialis Brachioradialis (while forearm is pronated)
Elbow extension	Shot put, pitching in baseball, golf swing, throwing a javelin	Triceps brachii
Shoulder flexion	Pitching in softball, tenpin bowling	Pectoralis major Anterior deltoid Biceps brachii
Shoulder extension	Holding an opponent tightly such as in a rugby tackle or a judo throw	Latissimus dorsi Teres major Deltoid Triceps brachii
Shoulder abduction	Preparing to serve in table tennis, preparing to spike in volleyball	Deltoid Supraspinatus

Table 2.3 Examples of muscular involvement in a range of physical activities

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Action	Examples of movements in various physical activities	Muscle(s)
Shoulder adduction	Action of the bottom arm in a golf swing, lifting body weight in rock climbing	Pectoralis major Latissimus dorsi Teres minor Coracobrachialis
Hip flexion	Kicking a ball, performing a high kick in sport aerobics	Rectus femoris Sartorius Psoas major Psoas minor Iliacus
Hip extension	Preparing to kick a ball, lifting in a Rugby lineout	Gluteus maximus Biceps femoris Semimembranosus Semitendinosus
Hip abduction	Outward movement in a star jump, pitching stride in baseball	Gluteus medius Gluteus minimus Tensor fascia latae
Hip adduction	Inward movement in a star jump, kicking a soccer ball with the inside of the foot	Adductor brevis Adductor longus Adductor magnus Pectineus Gracilis
Knee flexion	Swing phase in sprinting, preparing to lift	Biceps femoris Semimembranosus Semitendinosus Gastrocnemius Sartorius
Knee extension	Jumping to block in volleyball, kicking a ball	Rectus femoris Sartorius Vastus inetrmedius Vastus medialis Vastus lateralis
Ankle plantar flexion	Pushing off the ground while sprinting, pointing the toes while swimming	Gastrocnemius Soleus Plantaris Tibialis posterior
Ankle dorsiflexion	Preparing for foot strike while running, holding position in a ski jump	Tibialis anterior Extensor halluces longus Extensor digitorum longus Fibularis tertius

Table 2.3 *(continued)*

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Activity 2.7

Engage-in

Inquiry question: What major muscle groups and types of muscular contractions are involved in one or more movement sequences associated with physical activity that is the focus of your study this term?

Engage and understand

1 Using a format similar to the example in the table below, analyse the types of muscular contractions involved in one or more movement sequences associated with the physical activity that is the focus of your study. In a small group, select a movement sequence for the purpose of this movement analysis.

2 To do this, you will have to divide the whole movement sequence into its distinct phases. For example, a push-up could be divided into the 'up phase' and the 'down phase', and the leg action in walking could be divided into the 'push phase', 'recovery phase' and 'swing phase'. The movement sequence you choose may have two, three or maybe more distinct phases.

3 Name each of the phases of the movement sequence.

Apply and analyse

Analyse: Examine or consider something in order to explain and interpret it, for the purpose of finding meaning or relationships and identifying patterns, similarities and differences.

4 Complete your analysis with your group.

Description of movement sequence:

Phase of movement	Muscle groups involved	Type of contraction (concentric, eccentric or isometric)
Phase 1:		
Phase 2:		
Phase 3:		

5 What are the implications of this analysis for preparing athletes for competition in this sport? What types of activities should be included in training for this sport?

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Properties of force

Muscular forces can be described and measured in terms of four properties: magnitude, direction, point of application and line of action.

Magnitude refers to the amount of force that is being applied. The magnitude of a force, measured in newtons (N), is calculated by multiplying the mass (kg) of the object that the force is applied to by the object's rate of **acceleration** (m/s/s) caused by the force. For example, to accelerate a 2 kg discus at 40 m/s/s would require the application of a force of 80 newtons. It is obvious that objects with greater mass will require larger force to produce the same rate of acceleration. This law of acceleration is known as Newton's second law of motion, and is discussed in more detail later in the chapter.

The *direction* in which a force is applied will determine the resulting motion. In Figure 2.22, the direction is measured as the angle between the line of action of the force and the horizontal. In applying muscular force, it is rare that only one force acts to produce movement. Usually a number of forces act simultaneously to produce the resultant motion. The magnitude and direction of each of the contributing forces determine the resultant force. When an object (or the human body) is subject to a number of forces simultaneously, the resultant force is the force that would produce the resulting action if acting alone – in other words, a summary of the action of all forces. Resultant forces are often analysed in terms of the horizontal and vertical components of the force. For example, the force pushing on the blocks during a sprint start includes a horizontal component (to begin accelerating down the track) and a vertical component (to overcome gravity and avoid falling forwards). Another example of resultant force is illustrated by the action of the pectoralis major muscle. As shown in Figure 2.23, part of the pectoralis major attaches to the clavicle (collar bone) and part to the sternum (breast bone) and rib. The two components of this muscle exert force in different directions, but when both parts contract together, a resultant force occurs, pulling on the humerus.

acceleration the increase or decrease in an object's velocity

The *point of application* of a force is the point where force is applied to a body or object. *Line of action* refers to a theoretical line from the point of application of a force, extending in the direction in which the force is acting. The line of action of a force in relation to the *centre of gravity* of an object will have an effect on the type of motion that is produced. The centre of gravity of an object is a theoretical point

KEY MESSAGE Muscular forces can be described and measured in terms of magnitude, direction, point of application and line of action.

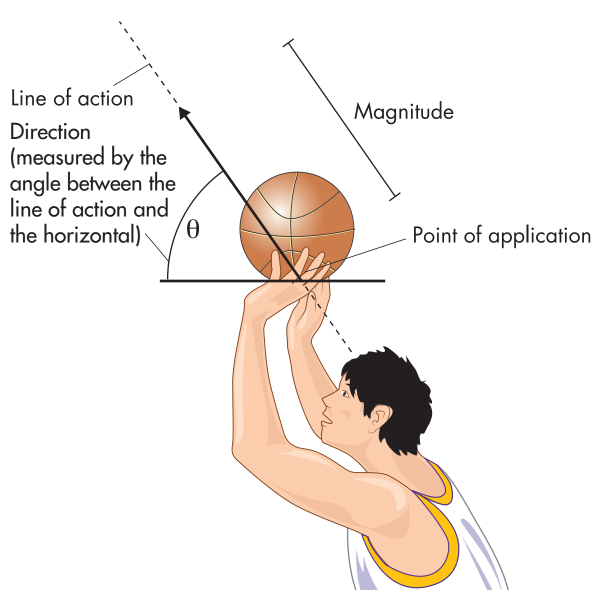

Figure 2.22 The four properties of force applied to a basketball shot

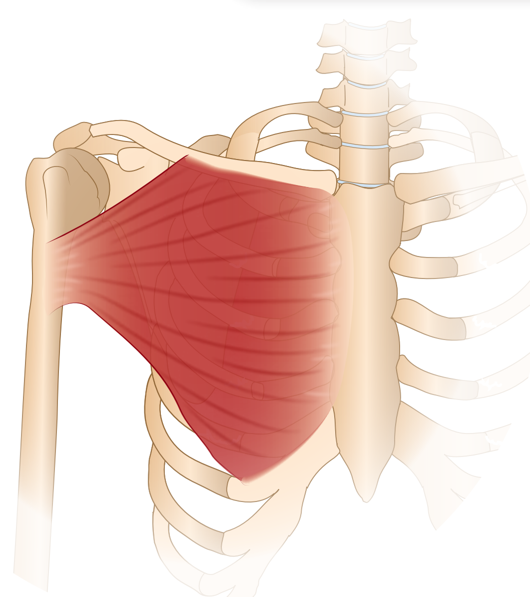

Figure 2.23 The pectoralis major muscle

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that represents the centre of the object's mass. (If an object was thrown with spin, it would rotate around its centre of gravity.) If a force is applied to an object through its centre of gravity, it will cause **linear motion**. If the force applied to an object does not act through its centre of gravity, it will cause linear and angular motion. For example, when the force of a kick applied to a soccer ball does not act directly through its centre of gravity, it not only causes the ball to move, but also to rotate (which in this case may cause the ball to curve in the air).

linear motion movement of an object from one place to another

Figure 2.24 Soccer strikers intentionally apply force to the ball that does not act directly through its centre of gravity, thus applying rotation that causes the ball to curve in the air.

Activity 2.8

Check-in

1. Free throw success in basketball is improved by adding a little backspin to the ball. Describe how this is achieved with reference to line of application of force and point of application of force.
2. Use the principles of force application to explain why sprinters are advantaged by using a crouch start.
3. When performing a crouch start, what are the movements occurring at the ankle, knee and hip joints the moment after the gun goes off? What muscles are the agonists in these movements?

Types of motion

There are two types of motion: *linear motion* and *angular motion*. Linear motion is the type of motion that moves an object (possibly a human body) from one place to another. This can occur in two ways. An object can move from one place to other in a straight line, which is called *rectilinear motion* (e.g. a snooker ball rolling along the table), or an object can move from one place to another in a curved line, which is called *curvilinear motion* (e.g. the flight path of a javelin through the air). The distance covered by an object moving from one point to another is known as *displacement*. For instance, a 100 m sprinter at the halfway point of a race has a displacement of 50 m.

2.2 Motion

Motion is another word for movement. Motion occurs as a result of force acting on an object (which may be a human body). A force may change an object's motion by speeding it up, slowing it down, changing its direction or causing it to spin. The motion of an object (possibly the human body) that occurs in physical activity is often described in terms of displacement (how far the object has moved), velocity (how fast and in what direction the object is moving) and acceleration (whether the object is getting faster or slowing down).

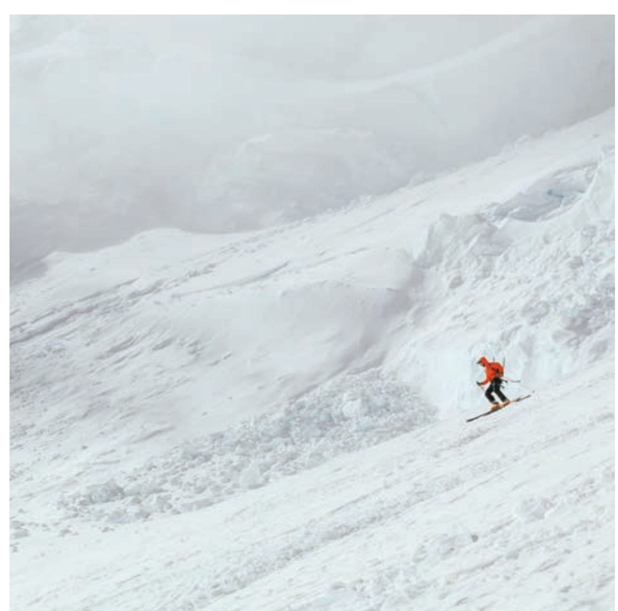

Figure 2.25 Linear motion of a downhill skier

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Figure 2.26 Angular motion of a gymnast around the high bar

Figure 2.27 Angular displacement of the thigh at the hip joint while kicking an Australian Rules football can be up to 150 degrees.

Angular motion is the type of motion that involves rotation around a fixed point or axis of rotation. This type of motion is sometimes called *rotary motion*. Some examples include performing a front somersault, the action of the body in a circular discus sling and the action of the hip joint while sprinting.

In fact, almost all the motion that muscles can produce at the joints is angular motion. One bone rotates around another at a joint that acts as the axis of rotation. Because angular motion does not involve moving from one place to another, displacement is not measured in metres. Angular displacement is a measure of how many degrees of rotation have occurred between a body part or an object's starting position and its final position. For example, rotating the arm in a full circle would represent an angular displacement of 360 degrees around an axis of rotation at the shoulder joint. The Greek letter theta (θ) is used to represent angular displacement.

Some physical activities such as gymnastics and diving contain very complex series of angular motion. Twisting somersaults, for instance, represent simultaneous angular motion around two axes of rotation.

Rectilinear motion	Curvilinear motion	Angular motion
• The motion of bike and rider while cycling • A tenpin bowling ball rolling down the lane	• The flight path of a javelin • The motion of the body while long jumping	• A front somersault • Action of the shoulder joint in swinging a golf club

Table 2.4 Examples of types of motion

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Motion of the human body

The angular motion at our joints can be transformed into linear motion (rectilinear or curvilinear). For example, walking is performed by pushing off the ground and then rotating one of our hip joints forwards. This causes our body to over-balance. Balance is regained each time a foot hits the ground. Force exerted by our muscles causes angular motion at the joints, and combined with the effects of gravity, is transformed into the linear motion (more specifically, a continuous series of smaller curvilinear movements) of the whole body moving forward. In another example, the circular discus slinging technique uses angular motion of the trunk and limbs to produce the angular spinning action of the discus and its curvilinear flight path (Figure 2.28).

Figure 2.28 Discus slinging translates the angular motion of the joints into the curvilinear flight path of the discus.

As is the case in most physical activity, linear motion of our whole body or a projectile propelled by our body occurs because of the angular motion produced at our joints by muscular force.

Linear velocity and acceleration

Linear velocity, which is commonly referred to as speed, is a measure of how fast an object is moving and is defined as the rate of change of an object's displacement. In other words, velocity measures how far an object moves in a given time period. Velocity also includes the direction of motion, but in most contexts in this course, the direction may not be specified. The velocity of a car is commonly measured in kilometres per hour (km/h). A car traveling at 80 km/h would be expected to have moved 80 km after one hour, 160 km after two hours and so on. Linear velocity in physical activity is usually measured in metres per second (m/s). Some fast bowlers in cricket can release the ball at 44.5 m/s, which is approximately 160 km/h.

Linear velocity is calculated by dividing the displacement of an object by the time it takes to travel over that distance.

$$\text{velocity (m/s)} = \frac{\text{displacement (m)}}{\text{time (s)}}$$

$$\text{or in abbreviated form } v = \frac{d}{t}$$

For example, a 100 m runner who takes 10 seconds to complete the distance has a average velocity of 10 m/s (100 m. ÷ 10 sec. = 10 m/s).

This is considered an average velocity because of variations to the sprinter's velocity that may have occurred during the race. A more accurate indication of velocity may result from calculating average velocity for each 10 m section of the race.

Linear acceleration is a measure of how quickly velocity is changing. In other words, acceleration is how quickly an object is slowing down or speeding up. Linear acceleration is calculated by dividing the change in an object's velocity by the time it takes for the change to occur.

$$\text{acceleration (m/s/s)} = \frac{\text{final velocity} - \text{initial velocity (m/s)}}{\text{time (s)}}$$

$$\text{or in abbreviated form } a = \frac{v_2 - v_1}{t}$$

Linear acceleration is measured in metres per second per second (m/s/s or m/s^2). A sprinter who is capable of accelerating at 2 m/s^2 from the beginning of the race, after three seconds of gaining 2 m/s of velocity every second, will be running at a velocity of 6 m/s.

As a positive value for acceleration represents an increase in velocity, a negative value represents a decrease in velocity or deceleration. A pole vaulter will show a negative acceleration (getting slower) on the way up to the bar until maximum height is reached, and a positive acceleration (getting faster)

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Figure 2.29 Sprinters aim to accelerate to maximum velocity as quickly as possible.

on the way to the mat. An object with an acceleration of 0 m/s^2 would be neither slowing down or speeding up, but rather remaining at a constant velocity.

One example of the application of the principles of linear velocity and acceleration is in sprint analysis. By calculating average velocity and acceleration over each 10 m interval of a 100 m sprint race, the athlete may identify training priorities. For instance, if it is found that velocity decreases over the final 10 m, it may indicate that the athlete should train towards maintaining top velocity for 100 m. The athlete may find that maximum velocity is not reached until the 70 m mark, indicating a need to work on muscular power and acceleration.

Angular velocity and acceleration

As for linear motion, it is possible to calculate velocity and acceleration for angular motion. The difference is that in linear motion, displacement is measured in metres, in angular motion it is measured in degrees. Angular velocity, therefore, is calculated by dividing the angular displacement around an axis, by the time the movement takes. Angular velocity is commonly measured in degrees per second and is represented by the Greek letter omega (ω).

$$\text{angular velocity (deg./s)} = \frac{\text{angular displacement (°)}}{\text{time (s)}}$$

$$\text{or in abbreviated form } \omega = \frac{\theta}{t}$$

A tennis player's racquet that moves through 90° in 0.5 of a second has an angular velocity of 180°/s (90°/0.5 s).

Angular acceleration, as is the case with linear acceleration, is a measure of how quickly velocity (in this case, angular velocity) is changing – in other words, how quickly an object in angular motion is speeding up or slowing down. Angular acceleration is calculated by dividing the change in an object's angular velocity by the time it takes for the change to occur. The Greek letter alpha (α) is used to represent angular acceleration and it is measured in degrees per second per second (°/s/s or $°/s^2$).

$$\text{angular acceleration (°/s/s)} = \frac{\text{final ang. velocity} - \text{intial ang. velocity (°/s)}}{\text{time (s)}}$$

$$\text{or in abbreviated form } \alpha = \frac{\omega_2 - \omega_1}{t}$$

Calculations of angular velocity and acceleration would be very useful, for example, in the analysis of an individual's golf swing. An individual player's height, arm span, angular acceleration of swing and final angular velocity of the club head will all contribute to how fast the ball will come off the club. These measurements can be used to make adjustments to swing technique towards producing maximum ball velocity with control.

Figure 2.30 The action of swinging a golf club is an example of rapid angular acceleration.

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	Linear motion		Angular motion	
	Calculation	**Example**	**Calculation**	**Example**
Displacement	Linear displacement (d) measured in metres (m)	The distance over which a sprint race is contested	Angular displacement (θ) measured in degrees (°)	The angle through which a tennis player swings the racquet while hitting a forehand shot
Velocity	Linear velocity (v) = displacement (d) divided by time (t) measured in metres per second (m/s)	The average velocity of a sprinter running 100 m in 11 seconds is 9.1 m/s.	Angular velocity (ω) = angular displacement (θ) divided by time (t) measured in degrees per second (°/s)	The angular velocity of the head of a golf club that moves through 90° in 0.2 seconds is 450°/s.
Acceleration	Linear acceleration (a) = change in velocity ($v_2 - v_1$) divided by time (t) measured in metres per second per second (m/s/s).	A sprinter who goes from standing to 10 m/s in five seconds is accelerating at 2 m/s/s.	Angular acceleration (α) = change in angular velocity ($\omega_2 - \omega_1$) divided by time (t) measured in degrees per second per second (°/s/s).	A hammer that begins at rest goes to 720°/s in three seconds and has an angular acceleration of 240°/s/s.

Table 2.5 Displacement, velocity and acceleration

KEY MESSAGE

Linear motion occurs when an object moves from one place to another.

KEY MESSAGE

Angular motion involves rotation around an axis.

KEY MESSAGE

Human motion is created by the angular motion of bones moving at the joints.

Activity 2.9

Check-in

1 Consider the types of motion that occur in the following sports:

a shot put

b downhill skiing

(continued)

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c basketball
d tennis
e sport aerobics.
2 Discuss aspects of the types of motion involved in these sports in terms of the requirement for linear and angular velocity and acceleration.
3 Consider the physical activity that is the focus of your study this term. List the types of motion involved in the various aspects of this physical activity, and when and where they occur.

Activity 2.10

Engage-in

Inquiry question: What implications for training can be determined from an analysis of sprinting velocity over 100 metres?

RECOGNISE & EXPLAIN
ANALYSE & SYNTHESISE
MAKE DECISIONS

Engage and understand

1 You will be calculating the average velocity and acceleration from data collected during a 100 m sprint performed by a Year 11 Physical Education student in competition. The table below shows the cumulative time for each 10 m interval of the 100 m sprint; that, is 0–10 m, 0–20 m, 0–30 m, 0–40 m, 0–50 m, 0–60 m, 0–70 m, 0–80 m, 0–90 m and 0–100 m.

Distance interval	Cumulative time	Time for distance interval	Average velocity	Average acceleration
0–10 m	1.72			
10–20 m	3.16			
20–30 m	4.49			
30–40 m	5.76			
40–50 m	6.98			
50–60 m	8.14			
60–70 m	9.38			
70–80 m	10.72			
80–90 m	12.08			
90–100 m	13.41			

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2 Complete the steps below.

a Calculate the time taken to sprint each 10 m interval by subtracting the previous cumulative time. For example, if the time taken from 0–40 m was 9.9 seconds and from 0–30 m was 7.8 seconds, the time taken for the distance interval 30–40 m was 2.1 seconds.

b Calculate the average velocity (in metres per second) for each distance interval using the formula:

$$v = \frac{d}{t}$$

For example, if the time taken for the distance interval 30–40 m was 1.5 seconds, the average velocity is 10 m ÷ 1.5 seconds = 6.67 m/s.

c Calculate the average acceleration for each interval by dividing the change in velocity (velocity for the interval – velocity for the previous interval) divided by the time taken for the interval.

$$a = \frac{v_2 - v_1}{t}$$

For example, if the velocity for the interval 0–10 m was 5 m/s (10 m in 2 seconds), the average acceleration for the interval is:

(5 m/s – 0 m/s) ÷ 2 = 2.5 m/s/s.

If the velocity for the interval 10–20 m was 5.21 m/s (10 m in 1.92 seconds), the average acceleration for the interval is:

(5.21 m/s – 5 m/s) ÷ 1.92 = 0.11 m/s/s (which represents an increase in velocity or acceleration).

Apply and analyse

KEY COGNITION

Analyse: Examine or consider something in order to explain and interpret it, for the purpose of finding meaning or relationships and identifying patterns, similarities and differences.

Synthesise: Combine different parts or elements (e.g. information, ideas, components) into a whole, in order to create new understanding.

3 Using this data, create a line graph of velocity over each interval of the 100 m sprint.

4 At what distance in a 100 m sprint does research recommend that elite sprinters reach top velocity? How did the subject of this data compare to this recommendation?

5 Based on the subject's 100 m sprint data, what are the possible training implications for planning training activities for this athlete? Consider the implications of the rate of acceleration and speed maintenance in this performance. What training activities would you recommend based on this analysis?

6 You may consider collecting this data for yourself and each member of your class and calculating class average top velocities as a point of comparison.

7 You may also consider using a spreadsheet to calculate and represent data graphically. It could be interesting to research the 10 m split-time data for an elite sprinter and plot this graphically against your data as another point of comparison.

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2.3 Principles governing the application of muscular force

The relationship between muscular force and the motion it causes can be described and predicted using a number of the laws and principles of physics. This section outlines the general principles governing the application of muscular force. Coaches and performers can apply these principles in order to refine performance techniques rather than relying just on copying the technique of champion performers or refining performances through trial and error.

Newton's laws of motion

Sir Isaac Newton (1642–1727) is credited with many important developments in science and mathematics. Among his achievements was the development of three laws of motion, which define the relationships between force and motion.

Newton's first law of motion: The law of inertia

Newton's first law of motion (the law of inertia) states that a body will continue in its state of rest or constant velocity in a straight line unless it is acted upon by an external force. In other words, an object will not move or change the way it is moving until a force causes it to do so. Forces may cause an object to speed up, slow down, change shape, change direction or start to rotate. In a simple example, a golf ball will remain stationary on a tee until it is struck by a club. This tendency to remain at rest or in the same state of motion is known as *inertia*, which can be considered as an object's resistance to changing its state of motion. Inertia is sometimes difficult to realise because of the effects of the force of gravity. An example can be seen in the slinging of a discus. The discus will not move until the muscles of the thrower provide a force to start its motion. After the discus is slung, it does not remain in the same motion because the force of gravity acts to pull to the ground and air resistance acts to slow it down. The law of inertia could be well illustrated in space where, without gravity or air resistance to change the inertia of an object after it has been set in motion, it will continue in the same direction at the same velocity.

The amount of inertia that an object possesses is determined by its *mass*. The more mass an object has, the more inertia it has, and the larger the force that will be required to change its state of motion. Figure 2.31 shows a rugby scrum about to pack. If the combined mass of the players on the left is 900 kg, as opposed to a 700 kg opposition, the heavier pack – because it possesses more inertia – will be more difficult to move. In all situations in physical activity where athletes attempt to change the motion of an object (including their body), inertia must be overcome in order to cause such a change.

Figure 2.31 In a Rugby Union scrum, both teams attempt to overcome the inertia of the opposition.

Newton's second law of motion: The law of acceleration

How quickly an object will speed up or slow down (accelerate) depends on two factors: the size of the force acting to change the object's inertia and the mass of the object. First, Newton's second law of motion (the law of acceleration) states that the acceleration of an object will

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increase if the amount of force that is applied to it is increased. In other words, a larger force will cause greater acceleration than a lesser force. For example, the shot putter who can produce the most muscular force will be able to speed up the shot more quickly and should (depending on technique) therefore put the shot further than other competitors. Second, Newton's second law of motion states that if the mass of an object is increased, the acceleration caused by the same force will decrease. Objects with a larger mass require more force to accelerate them at the same rate as lighter objects. If the same force is applied, a 4 kg shot will accelerate more rapidly than a 5.3 kg shot and, depending on the angle of release, will go further.

The relationship between the mass of an object, the force applied to it and the resulting rate of acceleration can be represented by the formula:

$$F = m\,a$$

where F is the force applied in newtons, m is the mass of the object in kilograms, and a is acceleration in metres per second per second. To accelerate a 4 kg shot put at 20 m/s/s would require a force of 80 N (4 × 20 = 80 newtons). A sprinter on a weights program to improve leg power may increase the amount of force they can apply to the ground, which would increase their acceleration; however, if the weights program also caused an increase in body mass, some of the gains in force would be used in accelerating the newly acquired body mass.

Newton's third law of motion: The law of action–reaction

Newton's third law of motion (the law of action–reaction) states that for every action there is an equal and opposite reaction. For every force applied by one body on another, there is an equal force acting in the opposite direction, applied by the second object on the first. In a simple example, a long jumper applies downward force onto the take-off board, which in turn applies an equal force upwards, propelling the jumper into the air. Figure 2.32 shows the equal and opposite forces involved in the take-off in long jump. Because the take-off board is fixed to the ground, there is no effective reaction movement of the ground because of the large mass of the Earth compared with the jumper.

The presence of equal and opposite forces in more complicated movements, involving a number of forces acting simultaneously – such as a twisting somersault dive – becomes more difficult to analyse.

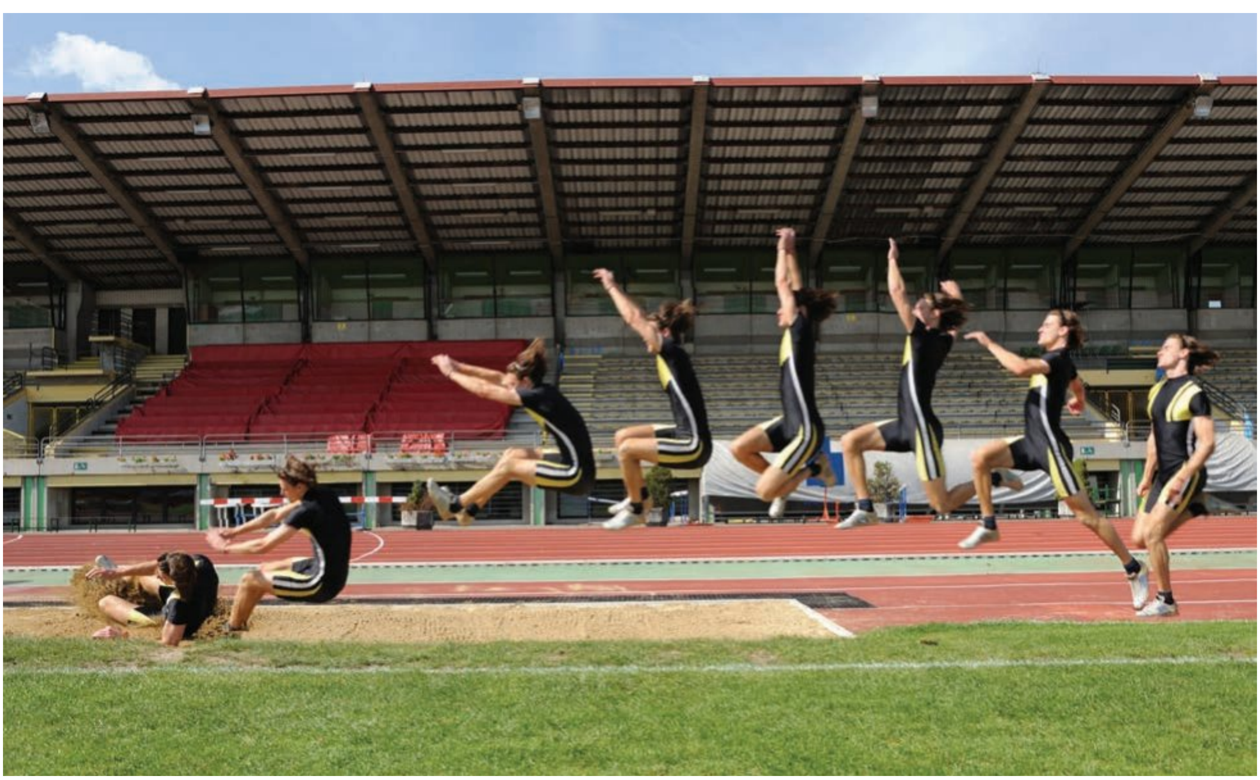

Figure 2.32 The downward force caused by the long jumper's leg muscles results in an upward force that is equal in magnitude.

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Activity 2.11

Check-in

1 For each of Newton's laws, list three specific movement sequences from various sports that nicely illustrate the principle.

2 It has been determined that, in his world record run, Usain Bolt applied a driving force of 817 N to the blocks at the start. He weighs 94 kg. Calculate his acceleration as he left the blocks.

3 Discuss the application of each of Newton's laws with movement sequences specific to the physical activity that is the focus of your study this term.

Momentum, impulse and force application

Momentum is considered to be a measure of the amount of motion possessed by an object in motion. The momentum of an object in linear motion is calculated by multiplying an object's velocity by its mass. The letter p is used to represent momentum.

$$\text{momentum} = \text{mass} \times \text{velocity}$$

or, in abbreviated form

$$p = m\,v$$

The linear momentum of a moving object can be changed by altering either its mass or its velocity. In most physical activities, it is more common that mass remains constant and velocity is altered. If the velocity of an object is increased, there will be a proportionate rise in momentum (if velocity is increased by 10 per cent, momentum will increase by 10 per cent).

Figure 2.33 Sumo wrestlers attempt to build both body mass and velocity in order to increase their momentum.

The inertia of an object is related to its mass and its momentum is its mass multiplied by its velocity, so momentum is related to inertia and velocity. If two objects of the same mass are travelling at different velocities, the faster object will possess the greater momentum and will require more force to stop. For example, long jumpers attempt to increase the speed of the run-up, thus increasing their momentum and lengthening their jump. Conversely, if two objects are travelling at the same velocity, but are of different masses, the heavier object will possess the greater momentum and will require more force to stop. For example, it is harder to catch a cricket ball as opposed to a tennis ball travelling at the same velocity.

The effect of variations in mass and velocity on momentum must be considered by athletes in activities that require the use of a striking implement. A heavier cricket bat, for instance, will produce more momentum, thus hitting the ball further, provided the batter can provide enough muscular force to swing the heavier bat at the same velocity. If the batter cannot maintain the same swing velocity by choosing a bat that is too heavy, their swing will be late – particularly in response to faster bowlers. Conversely, batters using a bat that is too light may be tempted to swing too fast, causing problems with accuracy and timing. The distribution of the mass of a striking implement (whether it is heavier at one end or the mass is equally distributed along its length) will also have an effect on building momentum. Angular momentum (the momentum of objects in angular motion, such as striking implements) is discussed in more detail in the next section of this chapter.

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Figure 2.34 Modern cricket bats have increased in mass in order to impart greater momentum to the ball. Cricket laws have recently been modified to restrict the weights of bats that are allowed to be used.

Conservation of momentum

Momentum can be transferred from one moving object to another – for instance, much of the momentum of a golf club is transferred to the ball when it is struck. The principle of conservation of momentum determines that when two objects collide, the total of their momentum will remain the same, but the objects involved in the collision may speed up or slow down as a result. Balls colliding on a snooker table can provide examples of this principle. If one ball strikes a stationary ball in a straight line, the first ball will stop and the second will move off at the same velocity as the first (assuming they are of the same mass). Because momentum equals mass multiplied by velocity, the total momentum of both balls before the collision is the same as after the collision and total momentum is conserved. In the case of the golf club striking the ball, conservation of momentum is more difficult to observe because force continues to be applied to the club after striking the ball. A poorly hit shot, however, causes an inefficient transfer of momentum and often results in a jarring reaction of the club.

Impulse

In many physical activities, athletes attempt to build the largest amount of momentum that is possible (without the loss of accuracy or timing). In order to achieve this, force must be applied over the longest possible time. In fact, the greater the amount of time for which a force is applied, the greater will be the final velocity of the object to which the force is applied. On the other hand, in absorbing force, such as catching a hard ball or landing after a somersault in gymnastics, force must be absorbed over the longest possible time in order to lessen the impact and avoid possible injury. The application of force over a given time is known as *impulse*, which is the product of the force applied (in newtons) and the time over which the force is applied (in seconds). A force of 100 N acting for two seconds (200 Ns) on an object will produce the same final velocity as a force of 200 N acting for one second (200 Ns) on the same object.

By rearranging the $f = ma$ equation (Newton's second law of motion), it can be demonstrated that impulse is proportional to the change in an object's momentum. That is, if the impulse applied to an object is increased, the object's momentum will be increased. The mathematics of this rearrangement are shown below. The Greek letter delta (Δ) is used to represent 'change in'.

$$f = ma$$

can be rearranged to:

$$f = \frac{m\Delta v}{t}$$

(because acceleration equals change in velocity over time). This can then be rearranged to:

$$ft = \Delta mv$$

(impulse is equal to change in momentum)

This is known as the impulse–momentum relationship, where changes in an object's momentum are equal to the impulse (force × time) applied to it.

This relationship has a number of implications for athletes who wish to increase (or decrease) the momentum of their own body or an object. In order to increase the momentum of a body, the performer must increase the amount of force applied, increase the time over which the force is applied, increase both the force applied and the time over which it is applied, or increase one while sacrificing a small decrease in the other. In any attempts to increase momentum, coaches and athletes must also analyse the effects of increases in impulse on losses in timing and accuracy.

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Activity 2.12

Check-in

1 Consider the actions of throwing a javelin and pitching a fastball in softball. In both these actions, the objective is to accelerate an object to the maximum possible velocity on release. Discuss the following questions with regard to producing maximum velocity in these actions.

- **a** What aspects of the technical performance of these actions ensure force is applied over the longest possible time (without suffering losses in timing or accuracy)?
- **b** How important is building the momentum of the object prior to the release of the object?
- **c** What does Newton's third law of motion imply for the production of maximum acceleration?

2 What specific training techniques would aid in the production of maximum acceleration and velocity?

3 Construct a list of sports where building momentum is important. In each case, consider what is done to apply force over the longest period.

4 Increasing the mass of a striking implement such as a baseball bat could result in transferring more momentum to the ball when it is struck. What factors limit the success of merely using a heavier implement to transfer more momentum to an object?

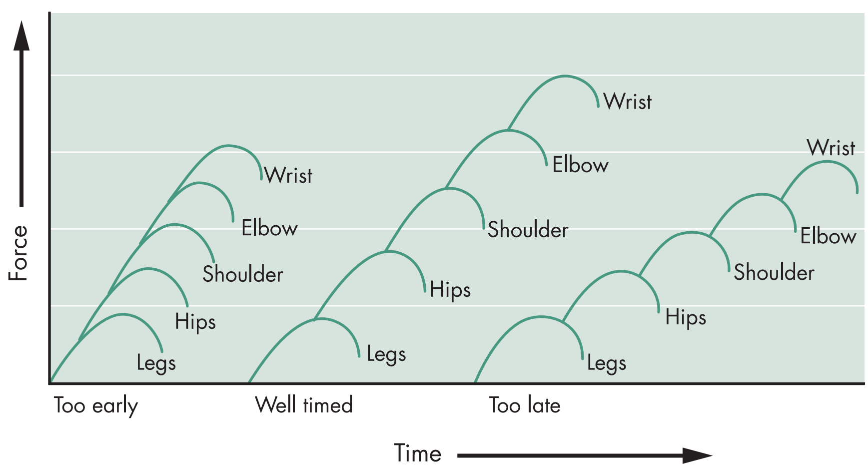

Figure 2.35 The effect of timing on gaining the maximum summation of force applied by the muscles involved in shot putting

Force summation

Almost all muscular force applied during physical activity occurs as a result of the coordinated action of many muscle groups. The resultant force is the sum of smaller forces applied by individual muscle groups (**force summation**). When a muscular force is applied with the intention of producing a maximum effort, such as in a javelin throw, each individual muscle group must begin to move at the instant that the previous muscle group is moving at maximum velocity. The release velocity of a javelin, for instance, will be at the velocity of the last body part in contact – in this case, the thrower's hand. With each muscle group beginning its action at the point of maximum velocity of the previous group, a maximum total force is achieved. Figure 2.35 uses shot putting to illustrate how timing the beginning of the action of each muscle group to coincide with maximum velocity of the previous group achieves maximum total force.

If each muscle group contracts too early (as is common in over-anxious athletes) or too late (as is common with athletes who are fatigued or beginners learning a new skill), the total *summation of forces* will be reduced. Sometimes athletes, in an attempt to apply maximum

force summation the total force produced by the coordinated actions of a group of muscles contracting in sequence

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force, contract each muscle group too early and mistime the action. For instance, trying to hit a forehand tennis shot with maximum force may result in the ball being hit inaccurately – a fault particularly common in beginners.

Physical activities that require the production of maximum force often involve as many muscle groups as possible in an attempt to summate the largest possible force. A baseball pitch begins with the action of the legs and trunk, followed by the shoulder and elbow, and finally the wrist and fingers. Most actions requiring maximum velocity are initiated by the larger, stronger muscles, such as the muscles of the trunk and thighs, in order to overcome intertia. After the movement has been initiated by these slower muscles, the weaker but faster muscles of the limbs complete the action. In some physical activities, the total action of all muscle groups from the stronger, slower muscles to the weaker, faster muscles occurs in such rapid succession that it is almost simultaneous. This explosive action of groups of muscles would be evident in activities where maximum velocity is required in a short space of time, such as a chest pass in netball or hitting a baseball.

KEY MESSAGE

Newton's three laws of motion govern the movement of objects in relation to forces applied to them. They also govern the motion of objects to which a force has not been applied.

KEY MESSAGE

Momentum is a measure of the amount of motion possessed by an object and can be transferred from one object to another.

KEY MESSAGE

Most muscular actions in physical activities involve the summation of the force applied by a number of muscle groups acting in sequence.

Activity 2.13

Engage-in

RECOGNISE & EXPLAIN | ANALYSE & SYNTHESISE | MAKE DECISIONS

Inquiry question: How do forces summate to produce maximum velocity of a thrown implement?

Engage and understand

1 In a table similar to the one on the following page, collect data regarding the throwing distance achieved from three different throwing positions.

2 Choose one of more students in your class as subjects to complete the throwing trials. Each subject completes three trials, trying to throw a tennis ball as far as possible, from three throwing positions:

- standing with the back against a solid wall, no step
- kneeling
- standing side on, taking one step into the throw.

(continued)

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3 For each subject, calculate the average throwing distance achieved from each throwing position.

Subject	Against wall			Kneeling			Standing side-on		
	Trial 1	Trial 2	Trial 3	Trial 1	Trial 2	Trial 3	Trial 1	Trial 2	Trial 3
	Average:			Average:			Average:		
	Trial 1	Trial 2	Trial 3	Trial 1	Trial 2	Trial 3	Trial 1	Trial 2	Trial 3
	Average:			Average:			Average:		
	Trial 1	Trial 2	Trial 3	Trial 1	Trial 2	Trial 3	Trial 1	Trial 2	Trial 3
	Average:			Average:			Average:		

Apply and analyse

Analyse: Examine or consider something in order to explain and interpret it, for the purpose of finding meaning or relationships and identifying patterns, similarities and differences.

4 Consider the following questions:

- Which throwing position produced the highest average distance for each subject?
- Which position produced the lowest average distance for each subject?
- What were the factors that limited throwing distance in each of the positions that produced the lowest two results?
- Explain why the throwing position that produced the highest average distance allowed forces to be summated with consideration to timing and impulse.

Body levers

Muscular force is applied to the bones of the skeleton, which form a system of levers. The bones, acting as body levers, are examples of simple machines that can change the way a force is applied. For example, a golf ball can be moved much further by using the leverage provided by a golf club than by throwing it. The golf club acts as a lever and provides a mechanical advantage. A lever is a rigid structure that rotates about an axis to which forces can be applied. In the human body, the bones are used as the rigid arm of the lever, rotating at the joints. Muscular force is applied to the bones in order to move a resisting force such as a shot put or merely the mass of the body itself. The components of a lever system are shown in Figure 2.36, and consist of:

- a *fulcrum* or *pivot point* – the point or axis of rotation (provided by a joint in the body)

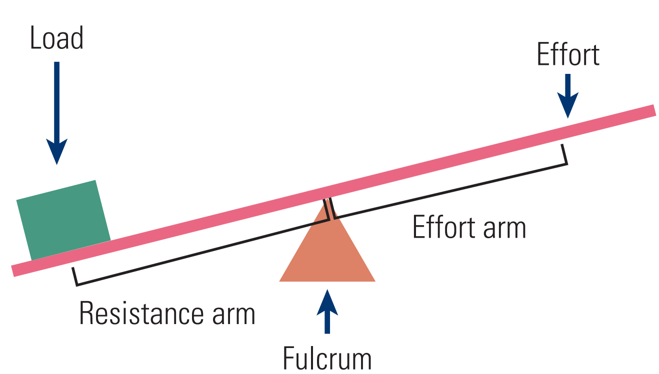

Figure 2.36 The parts of a lever system

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- an *effort point* – the point on the lever where effort (or force) is applied (provided by muscles in the human body)
- the *load point* – the point on the lever where a load (or resistance) force is applied, for example, the mass of the object to be moved which may be part of the body itself
- an *effort arm* – the distance from the effort point to the fulcrum
- a *resistance arm* – the distance from the load point to the fulcrum.

There are three types or classes of lever, which are determined by the location of the effort point, load point and fulcrum on the lever arm. These three classes of lever can provide an advantage in the way a force is applied in two ways:

- A lever can increase the amount of resistance force that can be moved becoming a force multiplier.
- A lever can increase the velocity at which the resistance force can be moved becoming a speed multiplier.

First-class levers

In a first-class lever, the fulcrum lies between the force point and the resistance point. A claw hammer and a pair of scissors are examples of this type of lever.

In a first-class lever, the position of the fulcrum in relation to the effort point and load point determines whether it provides the advantage of multiplying speed or multiplying force. If the effort arm (the distance from the effort point to the fulcrum) is longer than the resistance arm (the distance from the load point to the fulcrum), the lever act as a force multiplier. Figure 2.37 shows the use of a crowbar as a first-class lever, producing a force multiplier. The nail that cannot be moved by hand can be moved with the force-multiplying lever of the crowbar.

Figure 2.37 The longer effort arm of the crowbar acts as a force multiplier.

If the resistance arm of a first class lever is longer than the effort arm, the lever acts as a speed multiplier. Figure 2.39 on the following page shows how oars in a sweep boat are used as first-class levers in producing a speed multiplier. The boat could not be moved at the same velocity by merely using the arms instead of the oars.

In the human body, an example of a first-class lever can be found in the action of extending

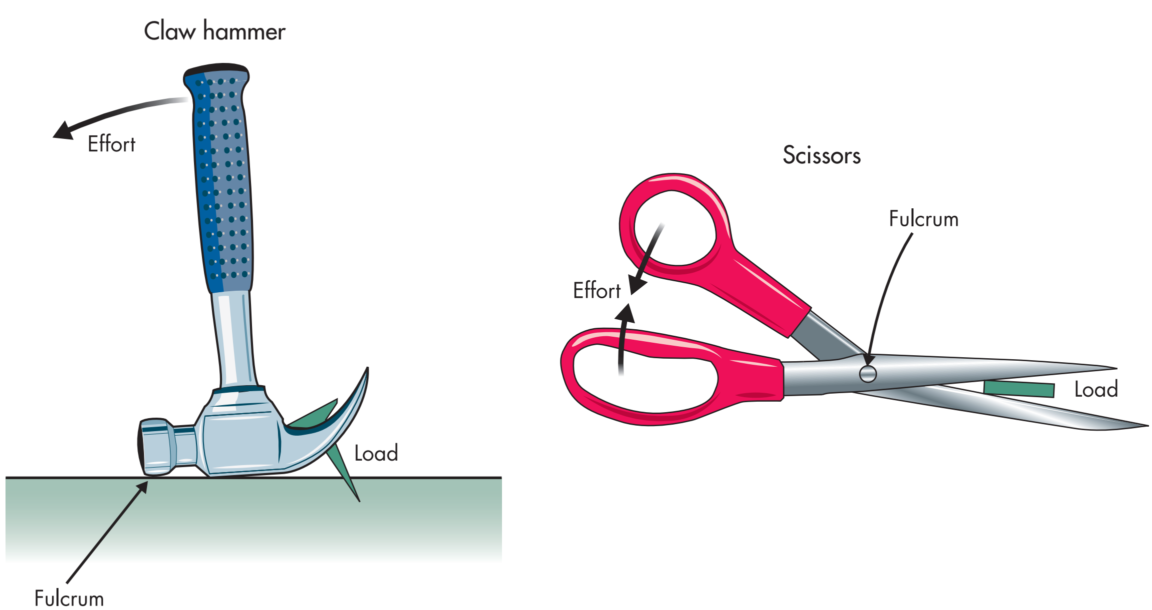

Figure 2.38 Examples of first-class levers – claw hammer and scissors

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Figure 2.39 The longer resistance arm of the oar acts as a speed multiplier.

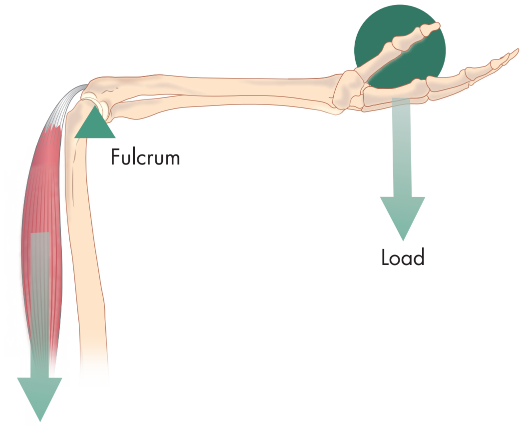

Figure 2.40 A first-class lever is seen in the action of the triceps brachii producing extension of the elbow.

the forearm, as would occur in throwing a ball. Figure 2.40 shows elbow extension using the action of the triceps brachii as an example of a first-class lever. The load is provided by the mass of the ball and arm, and the effort is provided by the action of the triceps brachii. The fulcrum (the elbow joint) lies in between the effort point and the load point, but because the fulcrum is very close to the effort point, the resistance arm is much longer. This first-class lever will therefore act as a speed multiplier.

Second-class levers

In a second-class lever, the effort point acts in between the fulcrum and the resistance point. A bottle opener and a nut cracker are examples of this type of lever.

Because of the arrangement of a second-class lever, the effort arm is always longer than the resistance arm, therefore producing a force-multiplying effect. Figure 2.42 shows how a wheelbarrow produces a force-multiplying effect, as

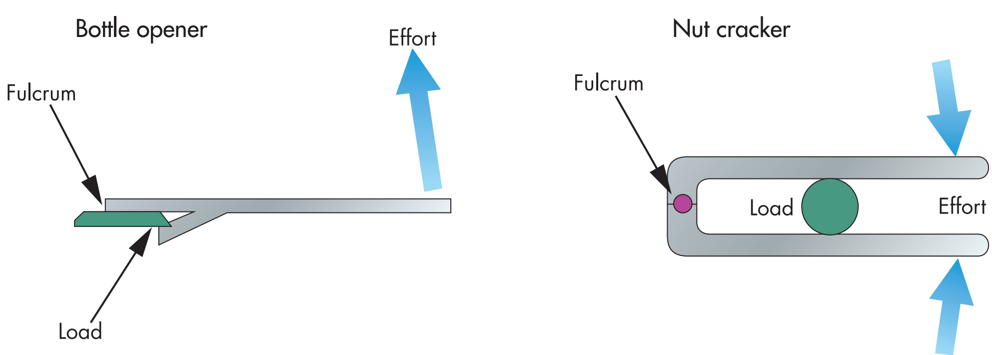

Figure 2.41 Examples of second-class levers

Figure 2.42 A wheelbarrow is a second-class lever and so acts as a force multiplier.

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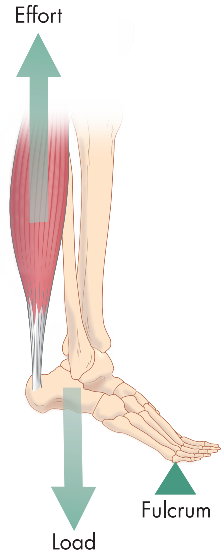

Figure 2.43 Raising the heel off the ground demonstrates a second-class lever.

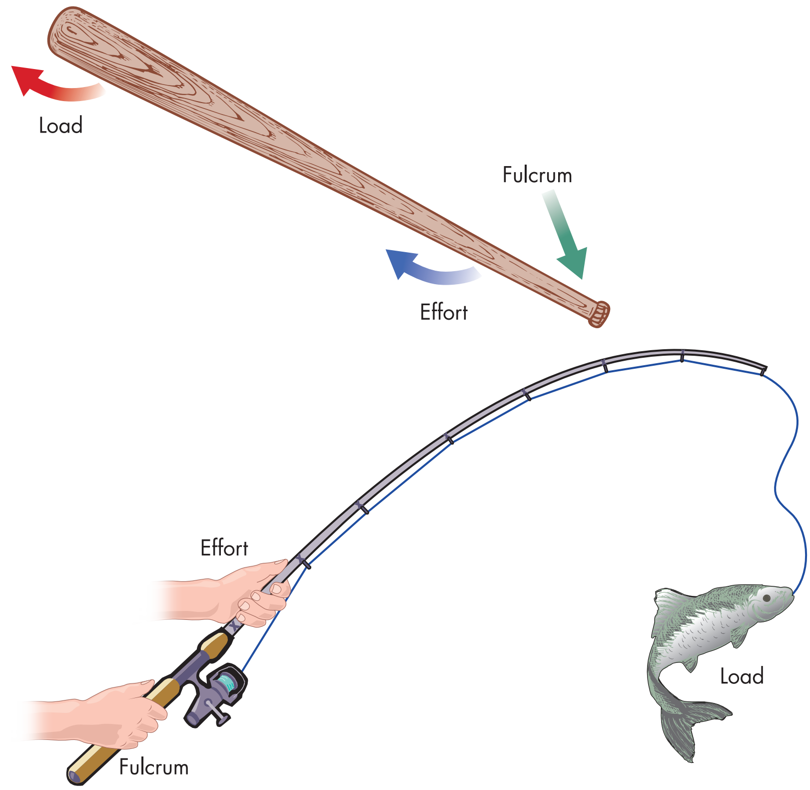

Figure 2.44 Examples of third-class levers

the effort arm is significantly longer than the resistance arm. A load that could not easily be lifted by hand is easily raised in the wheelbarrow.

In the human body, an example of a second-class lever can be found in the action of the gastrocnemius (calf muscle) in raising the heel off the ground. The ball of the foot acts as the fulcrum, the resistance is provided by the weight of the body and the force is provided by the gastrocnemius acting on the heel. The effort arm is longer than the resistance arm, therefore producing a force multiplier.

Third-class levers

In a third-class lever, the effort point is in between the fulcrum and the load point. A baseball bat and a fishing rod are examples of third-class levers.

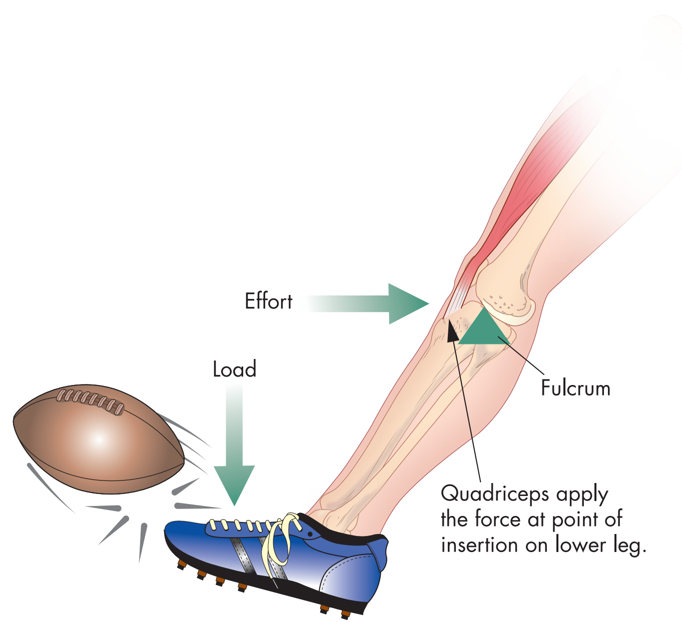

Figure 2.45 Kicking a ball demonstrates a third-class lever.

Because of the arrangement of a third-class lever, the resistance arm is always longer than the effort arm, therefore acting as a speed multiplier. With a long resistance arm, a fishing rod is used to produce a speed advantage. The sinker could not be cast nearly as far throwing it by hand.

In the human body, third-class levers are by far the most common. An example of a third-class lever acting in the body is the action of the quadriceps in kicking a ball. The knee joint acts as the fulcrum, force is provided by the quadriceps acting on the top of the tibia, and the load is the mass of the lower leg and the ball (see Figure 2.45). The resistance arm is longer than the effort arm, therefore acting as a speed multiplier.

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Leverage in physical activity

The human skeleton is made up predominantly of a series of third-class levers. Because the resistance arm is longer than the effort arm in third-class levers, the human body is quite efficient in the production of fast movements. The compromise is that the human body is less suited to lifting heavy weights. Because of generally short-effort arms and longer resistance arms (third-class levers), large amounts of muscular force are required to move heavy resistance. If a third-class lever is used to lift weight, such as lifting a barbell, the force required can be greatly reduced by shortening the length of the resistance arm. This can be achieved by lifting heavy objects as close as possible to the midline of the body.

Figure 2.46 A baseball pitcher begins the action with a shorter lever to overcome inertia, before lengthening the lever arm to produce speed.

In situations where maximum speed is required, such as throwing a fast ball, the action is initiated with a short resistance arm which is lengthened progressively during the action. In the case of pitching a baseball, the action begins with the elbow bent, thus shortening the resistance arm and allowing the inertia of the arm and the ball to be overcome with more force, and therefore greater acceleration. As the throwing action progresses, the elbow is extended, lengthening the resistance arm and allowing greater speed to be produced.

The resistance arm in many striking sports is lengthened by the use of a bat or racquet. The longer the implement, the greater will be the velocity of the hit. A longer golf club will, in theory, hit a ball further than a shorter club. However, as the length of the resistance arm of a lever system increases, so does the amount of force required to accelerate it. If a golfer progressively used longer and longer clubs, a point would be reached where the golfer could not generate the force required to accelerate the club effectively. This would result in losses in both the distance and accuracy of the shot. The selection of the length of a striking implement must be matched by the player's ability to produce the force required to accelerate the longer lever (and also possibly the larger mass). More powerful players can obviously choose longer and larger striking implements. This discussion also illustrates the role that strength training can play in producing maximum velocity.

In situations where accuracy is of great concern, often the resistance arm is reduced in length, producing a more controllable hit. Examples of this principle can be seen in a range of physical activities. In playing a forehand volley in tennis, for instance, players often shorten the resistance arm of the lever by bringing the elbow closer to the body, creating greater control. Wedge clubs in golf are shorter than those used for gaining distance and players sometimes move their hands lower down the grip to gain even more control over the shot.

The length and mass of the resistance arm in a lever system determine what is known as the *moment of inertia*, which is outlined in more detail in the next section.

KEY MESSAGE

Bones act as levers, providing a mechanical advantage in producing actions in physical activity.

KEY MESSAGE

Levers in the body can act as speed multipliers or force multipliers.

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Activity 2.14

Engage-in

Inquiry question: How do body levers act to give a speed or force advantage in producing movements?

Engage and understand

1 Choose an action or series of actions associated with the physical activity that is the focus of your study this term – for example, kicking a drop goal in Rugby League. Analyse the action in terms of the class (or classes) of body lever that act as speed or force multipliers. In order to do this, you will have to do the following:

- **a** Divide the action into any distinct phases that occur in producing it. In the example of the rugby drop goal, the kicking leg is first extended back at the hip while the knee is flexed, then swung forward at the hip, and finally extended at the knee with the ankle plantar flexed to contact the ball.
- **b** Determine the joints that produce each individual action in each phase.
- **c** For each action, determine the relative length of the effort arm (the distance from the insertion of the muscle producing the force to the moving joint that acts as the fulcrum) and the resistance arm (the distance from the centre of gravity of the load and the joint). The load in many actions may be the mass of a body segment being moved. As a rule, the centre of gravity of a limb (such as the whole arm) or a part of a limb (such as the forearm) is about four-tenths of the way down the body.

Apply and analyse

Analyse: Examine or consider something in order to explain and interpret it, for the purpose of finding meaning or relationships and identifying patterns, similarities and differences.

2 Determine the class of lever by locating the positions of the fulcrum, effort point and load point.

3 Consider the following questions:

- **a** Do the relative lengths of the force and resistance arms change during the total action?
- **b** Is there more than one class of lever operating?
- **c** How does this leverage arrangement advantage the performance of the action?
- **d** How could this information be useful to coaches or to you as a student of physical education?

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2.4 Human motion in physical activity

Human motion is produced by the interplay of the internal force of muscles contracting and pulling on the skeleton and external forces such as gravity and friction. Because muscles apply force to the skeleton, which moves at the joints between the bones, the resulting motion of body parts is, for the most part, angular motion. This angular motion can then be translated into linear motion of the whole body or an object set in projectile motion by the body. This section examines some of the principles involved in the application of force in producing human motion in physical activity.

Stability and balance

Balance is the ability – whether moving or stationary – to remain in a stable position. Balance plays an important role in almost all physical activities. Some activities require the performer to remain stationary, such as in archery or trap shooting. This is known as **static balance**. Sports such as basketball and hockey require **dynamic balance** where the performer has to remain balanced while moving. Both static and dynamic balance may involve the absorption of external force, such as in contact sports like wrestling or soccer.

A person's stability is determined by the position of their centre of gravity in relation to their base of support, and the direction of internal and external forces that are acting on their body. The following principles can be applied to increase a performer's stability in physical activities.

- To achieve static balance, the centre of gravity should be held directly over the base of support. The base of support is defined as the area between the points of contact with the ground. When the line of the centre of gravity is moved outside the area of the base of support, the performer becomes unstable.

balance the ability to remain in a stable position, whether moving or stationary

static balance the ability to maintain a stationary balanced position

dynamic balance the ability to maintain balance while moving

Figure 2.47 Dynamic balance is an important requirement in basketball.

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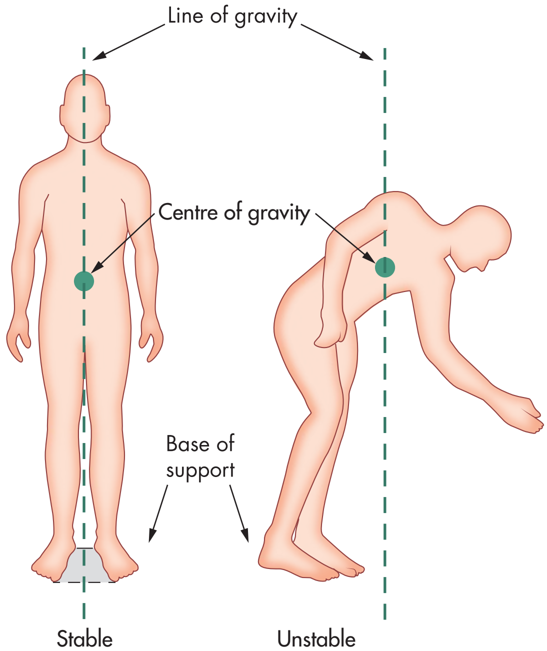

Figure 2.48 As the line of the centre of gravity is moved outside the base of support, stability is reduced.

Figure 2.49 The diver moves their centre of gravity forward, away from the base of support, to initiate the dive.

- When a static balance is required in a sport like judo, the centre of gravity is kept centred over the base of support, making it more difficult for the body to be unbalanced by the opponent. When a performer needs to maintain balance while being acted on by external force, such as in a rugby tackle, balance is improved by moving the centre of gravity towards the oncoming force and lengthening the base of support. In some activities, the centre of gravity is deliberately moved towards the edge of the base of support, creating a more dynamic position in preparation for movement. Sprinters, for instance, move their centre of gravity forward in the set position in order to assist their start.
- A more stable position is achieved by increasing the size of the base of support. A wrestler is more difficult to unbalance while on their hands and knees than while standing. Target sports, such as pistol shooting, require a stable but comfortable position. This is achieved by widening the base of support by positioning the feet about shoulder width apart. In activities that require quick movement from a stable position, such as receiving a tennis serve, the base of support is again comfortably widened, but weight is distributed on the balls of the feet with the knees slightly flexed. In preparation to move, performers often 'unweight' into a ready position by extending the knees and slightly raising the centre of gravity. This position is slightly less stable, but allows for quick movement into another position. The amount of friction between the supporting surface and the body's base of support will also affect stability. In some activities, sport shoes – such as sprinter's spikes – are designed to increase friction and therefore increase stability. In other activities, shoes are designed to reduce friction to allow more dynamic balances – such as ice skates or tenpin bowling shoes.
- Lowering the centre of gravity towards the base of support increases stability. After rebounding in basketball, players often widen their base of support and lower their centre of gravity to achieve a stable position and ensure ball retention.
- If a part of the body or piece of equipment is moved away from the base of support, stability is reduced. This movement causes the centre of gravity to move away from the centre of the base of support in the same direction. Moving another body part in the opposite direction can compensate, leaving the centre of gravity over the base of support.

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Figure 2.50 To remain stable, the tenpin bowler extends the leg backwards to compensate for the movement of the arm and the bowling ball.

Activity 2.15

Check-in

1. What actions can be taken by a player in a contact sport to maintain stability during contact?
2. Using an example from your current physical activity of study, explain how stability is achieved and why this is important for the success of your performance.

- Increases in body mass aid stability. Increases in mass cause an increase in inertia and greater forces are required to cause movement. This principle is used to great effect in sumo wrestling. In other contact sports where stability is important, such as Rugby League, increases in body mass must be balanced with requirements for agility and speed. When an external mass is added to the body – for example, picking up a shot put in preparation to throw – the centre of gravity moves towards the added mass. In the case of the shot putter, the opposite arm is positioned to compensate as well as lowering the centre of gravity in preparation for the put.

In many situations in physical activities, these principles are used in various combinations to produce the particular type of balance required, or are used to unbalance the opposition. Where dynamic balance is required, good footwork allows the performer to be in the correct balanced position to be able to efficiently apply or absorb force.

Stability is determined by the position of a person's centre of gravity in relation to their base of support and motion.

Moment of inertia

The inertia of an object in linear motion is determined by its mass. The greater the mass of an object, the greater its inertia is, or its tendency to remain in the same state of motion. Human movements are produced at the joints, and are angular rather than linear in nature. In angular motion, inertia is determined not only by the mass of an object but also by the distribution of mass along its axis. The distribution of mass along the axis of an object in angular motion is called its *moment of inertia*. The closer the centre of gravity of an object is to the axis of rotation, the easier it is to rotate.

The baseball bat in Figure 2.51 would have a lower moment of inertia when it is swung holding the larger end, as its centre of gravity would be closer to the axis of rotation.

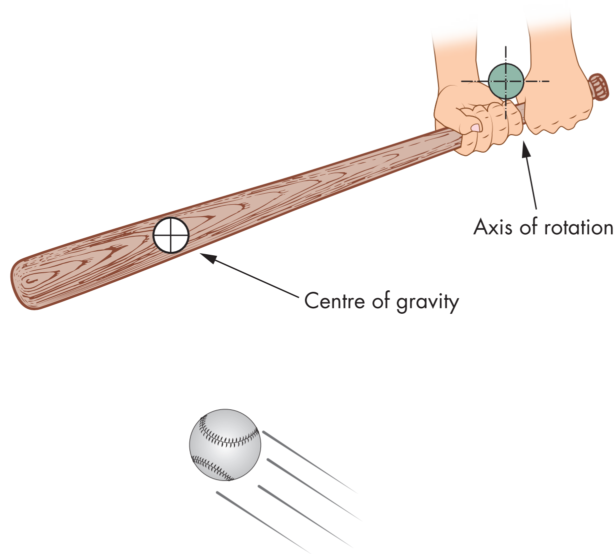

Figure 2.51 The position of the centre of gravity of the baseball bat in relation to the axis of rotation determines the moment of inertia.

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There are a number of implications of the principle of moment of inertia for human performance in physical activity. The design of various pieces of sporting equipment utilises this principle to increase player control by changing the distribution of mass within the implement. Modern tennis and squash racquets have more of the mass of the head of the racquet in the frame. By distributing the mass of the racquet away from its longitudinal axis, the moment of inertia along this axis is increased, making it harder to rotate. This has the effect of reducing the effect of off-centre hits, and therefore increasing the 'sweet spot' of the racquet. By increasing the thickness of the edges of a cricket bat, its mass is distributed further away from the longitudinal axis. Like the tennis racquet, this reduces the effect of off-centre hits as the increase in its moment of inertia makes it more resistant to rotation, thus increasing the likelihood of hitting the ball straight.

The equipment chosen for use by junior players must also consider the effects of moment of inertia. Many junior players in sports like baseball and softball have a tendency to grip the bat further down the handle. This reduces the moment of inertia and makes the bat easier to swing. It would be better in terms of learning correct skills and timing to supply junior players with implements that are shorter and can be swung comfortably with the correct grip. Players at any level will have to match the size and shape of striking implements with individual characteristics, such as the amount of force they are capable of applying and their arm span. Coaches in these sports must ensure that the choice of equipment does not interfere with basic technique.

Reducing the length of the axis of rotation also has the effect of lowering the moment of inertia. Sprinters can increase their stride frequency (the number of strides taken per second) by reducing the moment of inertia of the leg during the recovery phase (while the leg is swinging under the body to take another stride). By flexing the knee, the axis of rotation is reduced and therefore so is the moment of inertia of the leg, making it easier (and faster) to swing through for the next stride. Reducing the axis of rotation while performing a back somersault in gymnastics can be achieved by pulling into a tight tuck position. This will reduce the moment of inertia, making the somersault easier to perform. The next section examines the relationship of the size of the axis of rotation and angular velocity.

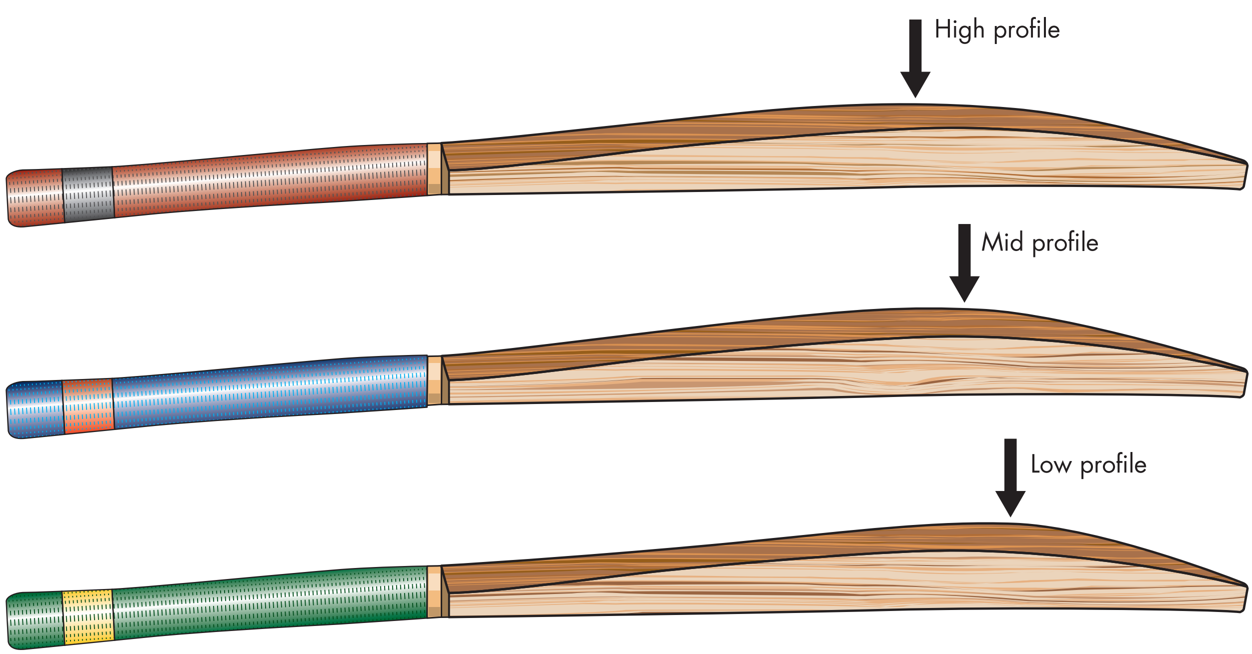

Figure 2.52 A range of cricket bats with varying mass distributions cater for individual player differences, preferences and skill levels.

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Angular momentum

As previously discussed, linear momentum is a measure of the amount of motion possessed by an object in linear motion and is the product of an object's mass and its velocity. Similarly, objects in angular motion possess angular momentum. The angular momentum of an object is not only related to its mass, but how its mass is distributed along the axis of rotation – in other words, the object's moment of inertia. If the angular momentum of a rotating object remains constant, reductions in the moment of inertia will cause an increase in angular velocity.

The principle of conservation of momentum (discussed in an earlier section of this chapter) applies to angular momentum in a similar way to which it applies to linear momentum. An object will continue to rotate with constant angular motion unless it is acted upon by an external force. Because human motion is produced by angular movements of the joints, this principle can be applied to many physical activities.

One example that illustrates the conservation of angular momentum is ice skating. A skater performing a spin with the arms outstretched can increase the speed of the turns by bringing the arms closer to the body. As the arms are moved towards the body, the total body mass is distributed closer to the axis of rotation, thus reducing the moment of inertia. Because angular momentum is conserved and remains constant, when the moment of inertia is reduced, angular velocity must increase.

A gymnast wishing to perform a double back somersault moves quickly into a tight tuck after take-off. This action reduces the moment of inertia, increasing the angular velocity of the rotation, allowing for both turns to be completed. The action of changing direction quickly in any physical activity often involves pulling the arms closer to the body to increase the velocity of the turn, such as a dummy pass and step in touch, or pivot and drive in basketball.

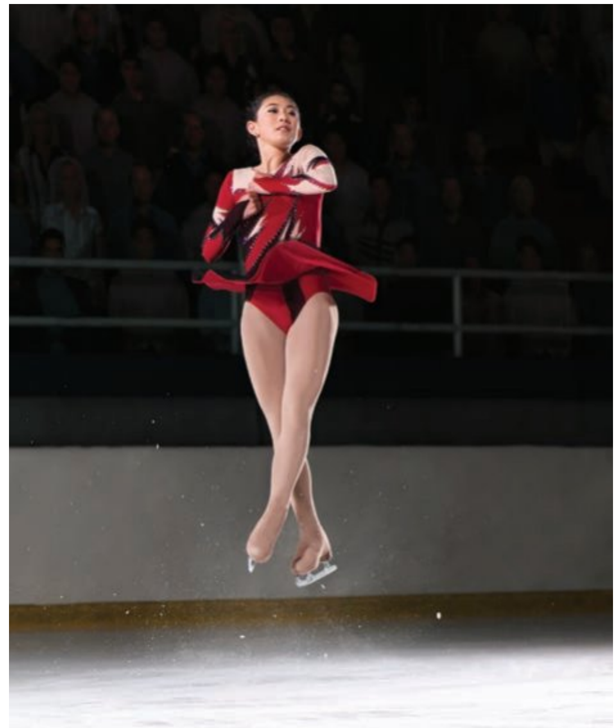

Figure 2.53 A figure skater pulls the arms into the body in order to reduce the moment of inertia and increase the speed of rotation.

An examination of a diver performing a front somersault illustrates how the angular velocity of rotation can be increased and decreased in order to produce a crisp somersault and controlled entry. After leaving the platform, the diver grasps the legs below the knees and tucks the head. This action reduces the moment of inertia, and therefore increases the

Figure 2.54 The moment of inertia of the diver is reduced in a tight tuck position, increasing angular velocity and allowing more rotations to occur.

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angular velocity of the somersault. The diver then straightens the body, which will reduce the angular velocity of the turn and allow the diver's body to align for entry into the water.

Transfer of angular momentum

In many physical activities, the angular momentum of one body segment is transferred to another. In the action of throwing a discus, the hips are rotated forward and then stabilised. The stabilising of the hips transfers the momentum of this rotation to the upper body, assisting the rotation of the shoulders and arms. In basketball, the action of performing a jump shot while turning also involves a transfer of angular momentum. The action is initiated by the upper body beginning to rotate in the direction of the turn before the feet have left the ground. When the player jumps into the air, the angular momentum of the shoulders is transferred to the whole body, causing it to rotate.

Figure 2.55 shows a snowboarder performing an aerial twisting trick. Angular momentum is built in the upper body by swinging the arms across the body to rotate the shoulder girdle just before take-off. This momentum is then transferred to the lower body, allowing the whole body to twist. Bringing the arms close to the body after take-off will reduce the moment of inertia and increase the angular velocity of the twists.

KEY MESSAGE The moment of inertia describes the distribution of mass along an object's axis of rotation.

KEY MESSAGE Angular momentum can be transferred from one part of the body to another.

Figure 2.55 The total angular momentum of the snowboarder is first confined to the upper body and then transferred to the legs and board, causing the whole body to twist.

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Activity 2.16

Check-in

List examples of movement sequences from various physical activities where the moment of inertia of the whole body or a body part is reduced or increased in order to perform the action.

2.5 Projectile motion in physical activity

An object that is propelled into the air is known as a *projectile*. Many physical activities involve applying force to an object in order to propel a projectile. Once in the air, the path the object takes will be determined by the direction and size of the force that propelled it, the effect of gravity and the effect of lift and drag forces caused by the air. The flight path of an object propelled into the air is called *projectile motion*. Some examples in physical activities include a tennis ball that has been struck by a racquet, a discus thrown by an athlete or the human body itself while high jumping. This section examines some of the principles involved in producing projectile motion in physical activity.

Projectile motion

When an object (which could be the human body) is propelled into the air, the shape of the flight path (or trajectory) it will follow is described as a parabola. This motion is best explained by separately examining the horizontal and vertical components of an object's motion. Consider the motion of a cricket ball that is hit in the air and over the boundary rope for six runs. Vertically, the ball, under the influence of gravity, will lose vertical velocity to a point where it reaches maximum height. At this point, it will begin to fall towards the ground, increasing its velocity until it hits the ground. Horizontally, the ball, influenced by its inertia at the point of being struck, will continue at close to the same velocity until hitting the ground, where the force of friction acts upon it to stop its motion.

The distance covered by an object in flight will be determined by a number of factors that occur at the point of release (or the point of being struck). These are the relative height of the point of release, the relative height of the point of landing, the angle of release, any aerodynamic lift forces due to its shape or spin, drag forces due to air resistance and the velocity of the object at the point of release.

- The higher an object is released above the ground, the further it will travel. Taller athletes in field events will hold a slight advantage over shorter athletes.
- If the objective of an activity is to gain maximum distance of a projectile, such as in long jump or

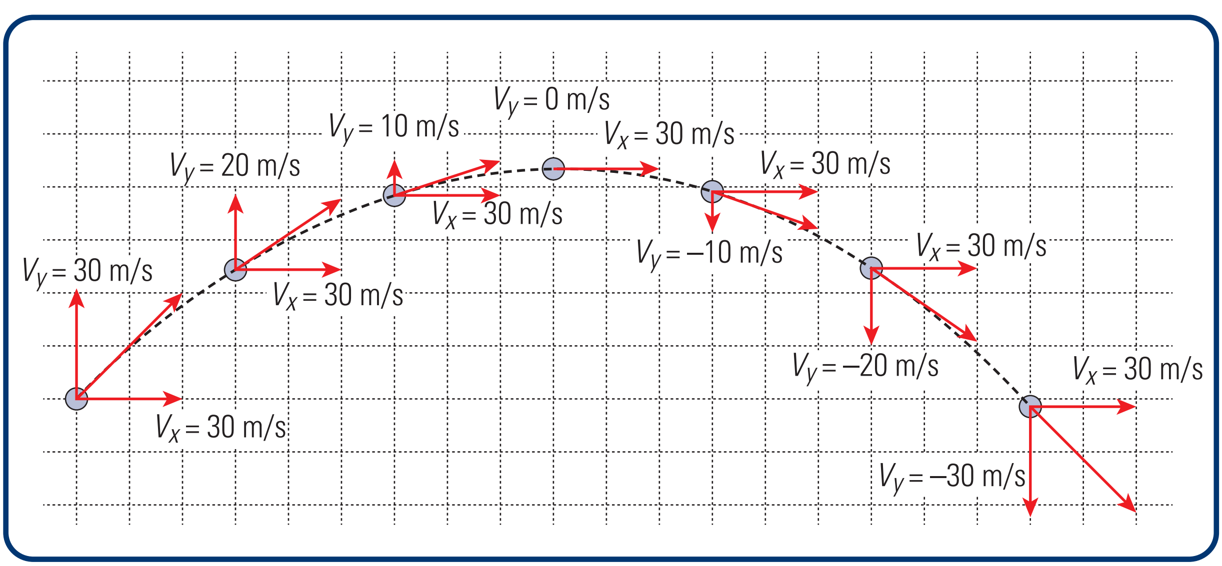

Figure 2.56 The vertical and horizontal components of projectile motion

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Throwing event	Optimum angle of release	Influence of air resistance and lift forces
Shot put	35–40°	Little influence
Hammer	45°	Little influence
Discus	30–40°	Good technique utilises lift force to advantage
Javelin	28–35°	Good technique utilises lift force to advantage

Table 2.6 Optimum angles of release in throwing events

javelin, the object must be released at an angle that will give the maximum horizontal distance. This angle is known as the *optimum angle of release*. In an environment without air, where the flight of an object is not influenced by air resistance or lift forces, the optimum angle of release would be 45 degrees. In reality, optimum release angles are generally less than 45 degrees, due to air resistance, optimum joint angles to produce maximum muscular force, lift forces and the release point above the ground. Table 2.6 lists the optimum angle of release used in throwing events.

- If the height of the release point is not at the same level as the landing point, as is often the case while playing golf, angles of release will have to be varied to produce the best result.
- The higher the velocity of an object at the point of release, the more momentum it will possess, and therefore the further it will travel. Athletes must ensure, however, that good technique is maintained in the attempt to produce maximum velocity. In many activities, a low angle of release is required in order to reduce the time that the projectile remains in the air rather than attempting to gain maximum distance. A netball pass, for instance, has less chance of being intercepted by the opposition if its trajectory is low and fast. If a lower angle of release is required, release velocity must be increased to ensure the object travels the distance to the intended target.

KEY MESSAGE

Projectiles follow a flight path or trajectory known as a parabola. Many factors can affect the trajectory of an object.

Activity 2.17

Check-in

1. Consider examples of physical activities that involve projectile motion of the human body. What actions are performed in these activities to ensure that the desired motion is achieved?
2. Consider examples of physical activities that involve projectile motion of an object. How do the principles that govern the application of force (discussed in detail earlier in this chapter) impact on producing the desired trajectory?

Drag and lift forces

The horizontal velocity of a projectile may be influenced by air resistance. When an object moves through the air, friction between the air and the object cause drag forces, which may slow the object down. The amount of friction is influenced by the frontal area and the shape of an object as it moves through the air. A more streamlined shape produces less friction with the air, and therefore less drag. The effect of air resistance on a well-thrown javelin would be very small compared with the air resistance acting on a shuttlecock. Drag forces produced by air resistance may influence the shape of the trajectory of some objects. Figure 2.57 on the following page shows the effect of air resistance on the trajectory of a shuttlecock in a defensive clear shot. As air resistance is high due to the shuttlecock's feathers and its mass is low, even when hit hard, the air resistance causes it to slow down quickly.

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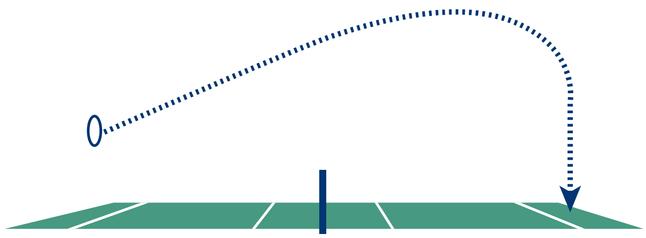

Figure 2.57 The effect of high air resistance on the trajectory of a shuttlecock

The trajectory of an object may also be influenced by lift force. The shapes of some objects as they move through the air cause the air to move faster over the object than underneath it. This results in an area of low pressure above the object, causing a lift force. This phenomenon is known as **Bernoulli's principle**. It is named after Daniel Bernoulli, who first described the variations in pressure that occur when fluids flow over various surfaces. A discus in flight provides a good example. When thrown at a slight angle to the horizontal, as illustrated in Figure 2.58, the discus produces a lift force that will resist the force of gravity and extend the distance of the throw. If the discus was thrown with poor technique, such as in a tumbling motion, no lift force would be generated, air resistance would be increased and the total distance covered would be reduced. Correct technique in taking advantage of lift force and reducing drag is very important in events such as discus and javelin.

Bernoulli's principle the trajectory of an object moving through a fluid may be influenced by lift or Magnus forces

The effect of spin on projectiles

Another application of Bernoulli's principle, regarding changes in pressure that occur as objects move through a fluid, involves objects that are spinning. If an object is spinning as it moves through the air, the spinning motion will produce forces that may alter the object's flight path. Top spin will cause a ball to drop faster, side spin will cause it to curve to one side and back spin will cause a ball to lift. This effect occurs because, as a ball spins while moving through the air, it creates a difference in air pressure on either side of the ball. The ball will be pushed towards the side with the lowest pressure. This force is also known as a Magnus force (or Magnus effect), which operates in the direction of the spin around the front of the ball as it travels. A ball with less mass will be more influenced by Magnus force – for instance, a spinning table tennis ball will move quite markedly, whereas the effect of Magnus force on a spinning shot put would be negligible. Figure 2.59 illustrates the production of Magnus force as a ball spins through the air.

Spin is used to alter flight paths in many physical activities that involve a ball. A topspin shot in tennis causes the ball to drop, which allows the player to put more speed on the shot and still allow the ball to

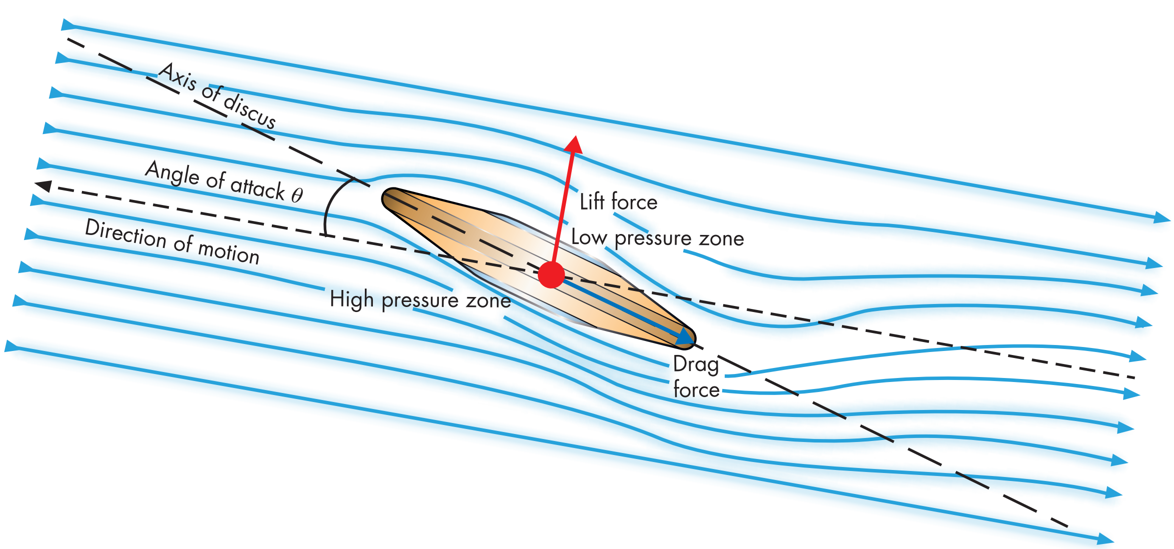

Figure 2.58 A well-thrown discus tilts upwards as it meets the air at an angle called the *angle of attack*. The air flow over the top surface is faster and creates a low pressure zone. The air flow under the bottom surface is slower and creates a high pressure zone. This pushes the discus up (the lift force). This is Bernoulli's principle.

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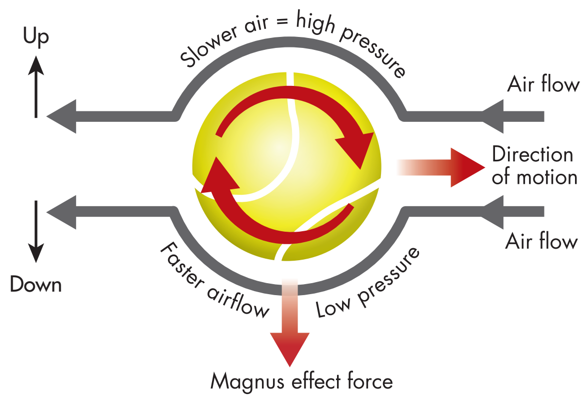

Figure 2.59 The production of Magnus force by a ball moving through the air while spinning with topspin as viewed from the side

land in the court. Side spin is used in activities such as baseball, cricket and table tennis to make the ball curve to one side and hopefully deceive the opposition player, forcing an error. In cricket, however, the ball 'swinging' or curving in the air occurs more as a result of the effect of drag forces that act on the stitching of the ball and over one side of the ball that has been rubbed to maintain a smoother surface than the other. In other activities, such as golf, players attempt to reduce side spin to avoid 'hooking' or 'slicing' the ball (however, very skilled golfers can deliberately impart side spin to flight the ball past obstacles).

Impact and rebound

When a spinning object bounces off a surface, the spin will have an effect on the angle at which the ball rebounds off that surface. The angle of rebound of a ball that is not spinning will in theory be equal to the angle at which it hit the surface. The rebound angle, however, is in reality affected by the friction between the ball and the surface it strikes, the hardness of the surface, how fast it is spinning and the elasticity of the ball.

When a ball strikes a surface with back spin, increased friction between the ball and the surface acts in the direction of the spin, causing an increase in the angle of rebound. Fast bowlers in cricket apply backspin to the ball, causing the ball to rise sharply when it hits the pitch.

When a ball with top spin strikes a surface, deceased friction between the ball and the surface acts in the direction of the spin, causing a reduction in the angle of rebound. This is evident in table tennis, as a ball with top spin will stay low after bouncing. This effect is not always obvious, as friction, drag and trajectory all affect the angle of rebound. For example, a top spin shot in tennis may in fact bounce higher because the Magnus effect has caused the ball to drop sharply, increasing the angle at which the ball hits the court.

A ball with side spin will cause the ball to rebound in the direction of the spin. The material from which a ball is made will contribute to the effect of spin on the angle of rebound. For example, if a spinning cricket ball lands on its stitches, friction between the ball and the pitch is increased and the angle of rebound will increase. In all cases, an increase in the angular velocity of the spin will result in greater deviations in the angle of rebound.

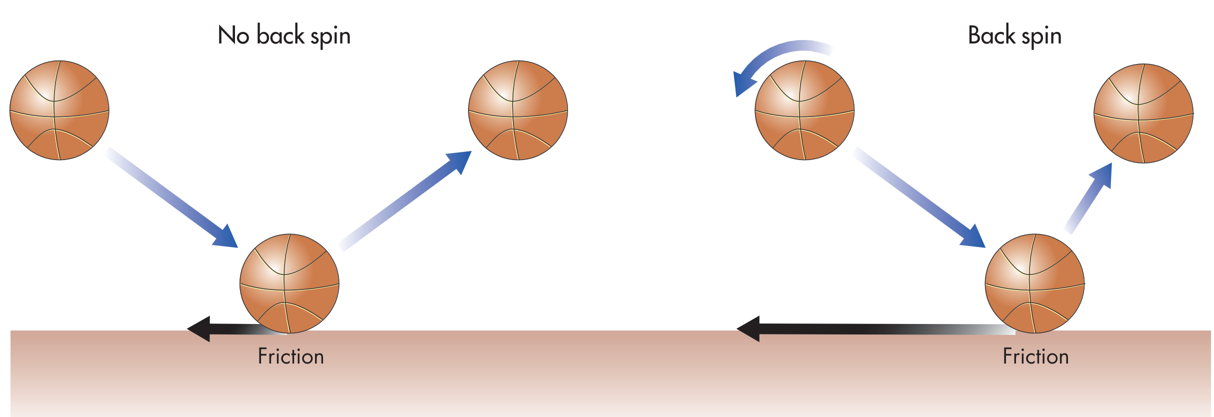

Figure 2.60 Back spin causes an increase in the angle of rebound. The lengths of the black arrows show the size of the friction force.

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> **KEY MESSAGE** Drag and lift forces influence the trajectory of objects.

> **KEY MESSAGE** Bernoulli's principle explains lift and Magnus forces that affect the trajectory and rebound of objects.

Activity 2.18

Check-in

1. Using table tennis balls and bats, try applying variations in spin on the ball:
   a. top spin
   b. back spin (slice)
   c. side spin.
2. What is the effect on the flight path of the ball when various types of spin are applied? Redraw Figure 2.59 (on the previous page) with the ball spinning in the opposite direction to represent the effect of back spin. Draw a second diagram to represent the effect of side spin showing the view of the ball from above.
3. What happens when a ball with heavy top spin strikes a vertical bat?
4. What must the receiving player do to counter the effect of top spin?

Inquiry cycle – stages 2 & 3: Apply and analyse; Evaluate and justify

In this section, you will be required to apply your knowledge and understanding of functional anatomy and biomechanics developed in Stage 1 of the chapter to analyse movement sequences and devise biomechanical strategies to optimise performance. You will also be required to justify biomechanical strategies and reflect on these in order to evaluate effectiveness in optimising performance.

2.6 Muscular analysis

Conducting a muscular analysis of particular movement sequences examines which muscles are working and the type of contractions they are performing. From this, coaches and athletes can determine what kind of exercises are appropriate for developing these muscles.

Steps in conducting muscular analyses

1 Select the movement sequence to be analysed. It is best to select distinct rather than serial movement sequences – for example, a spike in volleyball.

2 Break the movement sequence into phases where only one movement per plane is occurring (e.g. hip flexion is occurring, not hip flexion and hip extension). The number of phases in movement sequences will vary, but most sporting movement sequences can be described in two to five phases. A typical breakdown of phases may include:
- stance phase
- preparatory phase
- movement phase
- recovery phase.

The names given to describe each phase often use sport-specific terminology, and may include the name of the body part involved. For example, a baseball pitch is often described in five phases: wind-up, early cocking, late cocking, acceleration and follow-through.

3 For each phase, determine the joints at which movements are occurring and the type of

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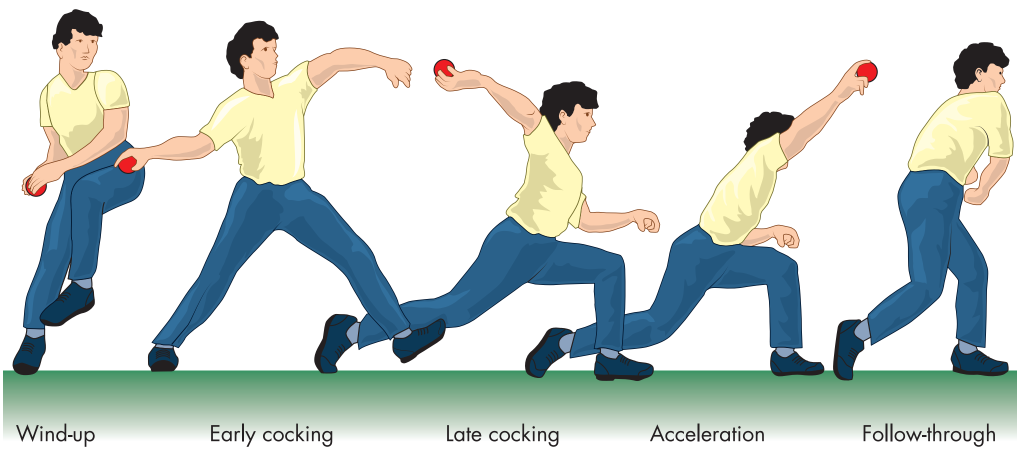

Figure 2.61 Phases of a baseball pitch

movement – for example, shoulder horizontal flexion, elbow extension.

4 For each phase, at each joint, determine the type of muscular contraction that is occurring.

When the agonist muscles in a movement are developing force while shortening to cause movement, the contraction is concentric. The antagonist muscles must relax to allow the movement to occur. This usually occurs when a body part is moving against gravity or in an acceleration phase.

When the antagonist muscles in a movement are developing force while lengthening to control or slow down movement, the contraction is eccentric. This usually occurs when a body part is moving with gravity or in a follow-through or recovery phase.

In the 'up' phase of a push-up, the action of the triceps brachii to extend the elbow is concentric. The triceps brachii is the agonist in elbow extension and is shortening to cause the movement. In the 'down' phase, elbow flexion is controlled by the eccentric contraction of the triceps brachii, which lengthens under force. The triceps brachii is usually the antagonist in elbow flexion, but in this case it is working eccentrically to control the speed of the 'down' phase.

5 Considering the types of muscle contraction occurring, list the muscles that are under force to produce each movement, at each joint, in each phase. See Table 2.7 for an example of a completed muscular analysis for a 'latissimus pull-down'.

Phase	Joint	Movement	Contraction	Muscles
Down	Elbow	Flexion	Concentric	Biceps brachii Brachialis Brachioradialis
	Shoulder	Adduction	Concentric	Pectoralis major Latissimus dorsi Teres minor
Up	Elbow	Extension	Eccentric	Biceps brachii Brachialis Brachioradialis
	Shoulder	Abduction	Eccentric	Pectoralis major Latissimus dorsi Teres minor

Table 2.7 Muscular analysis of a latissimus pull-down

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Muscular analysis determines which muscles are working and the type of contraction they are performing.

Figure 2.62 Latissimus pull-down

Activity 2.19

Active investigation

Inquiry question: What specific joint movements, muscles and types of muscle contraction occur in specific movement sequences?

Engage and understand

1 Select a movement sequence from the physical activity that is the focus of your study this term. Your teacher may select a less complex movement sequence for your first attempt and then move on to a more complex sequence.

2 Observe class members perform this action. Take notes, recording your initial thoughts about the phases and movements involved.

Apply and analyse

Apply: Use knowledge and understanding in response to a given situation or circumstance; carry out or use a procedure in a given or particular situation.

3 In small groups, follow the steps involved in conducting a muscular analysis outlined in the previous section. Construct a table similar to Table 2.7 on the previous page to record your findings.

4 Allow each group to share their findings. Discuss these findings and come to a class consensus about the analysis.

Evaluate and justify

Synthesise: Combine different parts or elements (e.g. information, ideas, components) into a whole, in order to create new understanding.

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5 Based on the analysis, construct a list of exercises that could be included in a training circuit designed to improve the performance of the identified muscle groups. Justify the inclusion of each exercise by discussing how the exercise targets the specific muscles and contraction types identified in the analysis. You may also consider matching the speed of the muscular contractions involved in each phase of the movement sequence.

2.7 Biomechanical analysis

Biomechanical analysis is an important part of performance enhancement in elite sport. Biomechanists use a range of measurement strategies to analyse specific movement sequences with a view to assisting athletes to develop more efficient movement patterns and avoid potential injuries.

As well as assisting elite athletes, biomechanical analysis can benefit athletes of all ages and skill levels. For example, biomechanical analysis of an athlete's sprint technique may reveal ways to improve the efficiency of the running stride and allow them to gain that extra metre of speed. There are two types of biomechanical analysis: quantitative and qualitative. **Quantitative analysis** involves collecting performance data that are measurable (defined using numbers). This type of analysis usually involves the use of expensive measurement tools, and therefore is only done for elite athletes. **Qualitative analysis** involves data gathered by observers watching the performance, and therefore is more accessible to all athletes at any level. The quality of this form of analysis is related to the biomechanical and sport-specific technical knowledge and experience of the observer.

quantitative analysis examination of events through measurement and assigning numeric values

qualitative analysis examination of events by recording observations that cannot be measured using numeric values

Qualitative biomechanical analysis often involves collecting video footage at various stages of the improvement process. This would involve an initial filming session, gathering footage of the targeted movement sequence (for example, the performance of an overhead serve in volleyball). This pre-practice footage would be examined and analysed using understandings of biomechanical principles and ideal technique. Based on this analysis, recommendations are made about how to improve the performance. Athletes are then given time to practise, making the necessary adjustments to correct the movement sequence. A second, post-practice filming session is then conducted. The pre-practice and post-practice footage is then compared to determine whether the period of practice was successful. This cycle is repeated until the coach and athlete are satisfied that the movement sequence has become as efficient as possible.

Steps in conducting qualitative biomechanical analyses

1 **Select the movement sequence to be analysed.** It is easier to analyse a discrete skill than a progression of serial skills.
2 **Describe the ideal technique of the movement sequence.** Use available research on websites, in coaching manuals or journals, or talk to coaches to deepen understanding of the skill sequence.
3 **Identify the purpose or goal of the movement sequence.** This is the desired outcome or measure of success of the skill. This may be more difficult to determine for some skill sequences than for others. Generally, it is easier to determine the mechanical goal of skills with an outcome that is measured objectively, such as in track and field, where there is a single objective. Other skills may have several purposes. The goal of a volleyball serve is to make it difficult for the opposition to set up an attack or win the point outright. The mechanical goal involves both speed and accuracy. The mechanical goal of a tennis serve may involve speed, spin and accuracy. In determining the mechanical goal of a particular movement sequence, consider the requirement for one or more of the following:
   - speed
   - accuracy
   - strength
   - power

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- amount of force required
- force/accuracy balance
- energy efficiency
- imparting spin
- adherence to technical rules.

4 **Identify the key biomechanical principles that govern the production of the movement sequence and allow mechanical goals to be realised.** Depending on the nature of the movements sequence, this may include:
   - principles of force application
   - Newton's laws of motion
   - impulse and momentum
   - force summation
   - leverage
   - transfer of momentum
   - stability and balance
   - drag and lift forces.

   Explain the application of key biomechanical principles to the performance of the movement sequence.

5 **Determine the best position to record video footage.** Consider the plane on which the movement sequence occurs. Video should be recorded perpendicular to this plane. In some cases, video footage may be required to be taken in two planes. For example, analysis of a sprint start may benefit from footage taken from the side and front. Capture the required pre-practice footage.

6 **Evaluate the performance of the movement sequence through comparison with the ideal technique.** Some video software applications allow analysts to view ideal and the subject's movement sequences side by side and in time sync. Identify errors in the movement that require correction. This list could be prioritised if many errors are evident. Explain the effect of identified errors on the quality of performance using the previously identified key biomechanical principles (step 4).

7 **Allow a period of practice** for the athlete to work on correcting the identified errors.

8 **Capture post-practice footage.** Compare pre-practice and post-practice footage to determine whether the period of practice was successful.

KEY MESSAGE

Qualitative biomechanical analysis involves collecting observations of performances and making comparisons with ideal technique.

Activity 2.20

Active investigation

RECOGNISE & EXPLAIN | ANALYSE & SYNTHESISE | EVALUATE | JUSTIFY | MAKE DECISIONS

Inquiry question: How can qualitative biomechanical analysis be used to identify and correct errors in movement sequences and further understanding of biomechanical principles?

Engage and understand

1 Select a movement sequence from the physical activity that is the focus of your study this term. Your teacher may select a less complex movement sequence for your first attempt and then move on to a more complex sequence.

2 Complete step 2 of a biomechanical analysis as outlined in the previous section. Record your research findings.

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Apply and analyse

Apply: Use knowledge and understanding in response to a given situation or circumstance; carry out or use a procedure in a given or particular situation.

3 Complete steps 3, 4 and 5 of a biomechanical analysis as outlined in the previous section. Record your findings.

4 Share and discuss these findings with the subject of the analysis.

Evaluate and justify

Synthesise: Combine different parts or elements (e.g. information, ideas, components) into a whole, in order to create new understanding

Evaluate: Examine and determine the merit, value or significance of something, based on criteria.

5 Complete the biomechanical analysis by following step 6 of the process.

6 Publish your findings as a report. Use the following as the heading and sub-headings of your report:

Biomechanical analysis of: ____________________

Subject: ____________________________________

- Ideal technique
- Purpose of the movement sequence
- Key biomechanical principles
- Performance evaluation
- Practice recommendations

You may consider publishing your findings in a multimedia format, including annotated video footage.

7 You may decide to complete the biomechanical analysis cycle by completing steps 7 and 8 of the biomechanical analysis process.

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Chapter summary

- Functional anatomy in the context of biomechanics is the study of the function of muscles and bones.
- Biomechanics is the study of the mechanics of human movement.
- A force is a push or a pull in a given direction.
- Forces that affect motion in physical activity can be either external or internal forces.
- The skeleton provides a framework that allows the body to move.
- Muscles, through their attachment to the skeleton via tendons, provide the forces for the skeleton to achieve movement.
- Synovial joints are freely moveable and allow a range of movement to occur.
- Synovial joints are categorised by their shape and the type of movements that can occur.
- A common language of anatomical terms is used to describe human movements at the joints, the planes on which movement occurs and the location of structures in the body.
- Internal forces are those produced by the contraction of muscle fibres that consist of many contracting units called myofibrils.
- Muscle fibres are arranged into motor units that consist of a bundle of muscle fibres and the nerve cell (neuron) that controls it.
- As the number of motor units stimulated by nervous impulses increases, so does the force produced by the muscle.
- Muscular contractions can be classified as concentric, eccentric or static contractions.
- Muscular forces can be described and measured in terms of magnitude, direction, point of application and line of action.
- 'Motion' is another word for movement.
- Linear motion occurs when an object moves from one place to another.
- Linear motion can be rectilinear or curvilinear.
- Angular motion involves rotation around an axis.
- Linear velocity is the displacement of an object in a given amount of time.
- Angular velocity is the angular displacement around an axis in a given amount of time.
- Linear acceleration is a measure of how quickly the velocity of an object is changing.
- Angular acceleration, like linear acceleration, is a measure of how quickly the angular velocity of an object or body segment is changing.
- Newton's first law of motion (the law of inertia) states that a body will continue in its state of motion unless it is acted upon by a force.
- Newton's second law of motion (the law of acceleration) states that the acceleration of an object is directly proportional to the amount of force acting upon it and inversely proportional to its mass. That is, as force is increased, acceleration will increase by the same factor and as mass is increased, acceleration will decrease by the same factor. This is summarised in the formula $F = ma$.
- Newton's third law of motion (the law of action–reaction) states that for every action there is a reaction equal in force and opposite in direction.
- Momentum is a measure of the amount of motion possessed by an object. Momentum is the product of an object's mass and its velocity ($p = mv$).
- Momentum can be transferred from one object to another. After a collision between two objects, the total momentum of the objects before the collision will be the same after the collision. This is known as the principle of conservation of momentum.
- Impulse is the product of force and the time over which it is applied. The greater time over which a force is applied, the greater will be the momentum of the object.
- Most muscular actions in physical activities involve the summation (or adding together) of the force applied by a number of muscle groups acting in sequence. Actions in physical activities that require the production of power are initiated by larger, more powerful muscles and completed by less powerful, but faster muscle groups.

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- Bones act as levers, providing a mechanical advantage in producing actions in physical activity. If the resistance arm of a lever system is longer than the effort arm, the lever acts as a speed multiplier. Conversely, if the resistance arm is shorter than the effort arm, the lever acts as a force multiplier.
- Stability is determined by the position of a person's centre of gravity in relation to their base of support. Changes to the size and alignment of the base of support can increase stability. The centre of gravity can be moved towards an oncoming force to increase stability.
- The moment of inertia describes the distribution of mass along an object's axis of rotation. Objects with greater moments of inertia are more resistant to rotation.
- Angular momentum is the product of an object's moment of inertia and angular velocity. Angular momentum can be transferred from one part of the body to another.
- Projectiles follow a flight path or trajectory known as a parabola. Many factors can affect the trajectory of an object.
- Drag and lift forces influence the trajectory of objects. Air resistance is an example of a drag force.
- Bernoulli's principle explains lift and Magnus forces that affect the motion of objects.
- Spin and friction affect the rebound of objects from solid surfaces.
- Muscular analysis of a particular movement sequence examines which muscles are working and the type of contraction they are performing.
- Quantitative biomechanical analysis involves collecting performance data that are measurable (defined using numbers).
- Qualitative biomechanical analysis involves data gathered by observers watching the performance and making comparisons with ideal technique.

Chapter review

Multiple-choice questions

1 The sterno-clavicular joint is an example of a:

A gliding joint.
B hinge joint.
C saddle joint.
D ball and socket joint.

2 A front somersault is a movement that occurs in the:

A sagittal plane.
B frontal plane.
C coronal plane.
D transverse plane.

3 The movements that occur in the up phase of a chin-up are:

A shoulder flexion and elbow flexion.
B shoulder extension and elbow flexion.
C shoulder flexion and elbow extension.
D shoulder extension and elbow extension.

4 Eccentric muscle contractions are produced when:

A a muscle is under tension but no movement occurs.
B a muscle lengthens as it relaxes.
C a muscle shortens under tension to produce a movement.
D a muscle lengthens under tension to control a movement.

5 Which of the following muscles contributes to producing shoulder adduction?

A Deltoids
B Soleus
C Latissimus dorsi
D Rectus femoris

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6 The time taken to complete a 10 km run could be calculated by:
   - **A** dividing the distance covered by average velocity.
   - **B** multiplying distance covered and average velocity.
   - **C** dividing average velocity by distance covered.
   - **D** maximum velocity achieved by distance covered.

7 Angular velocity is measured in:
   - **A** degrees per revolution.
   - **B** degrees per second per second.
   - **C** degrees per second.
   - **D** metres per second per second.

8 Which of the following will not result in an increase in the velocity of an object?
   - **A** Increasing the time over which force is applied to the object
   - **B** Increasing both the force applied and the time over which it is applied to the object
   - **C** Doubling the force applied to an object and halving the time over which it is applied
   - **D** Doubling the force applied to the object

9 The action of the gastrocnemius in raising the heel while the balls of the feet are still on the ground is an example of a:
   - **A** first-class lever with a longer resistance arm.
   - **B** first-class lever with a longer effort arm.
   - **C** second-class lever.
   - **D** third-class lever.

10 Which of the following explains why a tennis ball struck with heavy topspin causes the ball to drop?
   - **A** The spin of the ball as it moves forward causes air to flow more slowly under the ball, which results in an area of low pressure under the ball.
   - **B** The spin of the ball as it moves forward causes air to flow faster under the ball, which results in an area of low pressure under the ball.
   - **C** The spin of the ball as it moves forward causes air to flow more slowly under the ball, which results in an area of high pressure under the ball.
   - **D** The spin of the ball as it moves forward causes air to flow faster under the ball, which results in an area of high pressure under the ball.

Short-answer questions

1 List the movements that are possible at the following joints:
   - knee
   - hip
   - ankle
   - shoulder
   - wrist.

2 What are the four properties of force? How do these properties relate to achieving maximum distance in a javelin throw?

3 How does force summation operate in producing the action of hitting a softball for a home run?

4 What factors affect the distance that a ball will travel once it leaves the hand or bat?

5 What is momentum? Provide and explain one example in sport where the momentum of an object (which could be the body) is built up over time to improve the outcome of the action.

Extended-response questions

1 Explain in detail the biomechanical factors that would need to be considered by an individual in the selection of a striking implement (such as a cricket bat, tennis racquet, etc.) that is used to impart maximum velocity to a ball.

2 The following outline some sound coaching advice that was given to young, beginning long jumpers regarding their run-up approach.
   - Sound technique on the approach can increase the length of a jump.
   - Use a 12–19 stride run-up. Experienced and conditioned athletes may find that they can benefit from a longer approach.
   - Accelerate gradually to full speed. This, however, needs to be consistent.
   - Choose your preferred foot with which to begin your run-up. Many athletes begin the run with their left foot forward.

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- Lean forward in the early strides of the run-up.
- After a few strides, you should be in a fully upright sprinting position.
- It is important to keep accelerating through the board, to convert your maximum controlled horizontal velocity into vertical velocity.
- The penultimate (second last) stride differs from the rest as you prepare to jump. This stride should be longer, the foot placed flat on the ground and the knee and ankle flexed to lower your centre of gravity. There should be a visible lowering of your whole body.
- The last step is shortened to help maintain your speed. Your foot should be out in front of your body and flat on the ground. Extension of the knee begins, raising the centre of gravity.
- Stay relaxed and try to remember the long–short rhythm of the last two strides.

Justify the validity of this advice using your knowledge of biomechanical principles with particular attention to the principles governing the application of force.

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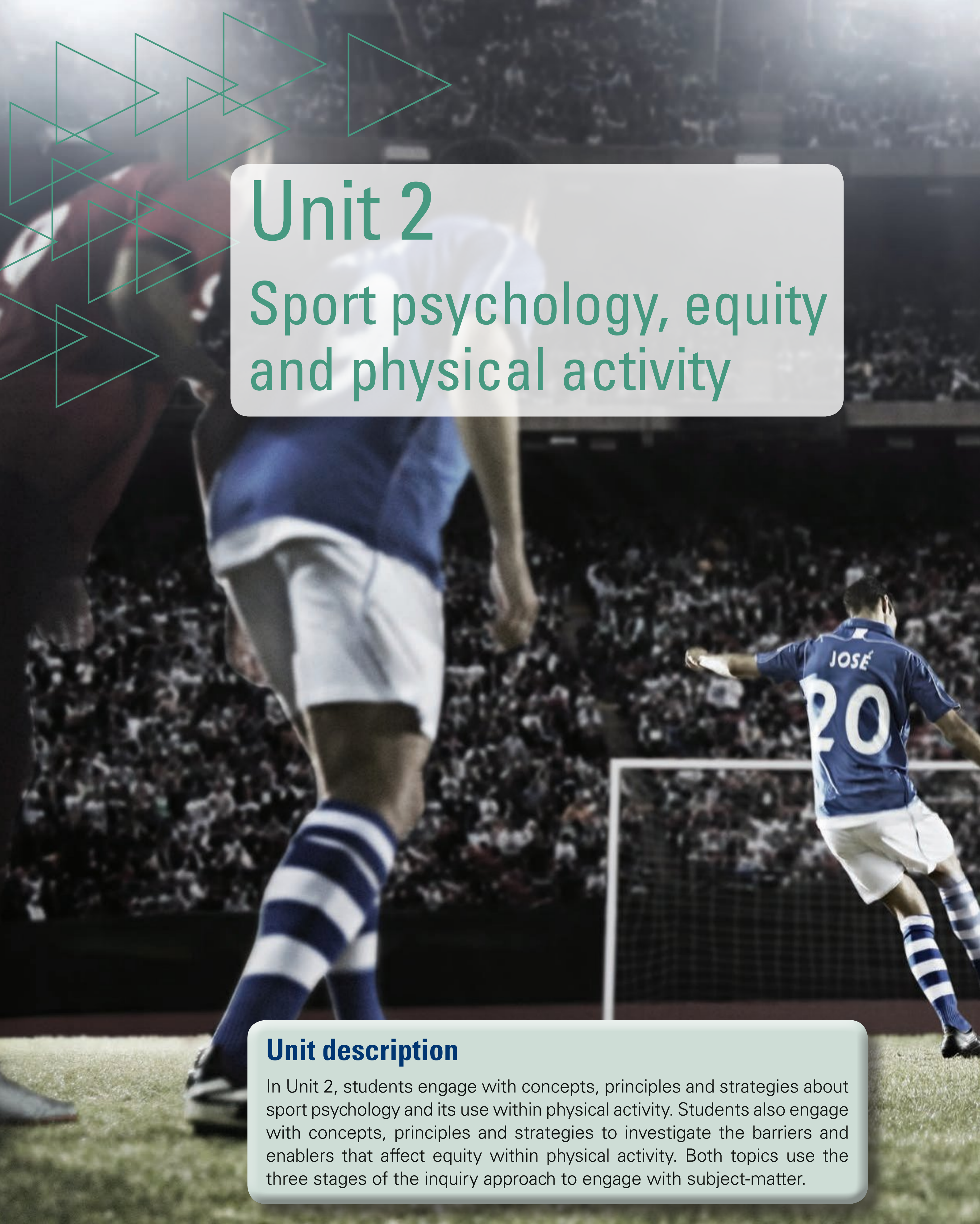

Unit 2

Sport psychology, equity and physical activity

Unit description

In Unit 2, students engage with concepts, principles and strategies about sport psychology and its use within physical activity. Students also engage with concepts, principles and strategies to investigate the barriers and enablers that affect equity within physical activity. Both topics use the three stages of the inquiry approach to engage with subject-matter.

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Unit objectives

Objectives	Activity icons
1 Recognise and explain sport psychology and equity concepts and principles about selected physical activities	RECOGNISE & EXPLAIN
2 Demonstrate specialised movement sequences and movement strategies in the selected physical activity	DEMONSTRATE
3 Apply concepts to specialised movement sequences and movement strategies in the selected physical activity	APPLY
4 Analyse and synthesise data to devise strategies about sport psychology and equity	ANALYSE & SYNTHESISE
5 Evaluate sport psychology, equity and movement strategies	EVALUATE
6 Justify sport psychology, equity and movement strategies	JUSTIFY
7 Make decisions about and use language, conventions and mode-appropriate features for particular purposes and contexts	MAKE DECISIONS

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Chapters in this unit

Chapter
3 Sport psychology in physical activity
4 Equity: Barriers and enablers in physical activity

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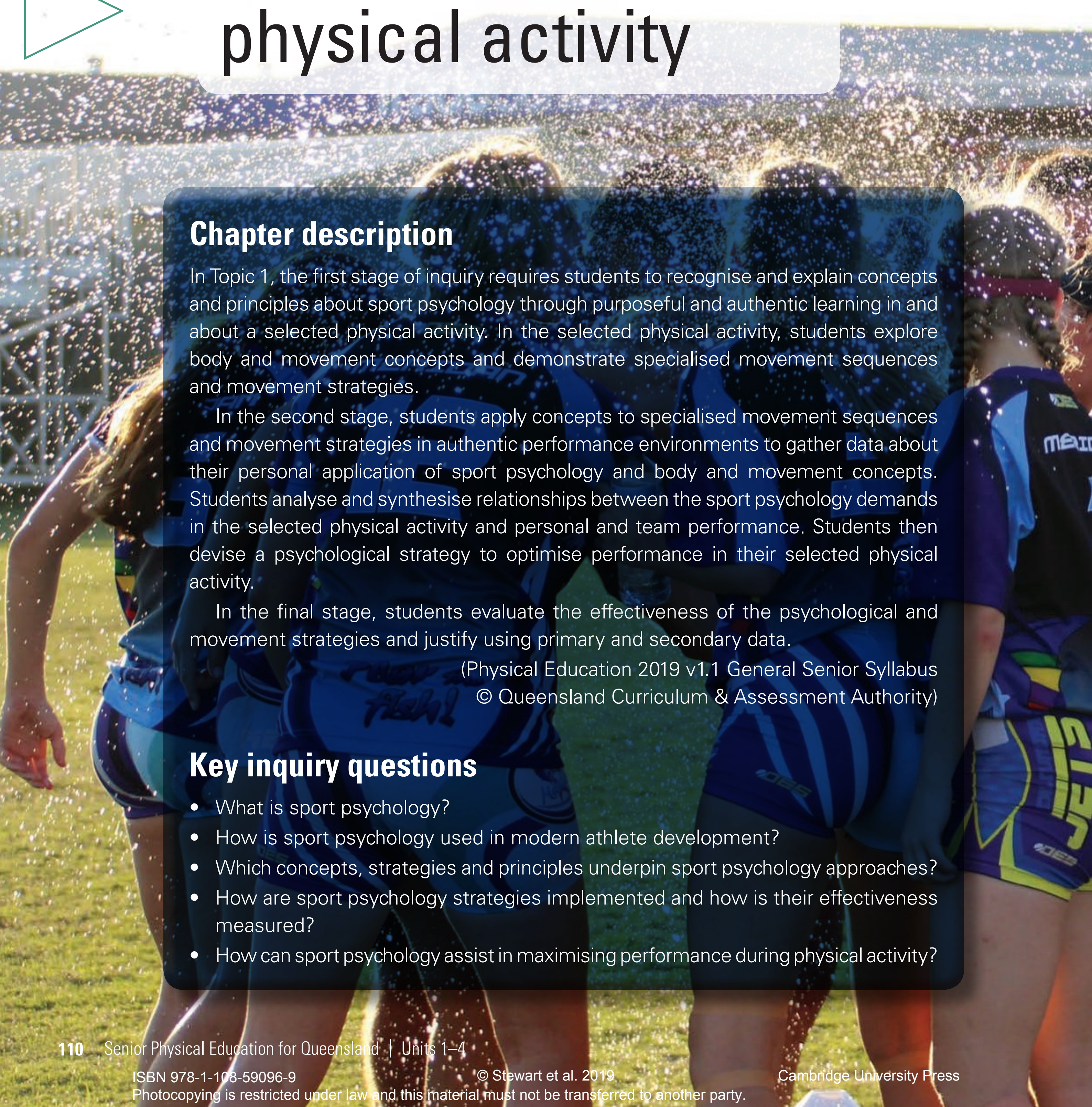
Chapter 3

Sport psychology in physical activity



Chapter description

In Topic 1, the first stage of inquiry requires students to recognise and explain concepts and principles about sport psychology through purposeful and authentic learning in and about a selected physical activity. In the selected physical activity, students explore body and movement concepts and demonstrate specialised movement sequences and movement strategies.

In the second stage, students apply concepts to specialised movement sequences and movement strategies in authentic performance environments to gather data about their personal application of sport psychology and body and movement concepts. Students analyse and synthesise relationships between the sport psychology demands in the selected physical activity and personal and team performance. Students then devise a psychological strategy to optimise performance in their selected physical activity.

In the final stage, students evaluate the effectiveness of the psychological and movement strategies and justify using primary and secondary data.

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Key inquiry questions

- What is sport psychology?
- How is sport psychology used in modern athlete development?
- Which concepts, strategies and principles underpin sport psychology approaches?
- How are sport psychology strategies implemented and how is their effectiveness measured?
- How can sport psychology assist in maximising performance during physical activity?

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Key terminology

affirmation	psychology
anxiety	self-belief
attention	self-efficacy
autonomy	self-fulfilling prophecy
cognitive anxiety	social cohesion
competence	somatic anxiety
concentration	sports psychology
confidence	task cohesion
motivation	team cohesion
outcome goals	team dynamics
over-aroused	under-aroused
over-confident	under-confident
performance goals	vicarious experiences
positive self-talk	visualisation
process goals	

Introduction

Being physically educated is being concerned with developing knowledge in the biophysical, sociocultural and psychological domains that underpin physical activity and utilising this knowledge to maximise enjoyment, engagement and physical performance for yourself and others. The physically educated become advocates for both the social and physical importance of being physically active.

This chapter explores the link between thoughts, feelings and behaviour towards learning in both individual and team-based performances. Sport psychology is a key element within the sociocultural and psychological sub-disciplines of physical activity. Through an understanding of social psychology, the physically educated can work to enhance performance and the enjoyment experienced through physical activity. They can identify the psychological underpinnings of social learners and apply relevant psychological concepts to improve physical performance.

They learn to identify relevant psychological responses before, during and after both individual and team-based performances. Furthermore, they can practise and refine a range of strategies to influence their thoughts and control their physical responses to learning.

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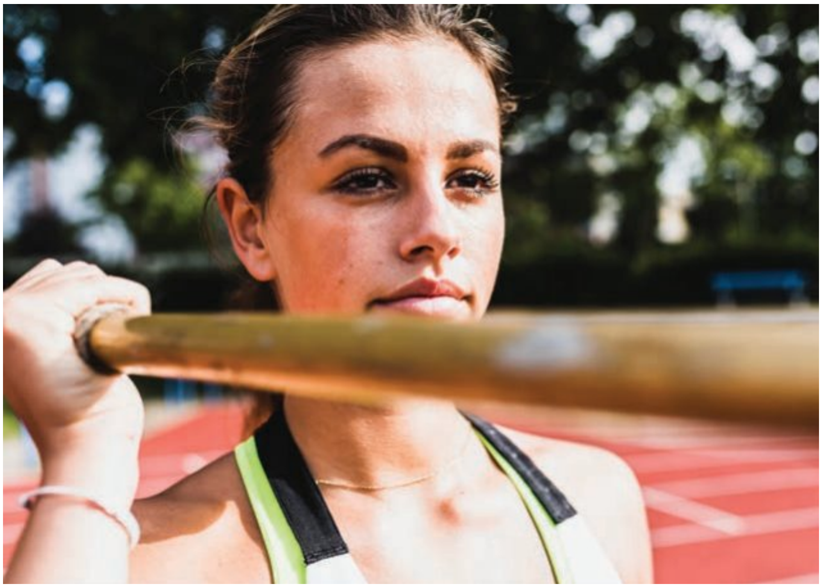

Figure 3.1 An athlete focuses before moving.

The mental aspects that have the largest influence on optimising sport performance are motivation, confidence, arousal, attention and concentration, and team dynamics. Learning which stimuli affect these elements and developing techniques to control them is the functional application of sport psychology. Simply put:

- motivation = the desire to be successful
- confidence = the belief concerning the ability to be successful
- arousal level = the readiness to perform (immediate state of body and mind)
- attention and concentration = the ability to focus on relevant cues
- team dynamics = functioning as a group to achieve a common goal.

Inquiry cycle – stage 1: Engage and understand

3.1 Understanding sport psychology

psychology the study of how thought influences behaviour

sport psychology the study of the human mind and how it relates specifically to physical performance

Psychology is the study of how thought influences behaviour. In relation to physical activity, behaviour can be considered the physical movements or sporting actions being performed. The study of the human mind and how it relates specifically to physical performance is known as **sport psychology**.

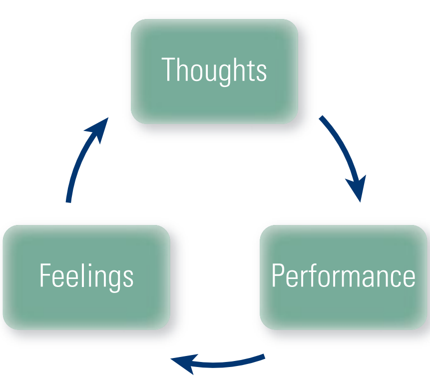

Figure 3.2 Thoughts, feelings and performance are linked.

3.2 Motivation

motivation enthusiasm for doing something; the direction and intensity of effort

An athlete's **motivation** reflects the intensity and direction of the effort they are willing to apply to a task. The direction of effort refers to the situations that they seek out, approach or are attracted to. The intensity of someone's motivation refers to how hard they are willing to work to achieve the given task. A low level of motivation may be characterised by a competitor who is distracted or less interested when engaging in physical activity. Consequently, they will not gain the same performance benefits from training and are less likely to be successful during competition.

Furthermore, athletes with low levels of motivation may also experience increased stress and anxiety, leading to strained relationships with those around them. The level and causes of motivation of an athlete can differ due to both their internal drive and environmental factors. Sporting motivation reflects an athlete's desire to experience situations of competence, autonomy and relatedness.

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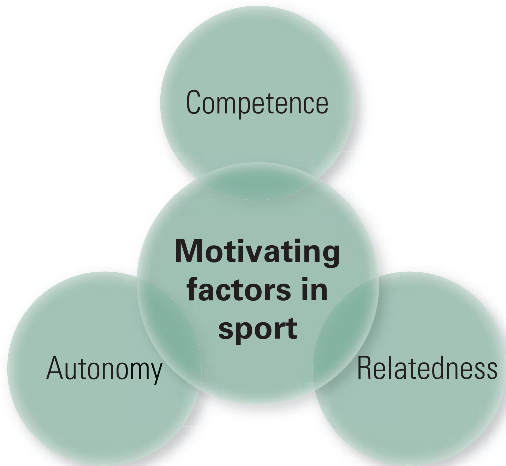

Figure 3.3 Factors affecting motivation towards sport can be categorised into three interconnected areas.

Competence is the perceived ability to succeed at a task. Competence ensures that motivation remains high, particularly when supported by feedback indicating skill mastery or that improvement is occurring. It is typical for motivation to be highest when an athlete is learning a new skill. Think of a beginner golfer trying to lower their handicap. Although this could be a frustrating stage, the initial learning experiences will involve the quick mastery of simple skills or strategies such as club choice and shot selection. This rapid improvement in ability would indicate an increase in competence, and consequently higher levels of motivation. However, after the initial improvement, the golfer's handicap and subsequent perceived ability would begin to plateau. New sources of motivation would be needed to maintain the required effort to learn the more complex skills and strategies needed for further improvement. Poor performances and an inability to improve build a perception of low competence for a performer – that is, they question their ability to be successful. Low levels of competence have a negative effect on motivation levels.

competence the ability to do something well

autonomy the ability to make your own decisions without being controlled by anyone else

Autonomy refers to the athlete feeling as if they have an influence on the decisions impacting on their performance. The main reason why people begin and

Sport	Competence	Autonomy	Relatedness
Golf	Lowered handicap Par or sub-par results Performing well against others	Choosing when and where to play Deciding strategy for approaching a hole	Discussing performance with playing partners Sharing experiences at 19th hole
Sport aerobics	Improved strength and endurance Mastery of difficult combinations in routine Successful performance	Influencing choreography Choosing when and where to train	Feeling part of a team Feeling welcome in the gym or training environment
High jump	Improved ability to clear previous unattainable heights	Selection of heights to attempt during training Selection of start height in competition	Sharing success of reaching personal bests with training partners and coaches Receiving acknowledgement from competitors for clearing challenging heights

Table 3.1 Examples of motivating factors

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continue with a new physical activity is because they find it rewarding. Specifically, they feel a sense of autonomy regarding the intensity and direction of the effort they apply. Having input into the composition of a performance, whether at training or during a match, would result in increased motivation, whereas being dictated to by a coach or domineering members of a team would diminish motivation.

relatedness situations where social acceptance reinforces the motivation for participation

Maintaining motivation in physical activities is also influenced by being able to share experiences with others. **Relatedness** involves situations where social acceptance reinforces participation. Although having strong *team cohesion* is a perfect example of this, relatedness is not limited to team sports. Athletes competing in individual sports build a sense of community with coaches, training partners, officials and even competitors. Not feeling welcome or accepted in a performance environment is very detrimental to motivation.

Activity 3.1

Check-in

RECOGNISE & EXPLAIN | ANALYSE & SYNTHESISE

1. Define the term 'motivation'.
2. Feeling like you have a say in how you perform is an example of which category of motivation?
3. Explain why motivation levels may be high when an athlete is:
   - a scoring under par for a hole
   - b selecting a tee-off time that suits their weekend schedule
   - c successfully recovering from a wayward drive
   - d first learning a new skill.
4. Categorise the following golfers' positive experiences as influencing their feelings of competence, autonomy or relatedness:
   - being greeted by locals at the golf club
   - posting footage of a successful long putt on social media
   - choosing which club to use
   - improving the accuracy of a specific golf club.
5. Identify an individual sport and a team sport towards which you currently have low motivation. Analyse your past experiences and provide an example that diminished your motivation in each category: competence, autonomy and relatedness.

Intrinsic motivation and extrinsic motivation

The level of competence, autonomy and relatedness experienced by an athlete determines their level of motivation. These three dimensions of motivation are influenced by a very broad range of factors that are specific to each individual. What motivates or demotivates a performer is uniquely personal. However, it is useful in sport psychology to investigate these factors in terms of being intrinsic or extrinsic.

Intrinsic motivation reflects the drive of an athlete to compete purely for the enjoyment of the experience. Intrinsic motivators include feelings of satisfaction when learning or improving skills, feelings of accomplishment when completing an event and feelings of stimulation when participating.

intrinsic motivation participating in an activity purely for the enjoyment of the experience

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Extrinsic motivation involves factors beyond enjoyment that drive an athlete to succeed. Extrinsic motivators may be self-determined or determined by others. Self-determined extrinsic motivation involves athletes completing tasks or working towards outcomes that they feel are valuable, but not necessarily enjoyable. On the other hand, extrinsic motivators determined by others rely on the need to attain external rewards as the focal point for an athlete's effort and persistence in an activity. These rewards can be material – like money, sponsorship or trophies – or perceived, like fame, recognition, social status or improved lifestyle.

Most sportspeople are motivated by a combination of both intrinsic and extrinsic motivators, and therefore could be placed on a continuum between the two extremes (see Table 3.3 on the following page). Understanding what intrinsic and extrinsic factors motivate and demotivate an athlete is essential when looking to increase and maintain motivation. A person who is primarily motivated intrinsically might find it hard to rise to big occasions, like grand finals, when rewards are on offer, and they may even perform poorly due to the increase in pressure. A person who is primarily motivated extrinsically may struggle to retain motivation when they are on a losing streak, injured, suffer defeat in big matches or miss team selection, or in 'normal' round matches when there is little at stake. When athletes are motivated by a good balance of intrinsic and extrinsic factors, they can find it easier to maintain high levels of motivation and are able to engage a wide variety of motivational techniques to optimise their performances.

extrinsic motivation participating in an activity for reasons other than the enjoyment

Intrinsic motivators		Extrinsic motivators	
Motivation to learn	Learning how to draw and fade shots in golf Learning a new sports aerobics routine Learning how to over-arm serve in volleyball	**Motivation to achieve a valued outcome**	Being selected in a representative team Putting for an eagle in golf
Motivation to accomplish	Improving a personal best in triple jump Executing a new set play in touch football Creating a new sequence in aerobics	**Motivation to complete a valued process**	Doing Pilates to improve your core strength for Australian Rules Football Doing resistance training to improve swimming
Motivation to feel stimulation	Enjoying the adrenaline rush when playing Australian Rules Football Finding the music choices in aerobics classes enjoyable	**Motivation to prove yourself to others**	Not wanting to feel guilty about missing training Going to the gym to improve your attractiveness to other people
		Motivation to attain external praise or reward	Winning trophies or prizes Receiving praise Not coming last in a competition

Table 3.2 Intrinsic and extrinsic motivators

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Type of motivation	Extrinsic motivation	←		→	Intrinsic motivation
Motivating factors	Praise and reward	Prove yourself to others	Complete a valued process	Achieve a valued outcome	Knowledge Accomplishment Stimulation
Source of motivation	External	Somewhat external	Somewhat internal	Internal	Internal

Table 3.3 Motivation as a continuum

Activity 3.2

Engage-in

Inquiry question: What factors are impacting your motivation to perform in chosen physical activities?

Engage and understand

1. Prepare the class to participate in a chosen physical activity for the duration of the lesson.
2. Before the lesson, rate your motivation towards participating in this physical activity using the motivation rating scale in Table 3.4.

Apply and analyse

Analyse: Examine or consider something in order to explain and interpret it, for the purpose of finding meaning or relationships and identifying patterns, similarities and differences.

3. Complete the physical activity and rate your motivation again.
4. List all factors that influenced your motivation during the performance.
5. Identify at least two cause-and-effect relationships between your performance and your motivation (e.g. I dropped the ball a lot in the first half (cause), my perceived competence decreased and I stopped trying (effect).

Evaluate and justify

6. Write a sentence justifying which factor (competence, autonomy, relatedness) had the most influence on your motivation.

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		Level of motivation	Description
Low	0	Amotivated	• No desire to perform. • Not concerned with negative repercussions from not participating.
	1	Competing through obligation	• You are only competing through obligation, *to satisfy a commitment made by, or to others.* • You believe your preparation has been inadequate to produce a successful performance. • You wish to avoid negative repercussions of not participating; *success is not a priority, only a minimum level of participation.*
	2	Competing for the benefit of others	• You are participating to allow others the opportunity to be successful. • You believe your training and preparation will not allow you to improve your own performance. • You seek social approval for participating; *success for self is not a priority – however, your level of performance cannot be detrimental to the overall success of others.*
	3	Competing to produce performance successfully	• You are trying to complete the task successfully while remaining within your comfort zone. • You believe your training has not allowed you to perform outside of your comfort zone or produce a performance beyond that typical for you. • You are trying to avoid the disapproval of other stakeholders that could result from a poor performance, so are striving to produce a performance on par with other comparable results.
	4	Competing to maintain a high-level performance	• You are trying to maintain a high standard of performance in an environment in which you are comfortable. • You believe your training and preparation have positioned you well to repeat past successful performances with the possibility of slight improvement. • You want other stakeholders (competitors, coaches and spectators) to approve of your performance and/or seek to replicate or better your personal best.
High	5	Competing to produce best performance	• You are trying to accomplish an outcome that you value highly and have been working towards (e.g. flawless routine or a new personal best), which may be performed in a new or challenging environment. • You believe your training and preparation have positioned you well to perform at a higher level and are committed to producing a performance that reflects this. • You want the people you care most about (friends, family, coaches) to be proud of your performance and will gain a large amount of personal satisfaction if this high level of performance is achieved.

Table 3.4 Motivation rating scale

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Competence, autonomy and relatedness are all key to developing motivation.

Motivating factors can be placed on a continuum from intrinsic to extrinsic sources.

Most sports require a combination of both intrinsic and extrinsic motivating factors.

confidence the quality of being certain of your abilities or of having trust in people, plans or the future

self-belief trust in your own abilities

self-efficacy a person's belief that they can be successful when carrying out a particular task

Confidence

Confidence is considered the most influential psychological factor in differentiating between successful and unsuccessful performances of athletes. Specifically, confidence refers to the belief an athlete has that they will complete a task successfully (e.g. a putt in golf) or attain a certain favourable outcome (e.g. a high score in an aesthetics routine). Furthermore, an athlete's confidence is influenced by their **self-belief** and **self-efficacy** for the task they are completing. Self-belief is the athlete's general trust in and acknowledgement of their abilities. Self-efficacy is the extent to which they feel prepared to successfully complete a specific task. For example, a tennis player may have high self-belief when starting a tournament and feel like they can win. They would also have high self-efficacy when playing in earlier rounds, as they are coming up against players they have beaten before and feel they can beat again. However, their self-efficacy may decrease during the finals when faced with a higher ranked opposition.

Figure 3.4 A successful tennis player, such as Angelique Kerber, may have high self-belief at the start of a tournament.

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Activity 3.3

Check-in

1 In your own words, explain the link between confidence, self-belief and self-efficacy.

2 Imagine that your teacher has organised a competition against a Year 8 class in the physical activity that is the current focus of your study.

a What factors would influence your self-belief during this performance?

b What factors would influence your self-efficacy during this performance?

c Evaluate the benefit that competing is such a competition would have for your level of confidence.

A performer who believes they are well prepared for the task or event will feel more confident and have a greater chance of completing a successful performance. High confidence results in an athlete:

- having positive thoughts about their ability
- being more likely to remain calm and composed during competition
- being more positive when faced with setbacks
- having increased levels of concentration regarding completing the task at hand
- applying more effort to their performance
- being able to implement strategies that allow them to control the situation at hand.

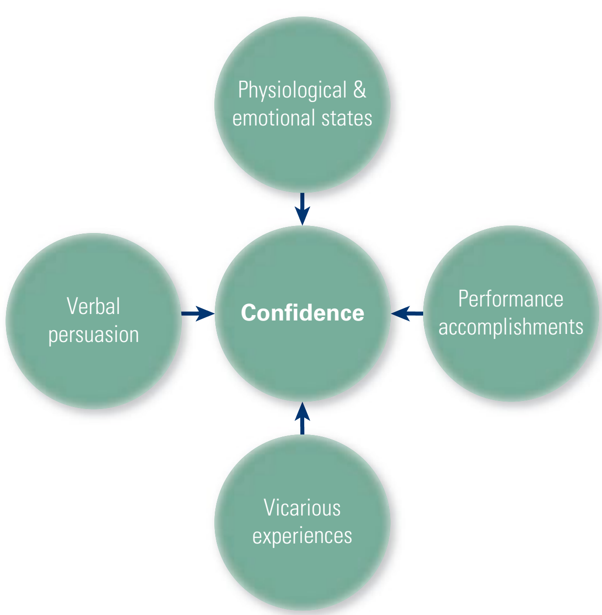

Figure 3.5 Verbal persuasion, vicarious experiences, performance accomplishments, and physiological and emotional states all contribute to confidence.

3.3 Sources of self-confidence

According to Bandura's theory, self-confidence in sport can be attributed to one of the following four major sources:

- performance accomplishments
- vicarious experiences (including imagery)
- verbal persuasion
- physiological states and emotional states.

Although these sources are not mutually exclusive, they can vary with regard to the influence they have for an athlete's confidence.

Performance accomplishments refer to the influence that positive outcomes have on one's level of confidence. Experiencing success when completing a physical task is the biggest influence on an athlete's confidence. The more successful an athlete is, the

Figure 3.6 A softball batter who continually strikes out and loses confidence is an example of performance accomplishments having a negative influence on an athlete.

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more confident they are going to be. Success does not necessarily relate to winning, but could also refer to the mastery of a skill or noted improvements in performance. When a skill is performed successfully, an athlete's confidence is increased and they are more likely to challenge themselves in a more difficult task. Someone performing in sports aerobics will often learn a new routine in stages. Once the first stage is mastered, they will be more confident to challenge themselves by adding more stages to their routine.

Alternatively, poor performance can lead to a substantive reduction in confidence levels. For example, if a softball batter is continually striking out, they may lose confidence and seek expert coaching or give up the sport altogether.

Vicarious experiences refer to watching someone else perform. Observing someone model the mastery of the skill, either live or on screen, can boost an athlete's belief in their own ability. Self-modelling can be achieved through watching recorded footage of performance or through the use of mental imagery. Viewing their own successful performance will enhance an athlete's belief that they can replicate that success in other situations. The modelling of success by other people, such as a coach or training partner, can also lead to an increase in confidence. This impact is strongest if the people being observed are someone close to the athlete and someone considered to be of similar ability.

Verbal persuasion involves the reinforcement of the ability to be successful at a task. Coaches and teammates will often remind athletes of reasons why they should feel confident through comments such as, 'You're playing well – keep it up' or, 'You can do this, just like you did in practice'. During a triathlon, a coach can enhance confidence through providing positive feedback about the athlete's form and split times. Likewise, an athlete can repeat positive encouragement to themselves regarding their belief in their ability. The key to verbal persuasion is to focus on the positive outcome for the performance – for example, keep in touch with the leaders – and avoid referring to the negative outcomes – for example, don't fall behind.

vicarious experiences knowledge or information about a skill or behaviour derived from viewing the performance

Source of confidence for a swimmer before a final

Performance accomplishments
- Improvements in swim times during training
- Strong swim against opponents during the heat swims

Vicarious experiences
- Viewing a strong heat swim with the coach
- Imagining a successful performance that includes a good start, efficient stroke and finishing on a full stroke
- Seeing a club member win a final
- Seeing a training partner swim a personal best

Verbal persuasion
- Positive encouragement from the coach regarding starts, split times and stroke length
- Encouragement from club members
- Positive self-talk

Physiological and emotional state
- Feeling fit and free of injury
- Feeling prepared and energised
- Feeling excited about the race
- Feeling relaxed and anticipating a good result

Figure 3.7 Sources of confidence for a swimmer

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The *physiological and emotional state* of an athlete can also improve confidence during an event. Following a successful heat swim, it is quite common for a swimmer being interviewed to comment on how great their body feels. Identifying these positive physiological states would enhance their confidence leading into the finals. Alternatively, an athlete who is identifying negative physiological states such as injury or fatigue will be less confident. Likewise, the emotional states of an athlete can influence confidence. Feelings of excitement, anticipation, calm, elation and preparedness will enhance levels of self-confidence. Athletes experiencing positive emotional states are more likely to give maximum effort, take risks and react positively to setbacks. Alternatively, negative emotional states that involve feeling sad, tense or fearful of failure will result in lower self-confidence. The effects of the negative emotional state could include a lack of effort or an unwillingness to take risks and a readiness to give up.

Figure 3.8 Swimmer reviewing footage of a race

Activity 3.4

Check-in

RECOGNISE & EXPLAIN

ANALYSE & SYNTHESISE

1. Explain the relationship between thoughts, feelings and performance.
2. Make a list of any five things about which you have confidence and five about which you lack confidence.
3. Select one item from each list in question 2 and explain what experiences may have led you to develop these confidence levels.
4. Analyse all the skills in your current physical activity and categorise them as ‘skills I am confident with’ and ‘skills with which I lack confidence’.

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Optimising self-confidence

The four aspects of self-confidence highlight the advantages that confidence brings to performance outcomes. However, it is important to strike a balance between being **under-confident** and **over-confident**. Being under-confident is exemplified by a low belief in one's ability to achieve success in a task and is a key contributor to experiencing failure. For example, if a dancer believes they are going to forget or 'stuff up' part of their routine, they actually help cause this to happen when performing. This is known as a negative **self-fulfilling prophecy**, and is associated with having negative thoughts and negative self-talk; it obviously leads to lower overall success.

Over-confidence, on the other hand is an exaggerated belief in one's ability and will make an athlete more prone to failure. A golfer who is over-confident may over-estimate their ability to hit a shot over a hazard and take an approach that is too aggressive, which leads to a poor outcome. Similarly, a touch football team that is over-confident against a lower ranked team may make poor decisions and take unnecessary risks, shifting away from the structured game plan. 'Impossible passes' due to over-confidence can bring about errors and poor completion rates that unnecessarily invite the opposition into the match. Additionally, being over-confident may lead an athlete to under-prepare, both physically and mentally, for a competition – either during the warm-up or the preceding training sessions. They may even fail to put in enough effort when competing. A swimmer who has regularly been successful in their races may under-estimate their opponents and neglect to complete their proper preparation leading up to an event.

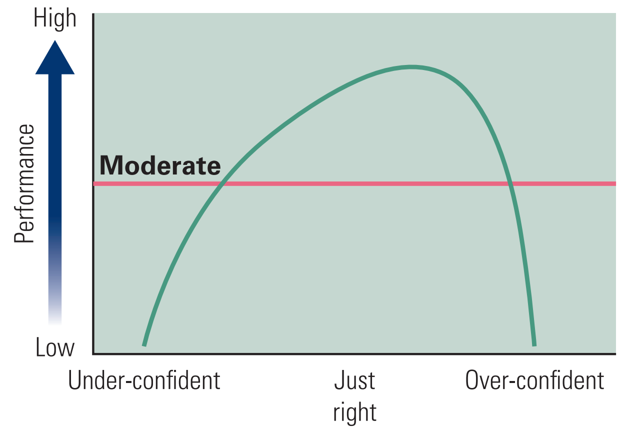

Figure 3.9 Relationship between confidence and performance

The optimal level of confidence that produces peak sporting performance can be located between under-confident and over-confident. This is a level of confidence that ensures an athlete can maintain appropriate levels of effort and concentration to achieve goals without being overwhelmed by the task. More specifically, as confidence increases, so does performance – but only to a certain point. The optimal level of confidence is found slightly closer to the over-confident side. This will allow athletes to continue to challenge themselves to reach their potential.

under-confident low level of confidence that is detrimental to performance

over-confident high level of confidence that is detrimental to performance

self-fulfilling prophecy something you cause to happen by saying and expecting that it will happen

KEY MESSAGE: Confidence is considered the most influential psychological factor in determining success.

KEY MESSAGE: According to Bandura's theory, there are four sources that will determine self-confidence.

KEY MESSAGE: Best performances occur when confidence is optimal and there is a balance between under- and over-confidence.

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		Level of confidence	Description
Low	0	**Absolutely no chance** of being successful	You feel overwhelmed by the performance requirements. You believe you can't be successful even if you try your hardest.
	1	**I believe there is not much chance** of being successful	You feel like you are out of your depth in this performance environment. You believe that you required much more preparation to be successful. You believe that you will not be successful without a lot of luck or assistance from teammates or other external factors.
	2	**I believe there is maybe a chance** of being successful	You are feeling good but have not experienced much success in this environment before. You believe you are slightly unprepared and feel anxious. You have received positive encouragement but believe external factors will need to play a substantial part in your success.
	3	**I believe I am more than likely** to be successful	You are feeling good about competing and have had experience competing in similar performance environments. You believe you have prepared well but feel nervous about competing. You have received positive encouragement but believe external factors will need to play a part in your success.
	4	**I strongly believe** I can be successful	You are feeling fit and healthy and have had previous success in similar performance environments. You believe you have had a good preparation and feel excited about competing. You have received positive encouragement from others and feel energised and excited about performing. You believe you can out-perform your opponents and can visualise a successful performance.
High	5	**I am totally certain** I can be successful	You are feeling fit and healthy and have been very successful in this environment before. You believe you have had a perfect preparation, feel excited and anticipate success. You have received a lot of positive encouragement from others and feel relaxed about competing. You can easily visualise being successful against your opponents.

Table 3.5 Confidence rating scale

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Activity 3.5

Engage-in

Inquiry question: What sources of confidence have the most impact on performance?

Engage and understand

1 Explain the relationship between confidence and performance.

Apply and analyse

2 Evaluate your confidence levels towards your current physical activity using the criteria in Table 3.5 on the previous page.

3 Collate primary data by conducting a survey of 10 other class members. Record their level of confidence and their yes/no responses to the following questions:

- **a** Have you experienced success in this (or similar) physical activity (performance accomplishments)?
- **b** Have you visualised yourself, or witnessed someone close to you having success in this physical activity (vicarious experiences)?
- **c** Have you received praise or encouragement from those around you and/or had had positive thoughts about your ability to compete in this physical activity?
- **d** Did you feel prepared, relaxed and positive about performing in this physical activity?

4 Present your primary data in a table.

Evaluate and justify

KEY COGNITION

Evaluate: Make an appraisal by weighing up or assessing strengths, implications and limitations; make judgments about the ideas, works, solutions or methods in relation to selected criteria; examine and determine the merit, value or significance of something, based on criteria.

5 From the responses you have collated, draw conclusions about the source of confidence that is most related to higher levels of confidence. Use your primary data as evidence to support your conclusion.

3.4 Arousal

The third psychological factor that can influence an athlete's physical performance is their level of **arousal**. Arousal is defined as a combination of the mind's and body's level of activation and preparedness to complete a task. These physiological responses, such as increases in heart rate and respiratory rate, along with psychological responses such as changes in attention levels and focus, will vary depending on the task at hand and motivating factors driving the performance.

arousal a state of physical excitement or attentiveness

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Relaxed drowsiness	Wakefulness	Curiosity & attentiveness	Joy	Exhilaration	Anxiety	Panic	Rage
Low arousal →							High arousal

Figure 3.10 Arousal continuum

Activity 3.6

Engage-in

Inquiry question: How do arousal levels influence my physiological and psychological state?

RECOGNISE & EXPLAIN · ANALYSE & SYNTHESISE · EVALUATE · JUSTIFY

Engage and understand

1 Think about previous physical activity experiences where you have noticed that your arousal levels have not been ideal. Compile two lists that categorise each of your experiences as feelings of under-arousal or over-arousal.

2 For each of your lists above, describe how your body typically felt, how clearly you could focus and your mood.

Apply and analyse

3 Participate in the series of activities below. As you complete each activity, collate primary data on your heart rate, your breathing rate, your level of arousal (use the Arousal rating scale in Table 3.6 on the following page), what you were thinking about and your ability to focus throughout the task.

- **a** Find a quiet space to lie down and focus on your breathing.
- **b** Listen to calming music.
- **c** Listen to upbeat music.
- **d** Watch footage of an elite performance in your chosen physical activity.
- **e** Stand in front of the class and give a one-minute recount of your most embarrassing sporting moment.
- **f** Complete a typical warm-up.
- **g** Participate in your chosen physical activity.
- **h** Continually punch a boxing bag or tackle bag for one minute.

4 Collate primary data by surveying 10 class members. Choose a series of graphical displays that identify trends within and between activities. For example, you could track changes in heart rate for each activity in a bar graph. Or you could determine percentages of people who could or couldn't concentrate during an activity.

Evaluate and justify

KEY COGNITION

Evaluate: Make an appraisal by weighing up or assessing strengths, implications and limitations; make judgments about the ideas, works, solutions or methods in relation to selected criteria; examine and determine the merit, value or significance of something, based on criteria.

(continued)

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5 Evaluate the most important physiological and psychological indicators that let you know whether you are over-aroused or under-aroused.

6 In a statement, justify how successful you are at identifying your arousal level before, during and after a performance.

		Level of arousal	Description
Low	0	Relaxed and drowsy	Your body is in a resting state. Your mind is not focusing on the performance.
	1	Wakefulness	You have started to contemplate the performance. You feel tired and are easily distracted. Your attention is mostly focused on external performance factors, such as weather, start time and getting equipment organised. Your body feels calm and relaxed.
	2	Curiosity and attentiveness	Your heart rate has increased, but you are still relaxed. You can visualise aspects of your performance. You are focusing on getting ready to perform.
	3	Joy	You feel energised and positive. Your muscles feel warm yet relaxed. You have clear thoughts of what you need to do to perform successfully. You can visualise vivid images of a successful performances.
	4	Exhilaration	You feel ready to produce peak performance. Your movements are coordinated and fluid. You have optimal focus and are 'in the zone'. You have distinct feelings of being successful in your task.
	5	Anxiety	You feel nervous. Your muscles feel tense. You can feel a strong pulse in the absence of exercise. You find it harder to concentrate on the complicated components of the task.
	6	Panic	You begin to feel jittery and irritable. You are having negative thoughts and are fearful of negative results. You feel overwhelmed and have lost confidence. You feel nauseous and have a dry mouth. You have started sweating more.
High	7	Rage	You feel extremely angry and may resort to violent outbursts (physical or verbal). You have lost focus of the task. Your heart is pounding and you breathe faster and move more (in the absence of vigorous exercise).

Table 3.6 Arousal rating scale

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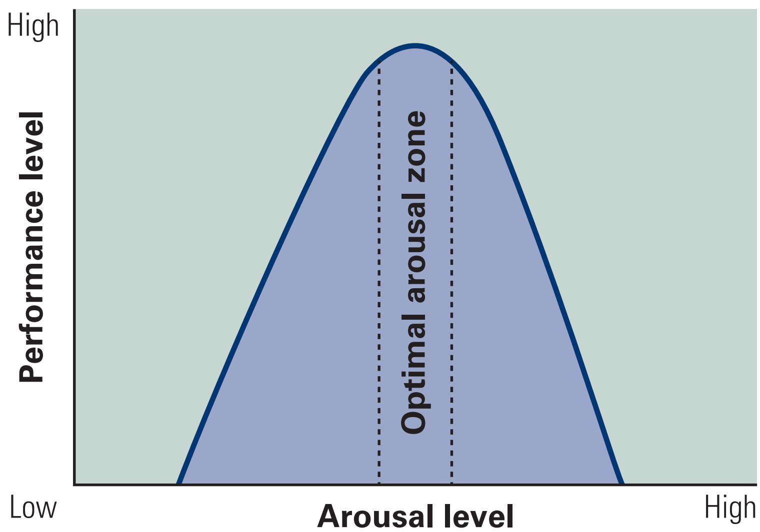

Figure 3.11 The inverted-U hypothesis – the optimal arousal zone is centrally located between levels of low arousal and high arousal.

Optimising arousal levels for performance

Levels of arousal fall along a continuum ranging from the low arousal levels experienced when you are just waking to the high arousal levels experienced with a heightened sense of excitement or rage. The inverted-U hypothesis suggests that athletic performance is hindered when arousal levels are either too high or too low for the designated task.

If an athlete is **under-aroused**, their body will be less responsive and their ability to concentrate and the attentiveness required to complete the task will be lacking. Being under-aroused can be caused either by feelings of over-confidence where the athlete expects to win or by feelings of low confidence where the athlete believes they have no chance of success. It can also result from a lack of appropriate stimulus in the training or the competition environment. It is hard to 'get excited' when training is repetitive and boring.

Alternatively, if an athlete's arousal levels are above those required to produce peak performance, they are **over-aroused**. This anxiety, panic or rage will lead to an increase in muscle tension, resulting in a variation in technique execution, being overly aggressive or feeling nauseous. Mentally, this may lead to poor reading of the game situation and irrational or ineffective decision-making. It may involve overthinking or second-guessing abilities or strategies. Over-arousal is usually caused by pressure placed on an athlete to be able to produce a successful outcome and manifests as anxiety or stress for the performer.

Further investigation into the inverted-U hypothesis has developed variations on where optimal performance zones would fall based on the level of experience of the athlete and the complexity of the task being performed. The more skill and experience someone has in completing a task, the higher the level of arousal

under-aroused when arousal levels are less than those desired by the athlete to produce optimal performance

over-aroused a level of physiological alert that is detrimental to performance

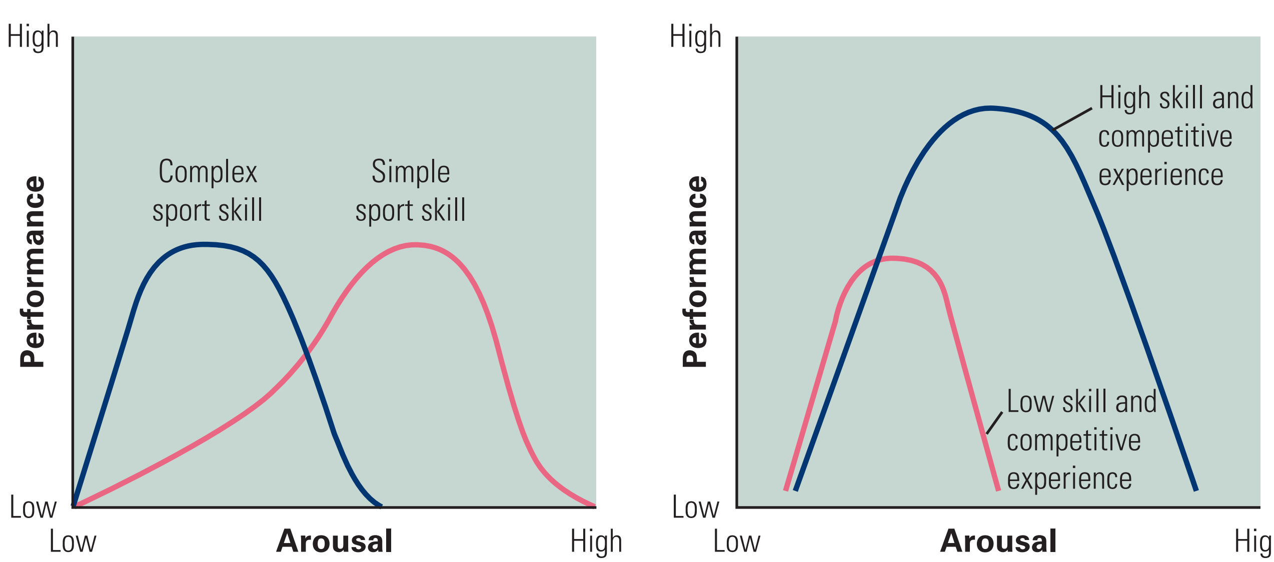

Figure 3.12 Strength training and conditioning

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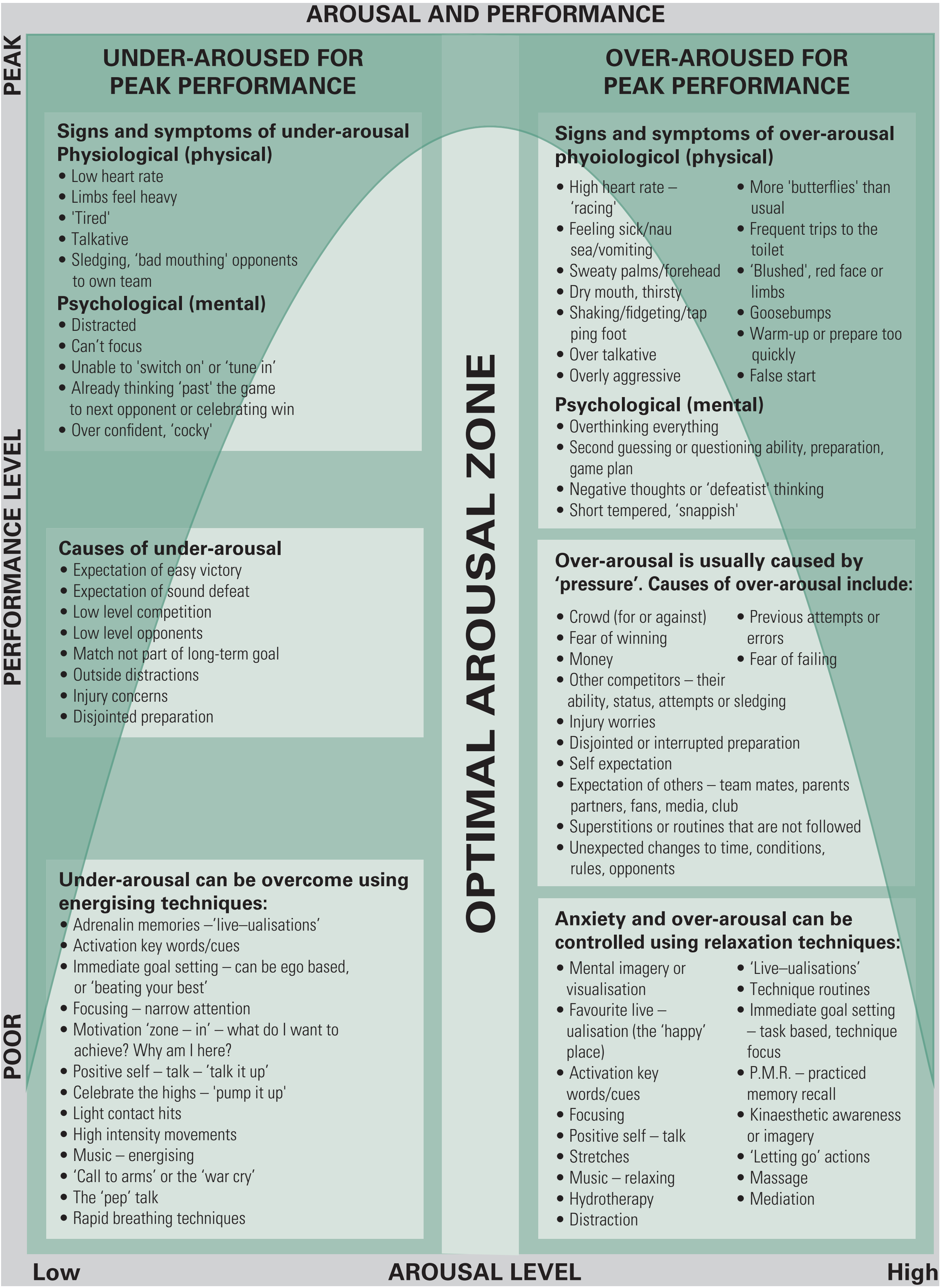

Figure 3.13 Signs, symptoms and causes of under-arousal and over-arousal

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Activity 3.7

Engage-in

Inquiry question: What are the causes of suboptimal arousal levels when performing in my current physical activity?

Engage and understand

1 Consider your experience in executing the required skills for your chosen physical activity. Construct a performance vs. arousal graph predicting the placement of the inverted-U (and optimal arousal zone) for each skill.

Apply and analyse

2 Participate in your chosen physical activity and compile a list of situations in which you felt you were either under-aroused or over-aroused and the impact this had on your performance.

Evaluate and justify

Justify: Give reasons or evidence to support an answer, response or conclusion; show or prove how an argument, statement or conclusion is right or reasonable.

3 Justify the three main causes for your arousal levels being too high or too low during this experience.

they are able to experience before their performance declines. For example, a less experienced archer may struggle to maintain a high level of performance under the pressure of a competition, whereas an experienced archer will be able to continue to perform at higher levels of pressure. Likewise, the skill level required to complete a task would dictate the influence of the arousal levels on performance. A touch football player experiencing high levels of arousal would probably have no trouble executing a simple skill like dumping the ball. However, even though they have mastered it in training, they may find executing a more complex task like throwing a long cut-out ball accurately too difficult if arousal levels are high.

Anxiety

Anxiety is the negative interpretation of arousal levels experienced by an athlete and is the first indicator that arousal levels are too high. When an athlete feels like they are not at an ideal level of preparedness for the task, they will begin to develop feelings of discomfort or uneasiness and a decreased level of confidence. **Cognitive anxiety** refers to the thought processes associated with anxiety and could include nervousness, negative thoughts and feelings of apprehension. **Somatic anxiety** involves the physical responses to anxiety, and may include experiencing butterflies, sweating, heavy breathing or an elevated heart rate. An athlete's anxiety is not set in stone, but is ever-changing throughout different stages of a performance. For example, it would be normal for a long jumper to feel an increase in heart rate and 'have butterflies in their stomach' immediately before a competition. If their first attempt is a successful jump, their symptoms

anxiety an uncomfortable feeling of nervousness or worry about something that is happening or might happen in the future

cognitive anxiety the specific thought processes that occur during anxiety

somatic anxiety the physical symptoms of anxiety

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of anxiety would reduce. However, if this first attempt was a foul, or believed to be unsuccessful, then increased anxiety could lead to negative thoughts about their ability or apprehension regarding the effort they are prepared to exert.

KEY MESSAGE Optimal levels of arousal for athletes lie between under-arousal and over-arousal.

KEY MESSAGE Cognitive and somatic anxiety result from negative responses to over-arousal.

KEY MESSAGE Optimal levels of arousal can vary, based on ability and complexity of skills.

3.5 Attention and concentration

Attention refers to all the internal and external factors of which an athlete is consciously aware at any one point in time. Internal factors include physiological responses such as fatigue or pain, as well as psychological responses like performance evaluation and feelings of self-efficacy. External factors typically originate from environmental conditions such as wind or the playing surface, or situational conditions like where the opposition is positioned. Being able to effectively utilise this information is vital to successfully completing a task. Whereas a beginner may be overwhelmed by the multitude of information or miss essential cues, a successful performer can effectively filter all this information and quickly categorise the cues as relevant or irrelevant for their task.

Concentration is the level of attention the athlete is paying to the relevant information needed for successful performance. Moreover, an athlete needs to continually adjust their attention in terms of the direction (internal to external) and range (broad to narrow) of information on which they are focused. Throughout a performance, an athlete's attentional focus can typically be placed within one of the following four categories: broad external, broad internal, narrow internal and narrow external (Table 3.7).

Different physical activities require different levels of concentration in each of the above categories. They will also vary with regard to the speed and frequency required to adjust their focus from one category to another during their performance. These differences are quite clear when comparing athletes in two very different sports such as archery and netball. An archer would not need to pay much attention to many external cues, as they perform in a predictable environment. Instead, they would place more emphasis on and take a lot more time to identify and categorise the relevant internal cues for each shot. They will place a higher focus and more of their attention on analysing the consistency of their technique and preparing for any required adjustments. Alternatively, a netballer would focus a lot of their attention on a range of external cues such as the position and movements of the other players on the court. Due to the fast-paced nature of the game, they would also have limited time to analyse and prepare for each skill. Furthermore, they would have to more quickly narrow their attention to concentrate on the ball when catching and passing before again broadening their attention to decide on their next movement.

attention the act or state of applying the mind to something

concentration the ability to think carefully about something you are doing and nothing else

Errors in performance typically are associated with lapses of concentration. The focus of the athlete's attention is not on the most important information required for that stage of performance. Concentration can be affected by both internal distractions (negative thoughts, fear of failure) and external distractions (crowd noise, score). Errors in performance can also be attributed to having an attentional focus that is too broad or too narrow. If focus is too narrow, key environmental cues may be missed. If focus is too broad, it would be difficult to efficiently filter the relevant and irrelevant information required for success.

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	External	Internal
Broad	**Assessing the scene** Shifts focus to general external cues in attempt to identify the most relevant information for their performance. This might include: • wind speed/direction • nature of playing surface • sounds of play • position, actions and sounds of other performers • score • surrounding noise (crowd, music).	**Analysing the options** Shifts focus to reviewing general internal cues to decide on the best course of action for their performance. This might include thoughts and feelings such as: • previous success • previous failures • what is most likely to succeed • how much risk is acceptable • level of fatigue • personal feelings.
Narrow	**Acting** Shifts focus to specific external cues in order to successfully execute the performance. Focus on specific external cues such as: • tracking objects or targets • tracking player positions.	**Preparing to perform** Shifts focus to the specific internal cues that will ready them for the performance. This could include psychological and physiological cues to ensure the body is ready to perform the skill (e.g. using a pre-performance routine).

Table 3.7 Categories of attentional focus

Skill	Required concentration	Possible errors in concentration	Errors in physical performance
Catching a netball	**Narrow external focus** – tracking the trajectory of the ball into the hands	**Broad external focus** – looking at the positions of other players on the court **Broad internal focus** – over-thinking the next play (e.g. where to pass, where to run, the score, recent errors)	Mis-timing the catch 

Table 3.8 Errors in concentration and performance

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Activity 3.8

Check-in

1 For the follow physical activities, classify one situation that requires a broad focus and one that requires a narrow focus:
- cricket
- lawn bowls
- badminton
- touch football
- netball
- sports aerobics
- high jump
- 200 m butterfly swimming race.

2 Using a pie chart, display the predicted percentage of time that you would need to maintain a broad focus vs. a narrow focus for each of the above activities.

3 Make and justify two statements regarding correlations between type of physical activity (team/individual, performance/invasion) and the attentional requirements.

4 Organise all the attentional requirements for your current physical activity into the four categories of attentional focus (broad external, broad internal, narrow internal, narrow external).

5 Select three errors that are common in your physical activity and identify how lapses in concentration contributed to these errors (refer to Table 3.8 on the previous page).

Activity 3.9

Engage-in

Inquiry question: What distractions impact your concentration and ability to perform with accuracy?

Engage and understand

1 Select a skill within your chosen physical activity and design a task that requires accuracy (e.g. shoot a free throw, pass a ball through a hoop).

2 Explain which category of attentional focus is the most important for this task.

Apply and analyse

3 Perform a control experiment by executing the skill 10 times with no distractions (note your score).

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4 Repeat this experiment by adding one of these distractions at a time:
   a loud music in the background
   b a classmate trying to distract you by jumping around near the target
   c a classmate trying to distract you by using negative, but not hurtful, comments (such as 'You're going to miss')
   d incorporating a punishment for inaccurate performance (e.g. 10 push-ups for every miss).

Evaluate and justify

KEY COGNITION

Justify: Give reasons or evidence to support an answer, response or conclusion; show or prove how an argument, statement or conclusion is right or reasonable.

5 Draw a conclusion from your data that indicates which distraction had the most influence on your performance.
6 Justify this conclusion with secondary research data that supports your results (for example, your research question may involve comparing how distracting loud music is to personal comments).

KEY MESSAGE The focus of an athlete's attention will fall into one of four categories.

KEY MESSAGE Attention is continually shifting from one category to another.

KEY MESSAGE Misdirected attention is linked directly to errors in physical performance.

3.6 Team dynamics and cohesion

Coaches will often state that 'a champion team will beat a team of champions'. Psychologist Dr William Schutz (1925–2002) undertook extensive research in the area of **team dynamics**. His theories assist in understanding interpersonal relationships by exploring the underlying motivation behind an individual's actions. They suggest that there are three drivers that motivate group relationships: the need for inclusion, the need for control and the need for affection. For each of the drivers, there is an ideal level that allows effective interactions to occur with other members of the group. When a group member displays an excess or shortage of these drivers, then group dynamics may suffer.

team dynamics the unconscious, psychological forces that influence the direction of a team's behaviour and performance

Teams that work effectively together or demonstrate strong cohesion are far more likely to achieve common goals when competing, and to play together as a team for longer. Obviously, in striving for a common goal, individual athletes may be required to sacrifice their own ambitions in order to put the needs of the team first. If an individual's need for control is balanced by their need for affection and inclusion, then they will be more willing to put in the extra effort to help the team reach its goal. The benefits of improving dynamics and building cohesion include:

- acceptance of roles and responsibility by team members
- dedication of members efforts towards collective achievement
- development of a positive and energetic environment

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- increased effectiveness of group meetings and practices
- reduction or elimination of negative team influences.

Team cohesion and improved team performance are generally considered reciprocal in team sports – that is, improvements in performance would also lead to an increased enjoyment and satisfaction. Furthermore, the respect and admiration that the players have for each other grow, further improving the cohesiveness of the team.

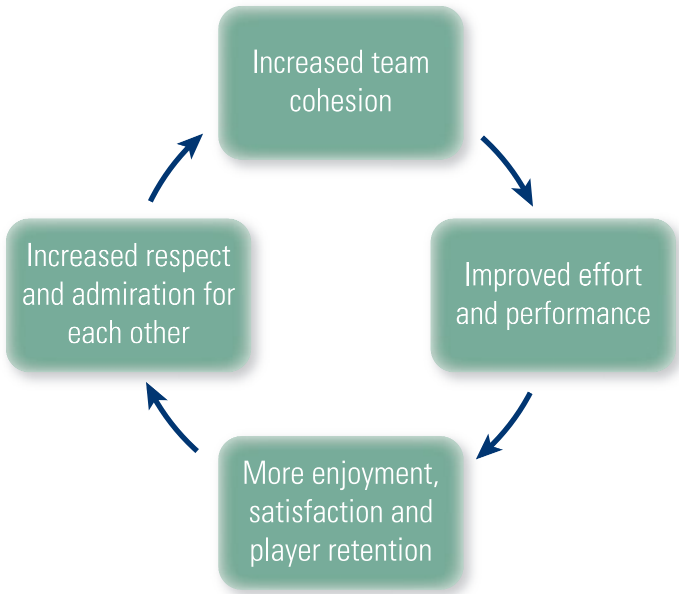

Figure 3.14 Increased team cohesion cycle

Optimising team dynamics and cohesion

Positive team dynamics rely on players developing a shared understanding of acceptable or **normalised** behaviours that will help the team to progress towards its goals. These normalised behaviours are also referred to as norms, and are essential to team cohesion. They provide shared understandings of how the team members interact with each other, and the level of commitment and effort expected by the playing group. Team cohesion can suffer if players are not complying with the team norms. If some team members are consistently late to training or are not providing the required social support to their teammates, resentment and anxiety levels will increase and the productivity of the team will decrease.

normalised to cause something to be accepted as normal or expected

Figure 3.15 A cricket team celebrating their good performance and, as a result, improving team cohesion

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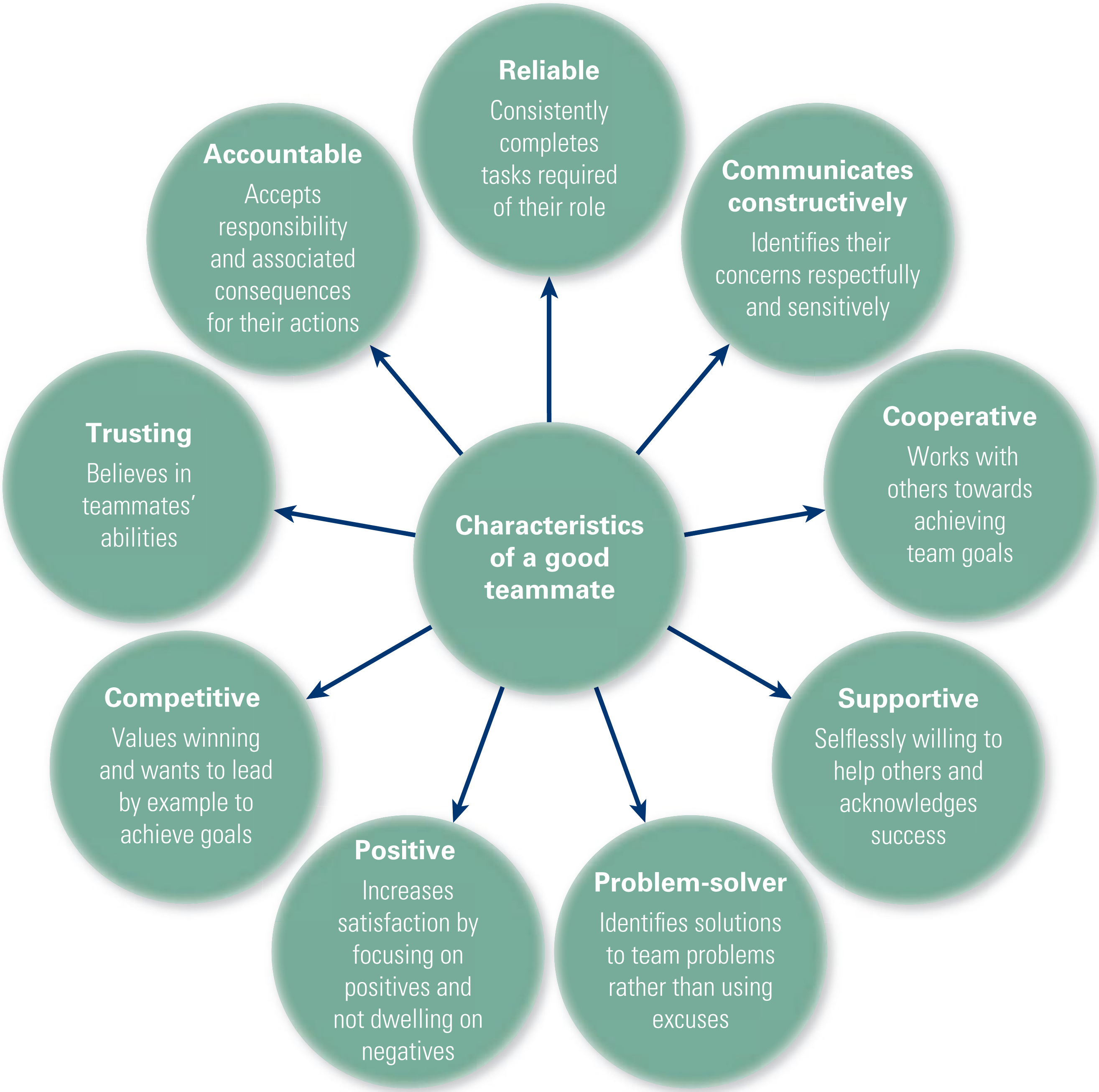

Figure 3.16 Characteristics of a good teammate

Activity 3.10

Check-in

RECOGNISE & EXPLAIN ANALYSE & SYNTHESISE

1 As a class, brainstorm the characteristics of the teammates you have found to be the most annoying or most destructive with regard to their team dynamics.

2 Categorise these factors in terms of how they are not meeting the characteristics of a good team member (e.g. not reliable).

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Activity 3.11

Engage-in

Inquiry question: How do successful teams develop positive team dynamics and strong team cohesion?

Engage and understand

Investigate: Carry out an examination or formal inquiry in order to establish or obtain facts and reach new conclusions; search, inquire into, interpret and draw conclusions about data and information.

Between 2006 and 2017, the Queensland Rugby League team has dominated New South Wales in the annual State of Origin competition. This dominance resulted in 11 series wins in 12 years and included an unprecedented streak of eight straight series wins. Much of the analysis of this dominance has related to the culture and cohesion of the Queensland team.

1 Investigate news articles from 2006 to 2017 referring to factors that influence either state's team dynamic and cohesion. Specifically, identify:

- environmental factors (player familiarity, club cultures/ success)
- personal factors (on- and off-field behaviours, adherence to norms, individual differences)
- leadership factors (leadership behaviour, style of leadership)
- team factors (group behaviour, desire to win, work ethic, team ability, player retention).

Apply and analyse

2 Represent your research using a Venn diagram comparing the two states.

Evaluate and justify

3 Write a conclusion about whether, and if so how, team performance has been influenced by team dynamics and cohesion. Use specific news articles to support your conclusion.

Factors affecting team dynamics

Carron's conceptual model of team cohesion stipulates that cohesion is dynamic between and within team environments. The multitude of factors that can influence team cohesion are categorised as:

- environmental factors
- individual factors
- leadership factors
- team factors.

Adjusting team norms and the level of social support to account for the specific requirements of the team will result in greater cohesion. Overall team cohesion consists of **social cohesion** and **task cohesion**.

For young athletes, the social cohesion of the team, or how much they like each other's personal characteristics, is paramount to their enjoyment, success and retention. However, for more competitive or elite athletes, the team's task coherence, or the extent to which they are working together to perform a task or reach a goal, is prioritised. If players are not adhering to the team norms, it is likely to be detrimental to the overall cohesiveness of the team and result in poor performance.

social cohesion refers to how much individual team members like each other and enjoy each other's company

task cohesion the team's ability to work towards a specific goal

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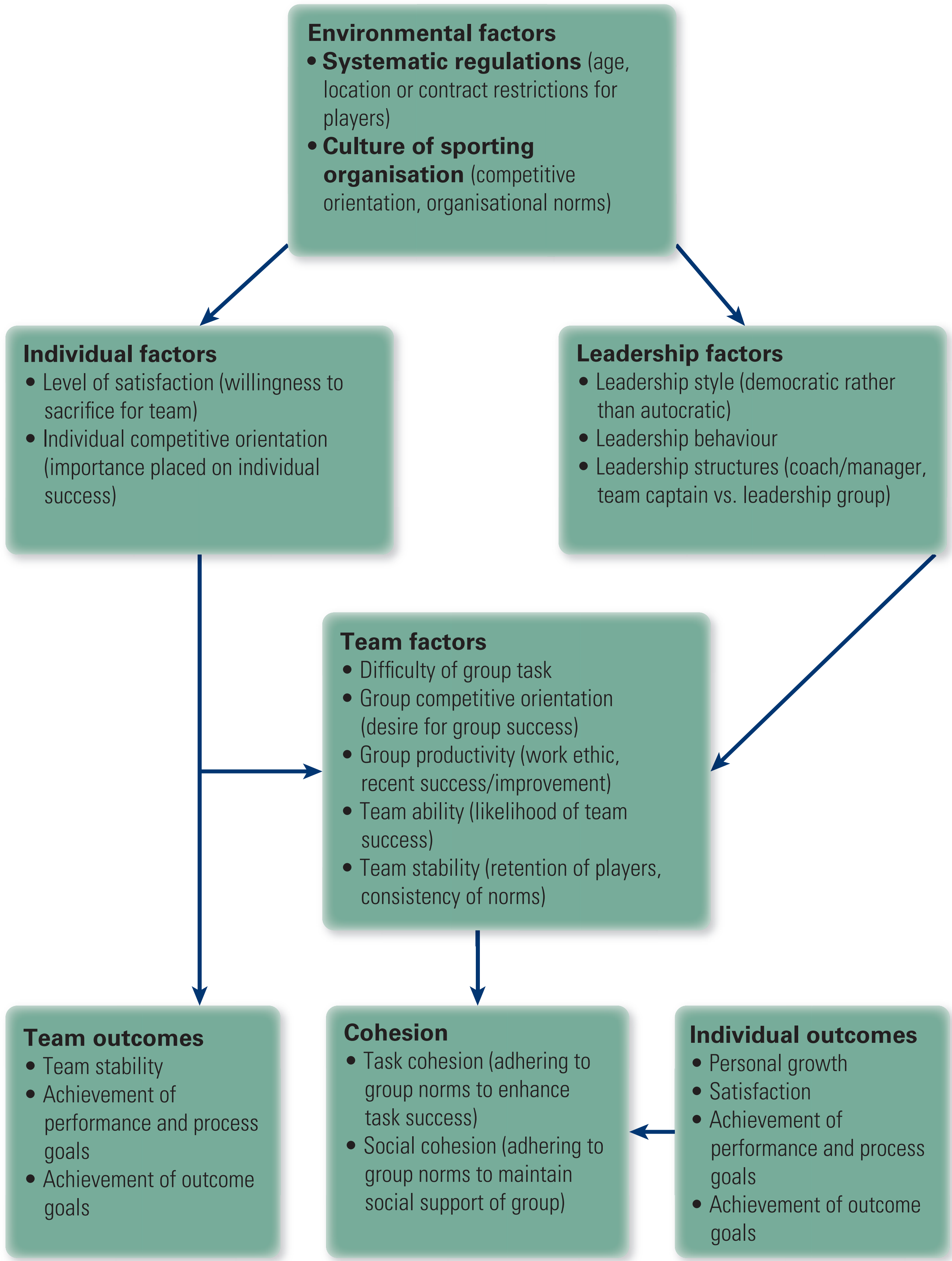

Figure 3.17 Factors influencing team dynamics

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Activity 3.12

Check-in

1 Make a list of 10 behaviours that could be displayed by teams to demonstrate they are putting in the required effort during games and competition.

2 Develop a flow chart of suitable consequences that could be implemented if team members did not adhere to these norms.

KEY MESSAGE Schutz believes group cohesion is driven by the need for inclusion, the need for control and the need for affection.

KEY MESSAGE There is a reciprocal relationship between team cohesion and team performance.

KEY MESSAGE Team dynamics are influenced by environmental, individual, leadership and team factors.

Inquiry cycle – stages 2 & 3: Apply and analyse; Evaluate and justify

3.7 Investigating techniques of sport psychology

Goal-setting

Goal-setting in one of the most fundamental psychological techniques used by many athletes, and has been shown to do the following:

- **Increase and maintain motivation**. Athletes feel more motivated as goals provide a context and direction for training. Achieving goals also boosts motivation towards new goals.
- **Increase confidence.** Achieving goals boost self-efficacy and improves self-belief when working towards future goals.
- **Improve attention and concentration.** By focusing on their goals, athletes are less likely to pay attention to distractions.
- **Regulate arousal.** The associated increase in motivation would also increase arousal levels, as the athlete wants to meet the challenge set. Additionally, when anxious, refocusing on goals can help to reduce arousal to optimal levels.

The process of setting goals helps an athlete to understand where their current level of performance is and how they want it to improve. The impact of goal-setting on an athlete's psychological state is strongest when they first set the goal and when they are close to achieving it. To maintain positive impacts of goal-setting over a long period, it is recommended that athletes set multiple goals.

Outcome, performance and process goals

There are three main types of goals that athletes can incorporate into their goal-setting system, and each is important in its own way. **Outcome goals** focus only on the end result, such as winning or improving a ranking. These goals are not fully within the athlete's control, as they can be influenced

outcome goals goals that focus on a desired outcome, like winning

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by the performances of other competitors. Although outcome goals provide high levels of motivation in people who are externally driven, an over-emphasis on them during competition can create anxiety. For example, an athlete who has an outcome goal of winning a triple jump competition may be so worried about not being in the lead after their first jump that they stop focusing on technique and their performance actually decreases. Outcome goals are typically best set as long-term goals, and athletes should have several performance and process goals that lead to the outcome.

Performance goals, on the other hand, are well within the athlete's control as they focus on what they are actually trying to achieve. These goals are typically measurable and involve times, distances, average scores or percentage of successful outcomes. While the long-term goal of a triple jumper may be to win a specific competition, a performance goal through training and in competition might be to increase their personal best by 30 cm, or their hop distance off the board to 3.2 m. These performance goals focus on improvement in their jump distance, and are not influenced by the results of other competitors, as an outcome goal would be.

performance goals goals related to a measured performance

process goals goals associated with improving essential processes that will lead to performance enhancement

Finally, **process goals** focus on particular behaviours or procedures that are required to improve performance and are totally controlled by the athlete. These goals are the underpinning building blocks that allow performance and outcome goals to be achieved. For example, in order to perform a personal best jump of 12 m and ultimately win the competition, the triple jumper may set a process goal of maintaining rhythm during the approach or improving landing technique. These process goals are targeted during training and may also provide a source of focus and attentional control during competition.

Developing SMARTER goals: How to construct and track goals effectively

The focus identified by any goal is important, as not all goals are effective in developing motivation. Many people spontaneously set goals that have no clear direction, may be beyond their capabilities and have no clear way of identifying when the goal is achieved.

The SMARTER goal-setting principle allows effective goals to be established:

- **S**pecific. Goals that are specific set out exactly what it is to be achieved in clear and precise words. Specific goals are much better at enhancing and maintaining motivation.
- **M**easurable. Goals must be measurable to ensure progress can be monitored and achievement is demonstrated clearly.
- **A**ction-based. Goals must be behaviourally based – that is, they should be observable by another person. This allows the performer and others, like a coach, to monitor the progress of the goal.
- **R**ealistic. Goals must be challenging, yet honestly within your means, if they are to motivate effectively.
- **T**imed. All goals should provide a deadline by which the goal is to be achieved. Without a target date, motivation will decrease and goals can drag out over time.
- **E**valuate. Once a goal has been set, it is important that progress towards achieving the goal is monitored. Goals that are inappropriate as they are too easy or too difficult can be reassessed. The performer can also be motivated by knowing how close they are to achieving the goal.
- **R**e-establish. Once a goal has been achieved, new goals must be set to maintain motivation and ongoing improvement. Ask the key questions: 'Where am I at now?' 'Where am I going?' 'How am I going to get there?'

Once a goal has been established, it is important to write it down, as this creates ownership of what is to be achieved. Writing down goals also ensures that the specifics cannot be manipulated when the going gets tough. In other words, writing goals down sets the expectations in stone.

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Activity 3.13

Active investigation

Inquiry question: How will the use of goal-setting influence my psychological state when performing in my chosen physical activity?

Engage and understand

1 Collect secondary data by conducting background research into the effects of goal-setting on your chosen physical activity, or its effectiveness for sport in general.

2 Write your hypothesis: 'If I incorporate effective goal-setting techniques, my ____________ levels would ____________ and my performance would improve because ____________.'

3 Reflect on your previous experience in the chosen physical activity and create one performance goal, one process goal and one outcome goal that relate to your performance. For each of these goals, use the following criteria:

- **a** specific (What is it?)
- **b** measureable (How will you know it has been achieved?)
- **c** action-based (What will other people notice when you are achieving?)
- **d** realistic (How achievable is it?)
- **e** timed.

Apply and analyse

4 Over a series of four competitive performances, collate primary data regarding the influence of goal-setting on:

- **a** the success of your performance
- **b** your level of motivation
- **c** your level of confidence
- **d** your level of arousal.

Analyse: Examine or consider something in order to explain and interpret it, for the purpose of finding meaning or relationships and identifying patterns, similarities and differences.

5 Analyse and interpret the primary data by developing a series of graphs and tables that demonstrate the main findings. Some examples of graphical displays could include:

- **a** column graphs that show results of your psychological state and performance throughout the goal-setting process
- **b** tables demonstrating percentage changes in psychological ratings and performance
- **c** X–Y scatter plots showing correlations between changes, psychological ratings and performance for a class or group of students.

6 Critique primary data by supporting or rejecting the identified trends based on valid and reliable research.

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Evaluate and justify

7 Evaluate the strengths and weaknesses of your goal-setting approach.

8 Using a paragraph, justify three recommendations for maintaining or modifying the elements of your goal-setting strategy for this performance.

KEY MESSAGE

Goal-setting has been shown to assist in optimising levels of motivation, confidence, arousal and concentration.

KEY MESSAGE

Process goals, performance goals and outcome goals are the three main types of goals.

KEY MESSAGE

Writing down goals increases ownership and increases the likelihood of them being achieved.

Mental rehearsal

Mental rehearsal, also known as imagery or **visualisation**, involves creating or recreating successful performances in the mind. It most effective when the mind simulates all of the senses required to complete the performance successfully. When visualising a performance, the same parts of the brain and nervous system are activated as if physically completing the tasks involved. The vividness (how realistic the imagery is) of this experience and the controllability (the ability to modify unsuccessful performance) are key factors in determining the usefulness of the practice. Mental rehearsal is most successful in sports where the athletes have a high degree of control over their environment, such as swimming, golf, archery and dance. However, it can also be advantageous to athletes playing direct interceptive sports when they are required to execute a specific task (serve in volleyball or free throw in basketball).

visualisation
creating and focusing on a range of positive mental images and experiences

Mental rehearsal has been shown to improve psychological states by doing the following:

- **Increasing confidence.** Visualising successful performance increases the self-belief that the athlete is up to the task at hand.
- **Increasing arousal.** Visualising high-energy images of competition can be used as a 'psyche up' technique and boost levels of preparedness.
- **Decreasing anxiety.** Visualising successful performance increases an athlete's sense of preparedness and provides a sense of comfort that they are up to the task.
- **Increasing motivation.** Visualising successful performance increases the intrinsic desire to compete.
- **Improving concentration.** Visualising successful performance prevents the mind from being overloaded with less important stimuli.

Types of mental rehearsal

Mental rehearsal can be implemented in a variety of ways to improve performance. First, visualisation can focus on the whole performance or specific parts of a performance. For example, a swimmer may visualise their whole performance in order to boost their confidence and motivation. However, visualisation could just include completing an effective start if the athlete is specifically looking to improve their concentration and decrease anxiety associated with this aspect of the performance.

Other variations in mental rehearsal revolve around the athlete's perspective. An *internal perspective* is where the visualisation occurs through the eyes of the athlete. This form of visualisation is typically recommended for athletes participating in sports where it is important to identify environmental cues like the flight path of an implement or movement of an opponent. Alternatively, an *external perspective* is where the athlete visualises their performance from someone else's viewpoint or 'watching a movie of themselves'. Visualising performance from an external perspective is most beneficial when competing in aesthetic activities where athletes are judged by others.

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Imagine entering the pool area. You smell the chlorine. You hear the echoing voices. The coaches and their swimmers are milling around. You take off your shirt and stretch to get ready for the event. You hear the splashing, and the beep of the starter for other races. This is your best race, and you're ready for it. You're as fit as you have ever felt. You hear the starter call the 100 Free. You step up on the blocks. The starter says, 'Take your marks', and you bend into your starting position, waiting for the beep. You launch into a powerful dive, streamlined. Your first powerful kick brings you to the surface, and you begin strong strokes. You see yourself from above. You are powerful and beautiful. Everything is working. With each stroke, you feel stronger and stronger. You approach the first turn. You are focused on nothing but your race. You throw your legs over perfectly, pushing off the wall into a tight, streamlined shape, gliding smoothly. You enter the second half of your race. Your strokes are smooth and powerful. Your breathing is perfect.

You tap into your reserve energy. You are exceeding your own expectations. You surge towards the wall and touch. You pull off your goggles and look up at the scoreboard. You won! And you beat your previous best time. You hear your breath slowing to normal. You become aware of the sights and sounds around you. You are a great swimmer.

Editor's note: This script was written for a 100 m freestyle event, but may be adapted to other events.

Figure 3.18 Visualising successful performance increases self-belief and the intrinsic desire to compete, and improves concentration.

Implementing mental rehearsal

The PETTLEP model for imagery created by Holmes and Collins in 2001 assists athletes to develop effective imagery routines to improve their performances. This model has been shown to have assisted a range of athletes, from novices to experts, and children to adults, and is most effective when they are imagining the whole skill or routine rather than just one part.

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Component		Recommendations to improve effectiveness of imagery
P	**P**hysical	Athlete should wear the same clothes (or similar), assume correct stance and hold any implements that would be used in competition.
E	**E**nvironment	Athlete should complete imagery in the same (or similar) environment where competition is held.
T	**T**ask	The imaged task should be identical to the actual performance. As skill level increases, imagery should change to suit this.
T	**T**iming	Imagery should be completed in real time. If the performance lasts for three minutes, the imagery should replicate this.
L	**L**earning	Imagery experiences should reflect the stage of learning. As a performer masters a new skill, this should be reflected in their imagery.
E	**E**motion	The level or arousal and specific emotions experienced during performance should be replicated throughout the imagery.
P	**P**erspective	Internal or external perspectives can be used. Usually, internal perspectives are recommended, but in aesthetic performances, external perspectives may be useful.

Table 3.9 Components of the PETTLEP model

Activity 3.14

Active investigation

RECOGNISE & EXPLAIN ANALYSE & SYNTHESISE EVALUATE JUSTIFY

Inquiry question: How will the use of mental rehearsal influence psychological state when performing in a chosen physical activity?

Engage and understand

1 Collect secondary data by conducting background research into the effects of mental rehearsal on your chosen physical activity.

2 Write your hypothesis: 'If I incorporate effective mental rehearsal techniques, my ______________ levels would ______________ and my performance would improve because ______________.'

3 Have each class member evaluate their levels of motivation, confidence and arousal towards the physical activity.

Apply and analyse

KEY COGNITION

Investigate: Carry out an examination or formal inquiry in order to establish or obtain facts and reach new conclusions; search, inquire into, interpret and draw conclusions about data and information.

(continued)

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4 As a class, use the PETTLEP model as a guide and devise a mental rehearsal routine for your chosen physical activity. This could involve using imagery for a whole performance (100 m race, golf shot or sports aerobics routine) or a segment of performance (a set of six in touch football, offensive play in basketball).

5 Divide the class into three even teams and prepare to compete in the physical activity. Each team will prepare for their performances in the following ways:

Team 1 – practical rehearsal only

Team 2 – mental rehearsal only

Team 3 – practical and mental rehearsal.

6 After completing the physical performance, have each player re-evaluate their levels of motivation, confidence and arousal, and collate the class data in a table.

7 Analyse and interpret the primary data by developing a series of graphs and tables that demonstrate the main findings. Some examples of graphical displays could include:

- column graphs that show the results of your class members' psychological states before and after their performance
- tables comparing percentage changes in psychological ratings of pre- and post-performance based on preparation.

Critique primary data by supporting or rejecting the identified trends based on valid and reliable research.

Evaluate and justify

8 In a paragraph, evaluate the effectiveness of the mental rehearsal routine using the following criteria:

a meeting the requirements of *personal and team psychological needs* (use primary data to justify)

b meeting the requirements of the specific *psychological demands of the sport* (use secondary data to justify).

KEY MESSAGE

Mental rehearsal of whole or part performance assists in optimising levels of motivation, confidence, arousal and concentration.

KEY MESSAGE

Internal perspectives are recommended for athletes who are required to track objects or opponents.

KEY MESSAGE

External perspectives are recommended for athletes being judged on aesthetic performance.

Building confidence through positive self-talk

An athlete's confidence is extremely fickle and can fluctuate based on a range of situations. It is widely acknowledged that thoughts directly influence an athlete's feelings, and ultimately the result of their performance. Expecting to be successful (high confidence) cannot guarantee a successful performance; however, expecting to be unsuccessful (low confidence) may guarantee failure. When preparing for a performance, athletes

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need to be mindful of negative thoughts, such as the following:

- 'I'm not good enough.'
- 'I'm not ready.'
- 'The opponent is too good.'
- 'I won't be able to finish.'
- 'I might mess up or get hurt.'

Focusing on negative thoughts results in feelings of anxiety, and can lead to increased muscle tension, which can impair the ability to perform successfully. **Positive self-talk** is a strategy used to readjust negative thought patterns that can affect sporting performance. It has been shown to boost confidence, enhance focus and concentration, and control levels of arousal.

positive self-talk making positive comments to oneself, either silently or out loud

Activity 3.15

Check-in

1. Explain the relationship between thoughts, feelings and performance.
2. Make a list of any five situations in physical activity that you think negatively about and five situations you think positively about.
3. Select one item from each list in question 2 and explain what incidences may have led you to develop these thought patterns.

affirmation a positive statement about you, your abilities or goals that is true or reasonable enough to be valid in the future

Frequently, positive self-talk is associated with the use of **affirmations**. Affirmations are simply positive statements about you, your abilities or goals that are true or reasonable enough to be valid in the future. Affirmations can reflect your present or future. For example, a tennis player may use the following affirmations to boost confidence levels:

- 'I was born to play tennis.'
- 'I can cover the court with ease.'
- 'I have a powerful and accurate serve.'
- 'I have sharp and accurate reflexes.'
- 'I have a range of effective shots.'
- 'I am developing into a top-level player.'

For most athletes, affirmations need to be complemented by further positive self-talk when reacting to stressful situations during the performance. This takes the form of either *instructional self-talk* or *motivational self-talk*. For example, a tennis player may enter a competition feeling relaxed and confident with their preparation and ready to perform. However, if they lose their first two service games, they may start overthinking why their performance is lower than expected. Negative thoughts such as, 'I'm not good enough for this opponent' or 'My serve is too weak' will lead to a build-up of anxiety. In turn, this would result in high levels of anxiety and muscular tension, so their technique would be less effective and it would be harder for them to get back into the set. As the name suggests, instructional self-talk involves replacing negative thoughts with thoughts about specific tasks or cues that will lead to successful performance. This type of positive self-talk is most beneficial when the successful performance relies on a degree of precision and coordination. For example, when a tennis player is serving, the may repeat instructional cues such as 'make high contact' and 'follow though straight'.

Alternatively, motivational self-talk involves the use of more general positive mantras and would be more beneficial for athletes relying on strength or endurance. The tennis player previously mentioned was commencing the third and deciding set of their match, so could incorporate mantras such as 'keep going', 'I can do this' or 'I know my training will pay off during this set'.

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Activity 3.16

Active investigation

Inquiry question: How will the use of positive self-talk influence my confidence and arousal during physical performance?

Engage and understand

1. Predict the situations that would lead to negative thoughts during your performance.
2. Identify three positive affirmations that are relevant to you and your chosen physical activity.
3. Write your hypothesis: 'I believe there will be a ____________ correlation between the reduction of negative thoughts and an improvement in my performance because ____________.'

Apply and analyse

Implement: Put something into effect.

4. Compete in your chosen physical activity and then do the following:
   - **a** Track the number of negative thoughts you have during a performance. You can do this by keeping count in your head or by placing a number of counters (paperclips will do) in your left pocket and moving one to your right pocket every time you have a negative thought about your performance.
   - **b** List three situation-specific negative thoughts that you experienced the most during your performance.
   - **c** Evaluate your performance using an appropriate evaluation tool.
5. For three situations in which you experienced negative thoughts, devise a positive self-talk phrase that can redirect your thinking.
6. Participate in another competitive performance, implementing your positive self-talk strategies created in task 5.
7. Re-evaluate your performance and record the number of negative thoughts you had.
8. Analyse the primary data and make links between the use of positive self-talk, negative thought processes and perceived performance.
9. Critique primary data by supporting or rejecting the identified trends based on valid and reliable research.

Evaluate and justify

10. In a paragraph, evaluate the effectiveness of the positive self-talk for reducing your negative thoughts and improving your performance. Justify one recommended change that would improve your positive self-talk process.

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> Positive self-talk eliminates negative thought processes that could be detrimental to performance.

> Instructional self-talk uses specific performance cues to focus attention away from negative thoughts.

> Motivational self-talk uses general positive statements and is most beneficial for endurance athletes.

Pre-performance routines

Pre-performance routines assist athletes to focus on specific performance cues instead of potentially damaging thought processes such as missing a shot, losing a game or negative evaluations of their competency and self-efficacy. Pre-performance routines traditionally have been associated with closed skills, in which an athlete has a high degree of control over the environment. Examples of closed skills associated with pre-performance routines include a golf swing or putt, a free throw in basketball, or a serve in tennis, table tennis or badminton. All these skills can be practised over and over without relying on teammates or opposition. The importance of pre-performance routines in sports was highlighted by NBA star Russel Westbrook. He was voted, the 2016–17 NBA Most Valuable Player and had a career free throw shooting percentage of 82.2 per cent. He had to modify his pre-performance routine to accommodate a new rule enforced by the NBA. This resulted in his success rate at the free throw line plummeting to 55.6 per cent at the beginning of the 2017–18 season.

Figure 3.19 Russell Westbrook shooting a free throw

> 'I used to shoot and walk back behind the 3, and I'm not allowed to do that because of this new rule. I've been doing that since high school. Just gotta figure it out, figure out a different routine where I can take some time, take a deep breath, and figure it out. But I'll be alright.'
>
> *– Russell Westbrook*

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When creating successful pre-performance routines, it is recommended to include both positive self-talk and a consistent set of actions that can easily be repeated before attempting the skill.

An example of a pre-performance routine for volleyball could include the following:

Preparation phase:

- Stand 1 m behind the service line.
- Take two deep breaths.
- Think 'My overhead serve is my strength'.

Focusing phase:

- Select service target.
- Bounce the ball twice with both hands.
- Focus on the target.
- Think 'swing fast, hit flat'.

Execution phase:

- Take two deep breaths.
- Throw the ball up with your left hand.
- Step forward and hit with your right hand.

Figure 3.20 Australian beach volleyball player Nicole Laird preparing to serve

Activity 3.17

Active investigation

Inquiry question: How will the use of pre-performance routine influence my confidence and arousal during physical performance?

Engage and understand

1 Identify a list of common errors or areas of inconsistency that occur when performing your chosen physical activity.

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2 Examine the causes of these errors. Consider factors such as technique, psychological state, concentration and fatigue.

3 Identify three key factors that you need to develop to improve your performance.

Apply and analyse

4 Participate in a competitive performance and evaluate your psychological state (confidence and arousal) and your level of performance.

5 Construct a pre-performance routine that incorporates a consistent set of actions and positive self-talk. Specifically, try to target the factors identified above that are impacting your performance. Make sure you clearly develop a preparation phase, focusing phase and execution phase.

6 Over a series of lessons, practise implementing your routine in a series of environmental conditions (high pressure, loud noise, different competitors).

7 Participate in another competitive performance and re-evaluate your psychological state and your level of performance.

8 Analyse the primary data and make links between the use of pre-performance routine, your psychological state and your performance.

9 Critique primary data by supporting or rejecting the identified trends based on valid and reliable research.

Evaluate and justify

KEY COGNITION

Evaluate: Make an appraisal by weighing up or assessing strengths, implications and limitations; make judgments about the ideas, works, solutions or methods in relation to selected criteria; examine and determine the merit, value or significance of something, based on criteria.

10 In a paragraph, evaluate the effectiveness of your pre-performance routine on reducing your errors and improving your performance. Justify one recommended change that would improve your positive pre-performance routine.

KEY MESSAGE

Pre-performance routines help athletes to mentally and physically prepare for performance.

KEY MESSAGE

Pre-performance routines typically are associated with closed skills.

KEY MESSAGE

A good pre-performance routine involves positive self-talk and a consistent set of actions.

Arousal-regulation techniques

Achieving optimal levels of arousal for performance can be achieved through the use of various relaxation and energising techniques. Elite athletes looking for a psychological edge are likely to engage one or more of these approaches to regulate their level of arousal. Like any essential skill, these techniques require specific training to master them.

Progressive muscle relaxation

Progressive muscle relaxation (PMR) is one common method of reducing arousal levels and associated somatic anxiety. It is also believed that cognitive

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anxiety is reduced as a result of decreased muscle tension. PMR involves progressively tensing then completely relaxing each muscle group. The purpose of this technique is to teach the athlete how to identify tension in the body and then to be able to release it when needed. Ideally, after practising this technique, competitive athletes would be able to identify tension in specific muscle groups and be able to relax them as they are competing.

Progressive muscle relaxation

- To begin, participants need to find a quiet space to either sit or lie down quietly where they will not be distracted.
- Start by focusing on your breathing. Take about 10 deep controlled breaths; each breath should fill the abdomen and slowly be released.
- Contract each muscle group for five seconds before relaxing. As you relax each muscle group, you should focus on releasing the tension from the area of the body. Contractions can be completed either unilaterally (one side at a time) or bilaterally (both sides at the same time).

Progressive muscle relaxation order:
Legs and lower body

- Contract the muscles of the feet at the toes by bending the toes down and curling the arches of the feet.
- Tense the muscles of your lower legs by flexing the ankles and pointing the toes back towards you. *Hold for five seconds and release.*
- Tense the muscles of the upper leg by squeezing the thigh muscles. *Hold for five seconds and release.*
- Contract the muscles of the buttocks by squeezing them together. *Hold for five seconds and release.*
- Contract your abdominal muscles by sucking your stomach in towards your spine. *Hold for five seconds and release.*

Arms

- Contract the muscles of the hand by making a fist and flexing the wrist. *Hold for five seconds and release.*
- Tense the forearm muscles by tensing the biceps and triceps. *Hold for five seconds and release.*

Upper body

- Contract the chest muscles by taking a deep breath and drawing your shoulders back. *Hold for five seconds and release.*
- Tense the muscles in your neck and shoulders by shrugging your shoulders up and tilting your head back. *Hold for five seconds and release.*
- Contract the muscles of the jaw by opening your mouth as wide as possible. *Hold for five seconds and release.*
- Contract the muscles of the eyes by tightly shutting your eyes. *Hold for five seconds and release.*
- Contract the muscles of the forehead by raising the eyebrows as high as possible. *Hold for five seconds and release.*

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Figure 3.21 British athlete Greg Richards preparing to compete using the progressive muscle relaxation method

Activity 3.18

Engage-in

Inquiry question: How effective is progressive muscle relaxation for reducing arousal?

Engage and understand

1 Have each individual class member evaluate their level of arousal.

2 Each person is required to find a place to sit back or lie down.

Apply and analyse

Apply: Use knowledge and understanding in response to a given situation or circumstance; carry out or use a procedure in a given or particular situation.

3 Read through the progressive muscle relaxation script on page 150. Remind students that this exercise is most effective if each individual muscle is tensed. Do not tense muscles to the point of strain, and refrain from tensing injured areas of the body.

4 Re-evaluate arousal levels.

5 Participate in five minutes of vigorous physical activity.

6 Re-evaluate arousal levels and analyse changes before and during activity. This could include looking at class averages, and identifying who had the largest decrease in arousal and whose level of arousal did not change.

Evaluate and justify

7 Use a series of statements to evaluate how effective this progressive muscle-relaxation exercise was in optimising arousal levels during rest and following vigorous physical activity.

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Breathing techniques

Anyone experiencing acute anxiety or panic will be told to take a deep breath. Therefore, teaching the skill of deep breathing can also help reduce an athlete's arousal levels. Somatic anxiety levels lead to feelings of tension and short, shallow breathing. Alternatively, deep, calm breathing is a sign that an athlete is relaxed and in control of a situation. By training their breathing, athletes will also be able to control their levels of tension and adjust their arousal to optimal levels. Controlled breathing is best used during breaks in performance, like a time-out or change of ends. To reduce arousal levels, extending the exhalation phase is required and a 1:2 ratio of inhalation to exhalation should be used. On the other hand, if trying to increase arousal levels, the inverse is true. An elongated inhalation implementing a 2:1 ratio will increase tension and energise the athlete.

Figure 3.22 By training their breathing, athletes can adjust their arousal to optimal levels.

Music

Music is another tool that can be used to help an athlete dissociate from distractions and regulate their levels of arousal. Listening to their favourite music will improve the athlete's mood. Many modern athletes will incorporate music into their pre-competition routine. Calming, slow music has been shown to calm an athlete's nerves and reduce levels of arousal. This would be most useful in sports that require higher levels of precision, like archery or golf. Alternatively, fast, stimulating music increases arousal and overall levels of motivation to perform. Athletes participating in sports likes athletic jumps and throws that require short, powerful movements would most benefit from faster music.

Activity 3.19

Engage-in

Inquiry question: Does listening to music during a warm-up influence arousal regulation?

Engage and understand

1. Have each individual class member evaluate their level of arousal before a game.
2. Conduct a class warm-up and evaluate levels of arousal.
3. Engage in competition and record when each class member believes they have reached their optimal arousal level.

Apply and analyse

Apply: Use knowledge and understanding in response to a given situation or circumstance; carry out or use a procedure in a given or particular situation.

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4 Create individual 10-minute playlists to listen to during warm-up, which help regulate arousal (towards optimal levels).
5 Engage in another competition and again record when each class member believes they have reached their optimal arousal level.
6 Analyse the data and make comparisons between initial arousal levels and the time taken to achieve optimal arousal with and without music.

Evaluate and justify

7 Use a series of statements to evaluate how effective listening to music was in optimising arousal levels during rest and following vigorous physical activity.

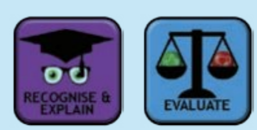
Visualisation

Finally, visualisation can also be used to manipulate arousal levels. If successful performance is clearly visualised, the athlete's motivation will increase. The extent of this increase is reliant on the ability to clearly visualise success and associated feelings of joy and excitement. Subsequently, the greater motivation to compete would result in an increased level of arousal. Visualising success can also help relax an athlete, as they feel more competent to complete the task successfully. This would reduce the anxiety related to failure and limit internal distractions.

Figure 3.23 Some athletes use music to dissociate from distractions.

Activity 3.20

Check-in



1 Have your teacher talk you through a simple scenario from the physical activity that is your current focus – for example, serving for the match in tennis, volleyball, badminton or table tennis; teeing off on the first hole or putting for the match on the 18th hole; running through a rucking pattern to work out of your half in a touch football match; using a centre pass move in netball; or competing in any of the athletic or swimming events.

The scenario should be quite specific and your teacher should outline the venue, the time of day, weather conditions, the score and any other features that might help imagine the performance. While the teacher sets the scenario, you are to close your eyes and imagine you are performing in the scenario.

2 Once you have completed the imagery activity above, use the scale on the following page to evaluate the effectiveness of your visualisation.

(continued)

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	1	2	3	4	5	
Distractible						Total concentration
Fuzzy						Sharp
Black and white						Colour
No feeling						Felt every move
No sound						Sound
Confused						Knew my job
Scared						Confronted situation
Unsuccessful performance						Perfect performance
No emotion						Emotional
Distorted time (fast/slow)						Real time
Self only one involved						Saw faces of opposition

KEY MESSAGE

Optimal arousal levels can be achieved by incorporating one or more relaxation or hype-up strategies.

KEY MESSAGE

Relaxation strategies reduce anxiety and include listening to music, progressive muscle relaxation and breathing.

KEY MESSAGE

Hype-up strategies increase readiness to perform and can be achieved through visualisation, listening to fast-tempo music and breathing.

Optimising attention and concentration

'Choking' is a common term used when athletes drastically under-perform during high-pressure situations. It is believed that lapses in concentration are caused by increases in anxiety and muscle tension. This might occur during important periods in a season, like finals games or important periods of an isolated performance. For example, batters in cricket place extra emphasis on scoring centuries, so their anxiety increases during the 'nervous nineties', where they are close to this milestone. This anxiety could inhibit their decision-making and their ability to play high-percentage shots.

Home ground advantage is often referred to in relation to athletes or teams. Most sporting teams naturally have a superior record when competing at their home ground. One reason for this is because they have become efficient at filtering information and accustomed to potential distractions in their environment. Competing in 'away' fixtures or competitions requires adjustments to effectively filter environmental cues and block out distractions. Naturally, opposition crowds and announcers are quite happy to provide visiting athletes with as many distractions as they can to support their own team.

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Strategies that athletes use to control attention and improve concentration include:

- training selective attention
- using trigger words
- performance segmenting
- pre-performance routines
- within-competition routines.

Training selective attention

Selective attention refers to the ability to efficiently filter relevant and irrelevant information to complete a task. This can be achieved by learning to block the internal and external distractions that occur during a performance. When training to improve selective attention, athletes would familiarise themselves with the playing conditions faced during competition. A player or team may prepare for a competition with loud music or simulated crowd noise playing in the background. This will help them to block out this irrelevant external information and maintain concentration on important performance cues. Similarly, they may practise executing their plays immediately following periods of intense physical activity in order to practise ignoring irrelevant internal cues associated with fatigue.

Trigger words

Trigger words are simple words, sayings or acronyms that an athlete can utilise to refocus their concentration back to the relevant performance cues. When focusing on the cues associated with trigger words, athletes are automatically blocking out distractions that could hinder their performance. When developing trigger words, it is essential that an athlete uses a phrase that is short, personal and positive. Furthermore, the phrase should relate directly to the performance and/or the potential distractions the athlete is likely to experience. In general, trigger words refocus attention to tactical, emotional and/or psychological cues. Trigger words are extremely important during a performance to re-establish focus after an error, as they help the athlete not to dwell on their mistake.

Segmenting performance

Segmenting performance is a strategy by which athletes plan ahead to complete smaller tasks within their performance and narrow their concentration accordingly. For example, a 400 m runner may break their race into two segments. They would focus the first part of their race on internally pacing themselves and ensuring that they are using an efficient technique and not burning too much energy. However, during the second segment of the race, they would adjust their concentration externally to be able to focus on their position and the strategy of their opponents. Segmenting performance would also be beneficial for quickly adjusting focus during a performance and isolating errors. A volleyball player, for example, would separate their attention from serving to playing on the court. When serving, they have a narrow focus, but would have to broaden their focus and start playing defence. By segmenting the different performance tasks, an error on serve would be less likely to influence their concentration during court play.

Figure 3.24 Darcy Gardiner (left) and Harris Andrews of the Brisbane Lions compete for the ball during a Lions' AFL pre-season training session.

Figure 3.25 Runners may break their race into two segments – one to pace themselves, and the other to focus on their position.

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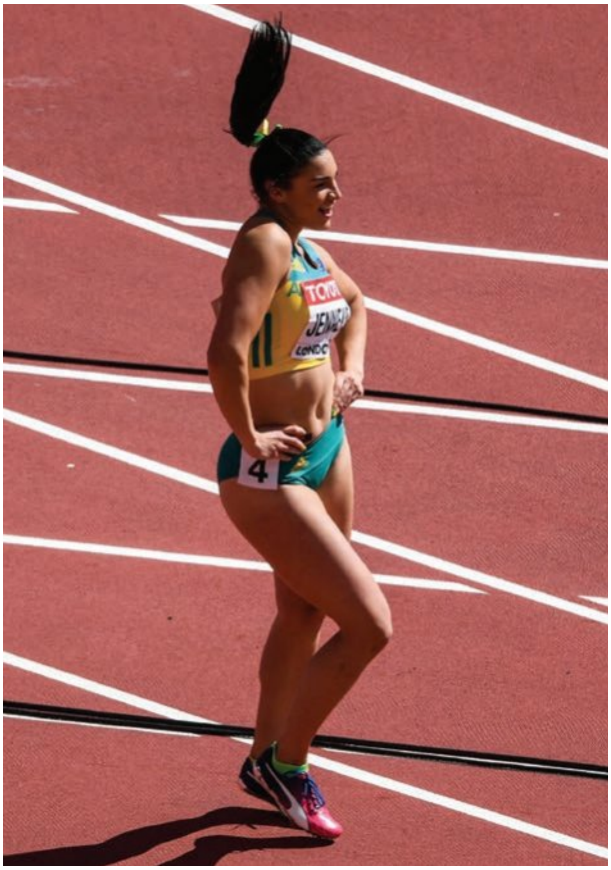

Figure 3.26 Michele Jenneke dancing as part of her pre-performance routine

Pre-performance routines

The use of pre-performance routines is commonplace where the environment is stable. These could include actions or sayings that help an athlete to narrow their attention to the task at hand and limit the distractions from external sources. Similar to using trigger words, if the focus of attention is on completing a familiar routine, there will be less focus on irrelevant distractions. A 100 m sprinter would incorporate a pre-performance routine to block out irrelevant internal and external distractions to prepare for their race.

Within-competition routines

During competition, routines are used to refocus attention and typically are used when the parameters of the performance change. For example, a goal shooter in netball would need to have a broad attentional focus to get away from the defender and into space. However, they would need to quickly change their focus after receiving a pass in the goal circle. A simple performance routine such as taking a deep breath and focusing on the back of the hoop would help block out the actions of the defender and narrow their focus in preparation for shooting.

Activity 3.21

Active investigation

Inquiry question: How will the incorporation of attention and concentration training impact performance in your chosen physical activity?

Engage and understand

1. Examine the key causes of distractions for you in your chosen physical activity. Think specifically about distractions that draw your concentration away from the essential cues of your tasks or skills.
2. Collect secondary data by conducting background research into common attention and concentration techniques used by athletes in your chosen physical activity.
3. Select an attention and concentration strategy to incorporate into your training and performance.

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Analyse and apply

4 Participate in a competitive performance and evaluate your psychological state (motivation, confidence and arousal) and your level of performance.

5 Design and implement a series of practice lessons in which you can incorporate your attention and concentration strategy.

6 Participate in another competitive performance and re-evaluate your psychological state and level of performance.

7 Analyse and interpret the primary data by developing a series of graphs and tables that demonstrate the main findings. Some examples of graphical displays could include:

- **a** column graphs that show results of your psychological states before and after implementing your strategy
- **b** tables comparing percentage changes in psychological ratings of pre- and post-performance based on preparation.

Evaluate and justify

KEY COGNITION

Evaluate: Make an appraisal by weighing up or assessing strengths, implications and limitations; make judgments about the ideas, works, solutions or methods in relation to selected criteria; examine and determine the merit, value or significance of something, based on criteria.

8 In a paragraph, evaluate the effectiveness of attention and concentration technique on reducing distractions and improving your psychological state and performance. Use both primary and secondary data to justify your evaluation.

KEY MESSAGE

Training to control attention and concentration will reduce the likelihood of 'choking' under pressure.

KEY MESSAGE

Training in environments that simulate performance will help an athlete to focus their attention more effectively.

KEY MESSAGE

Using words and actions before and during a performance assists to refocus attention on relevant stimuli.

Optimising team dynamics and cohesion

In line with the development of physical and strategic skills, a successful team also needs to work on team cohesion and improve team dynamics. People in leadership groups are responsible for developing and maintaining the required norms and social support for the team. Team leadership traditionally has been the responsibility of the captain or coach. However, many professional sports have started to utilise leadership groups instead. This approach involves more of the senior players demonstrating the team norms and also increases the amount social support provided by the leaders. Democratic leadership, where players feel comfortable to have their say and offer constructive criticism, is needed to build a positive

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team dynamic. Essential processes required to build team cohesion include:

- negotiate and clearly define the roles of the individuals
- provide leadership for the team
- negotiate specific and realistic common goals for the team
- create a specific team identity.

Activity 3.22

Check-in

1 Split the class into four groups. Each group explores one of the following topics:

a negotiating and defining roles

b providing leadership

c negotiating goals

d creating identity.

2 Each group is required to analyse the influence of its topic on the class dynamic. (e.g. Does the class have a unique identity?)

3 Report back to the class with at least one recommendation that could improve the dynamics and cohesion of the group.

Negotiate and clearly define the roles of the individuals

Providing players with the opportunity to consider their best role as a team member can be beneficial for reducing an athlete's anxiety. Having ownership of, and acknowledging, the role they will play as a team member will allow them to share the responsibility for the performance and be less anxious about failure. Being given a specific team role also increases motivation and willingness to make sacrifices for the team. Additionally, being entrusted with an important team role increases self-efficacy and boosts confidence.

Provide leadership for the team

Leaders play an important role in promoting and regulating team cohesion. A democratic leadership approach would involve open lines of communication where players feel free to provide constructive criticism regarding team processes and personal satisfaction. This approach emphasises feelings of inclusion for players and increases confidence and motivation. Dealing with concerns about player mood and satisfaction reduces resentment and improves player resilience, as well as the team's ability to overcome setbacks. Good leadership reinforces the importance of individual roles in the team's success and provides support and affection where required.

Figure 3.27 Good leadership is important to achieving team success.

Negotiate specific and realistic goals for the team

Goal-setting will provide motivation for the team's efforts. The negotiation process allows players to develop feelings of control over their goals, which will increase their desire to meet team norms and make individual sacrifices. Furthermore, teams that successfully reach their goals – especially early in their development – will be more cohesive and continue the cycle by improving their performance.

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Create a specific team identity

Building a team identity is arguably the most important means of developing social cohesion. A distinct team identity encourages unity within the team, strengthens social bonds and enhances feelings of inclusion. Players will put in more effort if they feel a strong affection towards their group. Incorporating team rituals, sayings, chants and warm-up practices are all means of building team identity and enhancing affection among teammates.

Figure 3.28 Team huddles can help strengthen social bonds.

Activity 3.23

Active investigation

RECOGNISE & EXPLAIN | ANALYSE & SYNTHESISE | EVALUATE | JUSTIFY | MAKE DECISIONS

Inquiry question: What is the influence of team cohesion on the psychological state of individuals?

Engage and understand

Identify: Distinguish; locate, recognise and name; establish or indicate what something is.

1 Divide the class into two even teams using an arbitrary selection process such as the suburb in which they live, where they were born or whether they have been overseas.

2 Compete in a competition against the other team. Upon completion, have each team member evaluate their psychological state (level of motivation, confidence, arousal) and their perceived level of task cohesion and social cohesion (out of 10) within their team

3 Allow each team the opportunity to identify:

a team roles, including leadership

b team goals (process, performance and outcome goals)

c essential team norms required to achieve goals

d their own team identity (team name, motto, chant or even mascots).

Apply and analyse

Apply: Use knowledge and understanding in response to a given situation or circumstance; carry out or use a procedure in a given or particular situation.

4 Allow each team to implement a series of training sessions in preparation for a culminating competition against their opponents.

5 Before and after the final completion, re-evaluate your psychological state and your perception of team cohesion.

(continued)

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6 Analyse and interpret the primary data collected from your team regarding changes in psychological state and levels of team cohesion (this can be done anonymously). Identify specific correlations within the data (e.g. as social cohesion increased, so did motivation).

7 Critique primary data by supporting or rejecting the identified trends based on valid and reliable research.

Evaluate and justify

8 Use a series of statements to evaluate the effectiveness of the process of developing your team's cohesion, and participating in training sessions and the competitive performance. Justify the three most significant experiences that influenced team dynamics, cohesion and overall psychological state.

KEY MESSAGE Team leaders are responsible for fostering group norms and applying consequences for undesirable behaviours.

KEY MESSAGE Athletes will be more compliant with norms if team roles and goals are negotiated with them.

KEY MESSAGE Developing a unique team identity influences social cohesion and fulfils the need for inclusion.

Figure 3.29 Ben Ainsworth of the Suns celebrates after kicking a goal.

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Chapter summary

- Sport psychology is the study of how thoughts influence sporting performance.
- The main psychological factors influencing performance are motivation, confidence, arousal, concentration and team dynamics.
- Competence, autonomy and relatedness are all key to developing motivation.
- Motivating factors can be placed on a continuum from intrinsic to extrinsic sources.
- Confidence is considered the most influential psychological factor in determining success.
- Best performances occur when confidence is optimal and there is a balance between under-confidence and over-confidence.
- Optimal levels of arousal for athletes lie between under-arousal and over-arousal.
- The optimal levels of arousal can vary based on ability and complexity of skills.
- Cognitive and somatic anxiety result from negative responses to over-arousal.
- The focus of an athlete's attention will fall into one of four categories.
- Attention is continually shifting from one category to another.
- Misdirected attention is directly linked to errors in physical performance.
- Group cohesion is driven by the need for inclusion, the need for control and the need for affection.
- There is a reciprocal relationship between team cohesion and team performance.
- Team dynamics are influenced by environmental, individual, leadership and team factors.
- Goal-setting has been shown to assist in optimising levels of motivation, confidence, arousal and concentration.
- The three main types of goals are process goals, performance goals and outcome goals.
- Mental rehearsal of whole or part performance assists in optimising levels of motivation, confidence, arousal and concentration.
- Internal perspectives are recommended for athletes who are required to track objects or opponents.
- External perspectives are recommended for athletes being judged on aesthetic performance.
- Positive self-talk eliminates negative thought processes that could be detrimental to performance.
- Instructional self-talk uses specific performance cues to focus attention away from negative thoughts.
- Motivational self-talk uses general positive statements, and is most beneficial for endurance athletes.
- Pre-performance routines help athletes to mentally and physically prepare for performance.
- A good pre-performance routine involves positive self-talk and a consistent set of actions.
- Optimal arousal levels can be achieved by incorporating one or more relaxation or hype-up strategies.
- Relaxation strategies reduce anxiety; they include listening to music, progressive muscle relaxation and breathing.
- Hype-up strategies increase readiness to perform; they can be achieved through visualisation, listening to fast-tempo music and breathing.
- Training to control attention and concentration will reduce the likelihood of 'choking' under pressure.
- Training in environments that simulate performance will help an athlete to more effectively focus their attention.
- Using words and actions before and during a performance helps to refocus attention on relevant stimuli.
- Team leaders are responsible for fostering group norms and applying consequences for undesirable behaviours.

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- Athletes will be more compliant with norms if team roles and goals are negotiated with them.
- Developing a unique team identity influences social cohesion and fulfils the need for inclusion.

Chapter review

Multiple-choice questions

1 Sport psychology is:
  A a strategy to psych out your opponent.
  B a science that explores the link between thoughts, feelings and physical performance.
  C a means of predetermining what sports you would be good at.
  D only relevant to elite athletes.

2 An athlete's motivation is directly related to their experiences of:
  A competence, relatedness and autonomy.
  B confidence, readiness and autonomy.
  C competence, relatedness and anxiety.
  D competence, relationships and a winning team.

3 Which of the following is NOT an intrinsically motivating factor?
  A Learning a new skill
  B Feeling stimulated
  C Proving yourself to others
  D Accomplishing a task

4 Self-efficacy is defined as:
  A being able to complete a task with minimal wasted energy.
  B the extent to which an athlete feels prepared for a performance.
  C how certain the athlete is that they are going to win.
  D the discrepancy between an athlete's ability and performance.

5 Which of these is not a key source of confidence?
  A Being told you're doing a great job
  B Seeing teammates produce a successful performance
  C The amount of prize money involved
  D Feeling positive about upcoming performances

6 Which of the following statements is true about anxiety?
  A Anxiety assists successful performance in some sports.
  B Anxiety falls within the optimal arousal zone.
  C Anxiety is the negative psychological and physiological response to decreased arousal.
  D Anxiety is the negative psychological and physiological response to increased arousal.

7 A broad external attentional focus is best described as:
  A being able to look at multiple players at once.
  B being able to identify a range of relevant environmental cues at one time.
  C being able to concentrate on a defender for a long period of time.
  D being able to quickly filter relevant information from irrelevant information.

8 Which of the following lapses in concentration would describe a touch football player missing a catch because they were looking for gaps in the defensive line?
  A Narrow internal instead of narrow external
  B Broad internal instead of narrow external
  C Broad external instead of narrow external
  D Broad external instead of narrow internal

9 According to Schultz, which of the following is not one of the three key drivers that motivate team cohesion?
  A The need for affection
  B The need for success
  C The need for control
  D The need for inclusion

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10 Improving team dynamics can influence performance by:

A improving skills.

B improving the effectiveness of practice.

C improving club reputation.

D eliminating weaker players.

Short-answer questions

1 Explain the link between thoughts, feelings and behaviours.

2 Explain how the inverted-U hypothesis explains optimal levels of arousal for different athletes and tasks.

3 Identify your level of motivation towards succeeding in your current physical activity. Explain the influence of three motivating factors.

4 Using an example for a positive team experience and a negative team experience, explain the most valuable characteristics of a teammate.

5 Explain how having a mis-directed attentional focus could lead to errors in your chosen physical activity.

Extended-response questions

1 Use primary and secondary data to justify the selection of any three psychological factors that have influenced your ability to perform in your chosen physical activity.

2 Evaluate the effectiveness of one psychological technique in improving your performance in your chosen physical activity.

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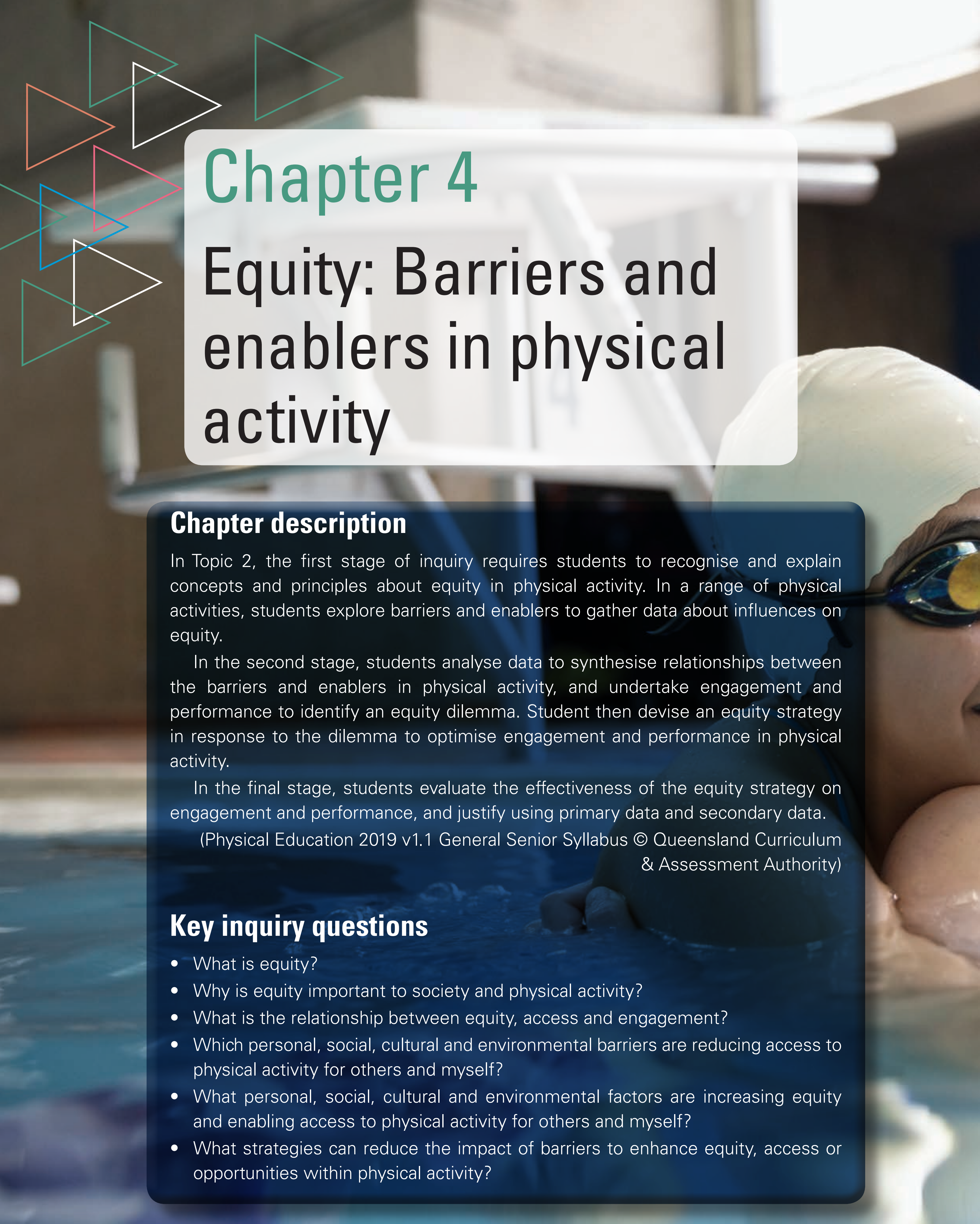

Chapter 4

Equity: Barriers and enablers in physical activity

Chapter description

In Topic 2, the first stage of inquiry requires students to recognise and explain concepts and principles about equity in physical activity. In a range of physical activities, students explore barriers and enablers to gather data about influences on equity.

In the second stage, students analyse data to synthesise relationships between the barriers and enablers in physical activity, and undertake engagement and performance to identify an equity dilemma. Student then devise an equity strategy in response to the dilemma to optimise engagement and performance in physical activity.

In the final stage, students evaluate the effectiveness of the equity strategy on engagement and performance, and justify using primary data and secondary data.

(Physical Education 2019 v1.1 General Senior Syllabus © Queensland Curriculum & Assessment Authority)

Key inquiry questions

- What is equity?
- Why is equity important to society and physical activity?
- What is the relationship between equity, access and engagement?
- Which personal, social, cultural and environmental barriers are reducing access to physical activity for others and myself?
- What personal, social, cultural and environmental factors are increasing equity and enabling access to physical activity for others and myself?
- What strategies can reduce the impact of barriers to enhance equity, access or opportunities within physical activity?

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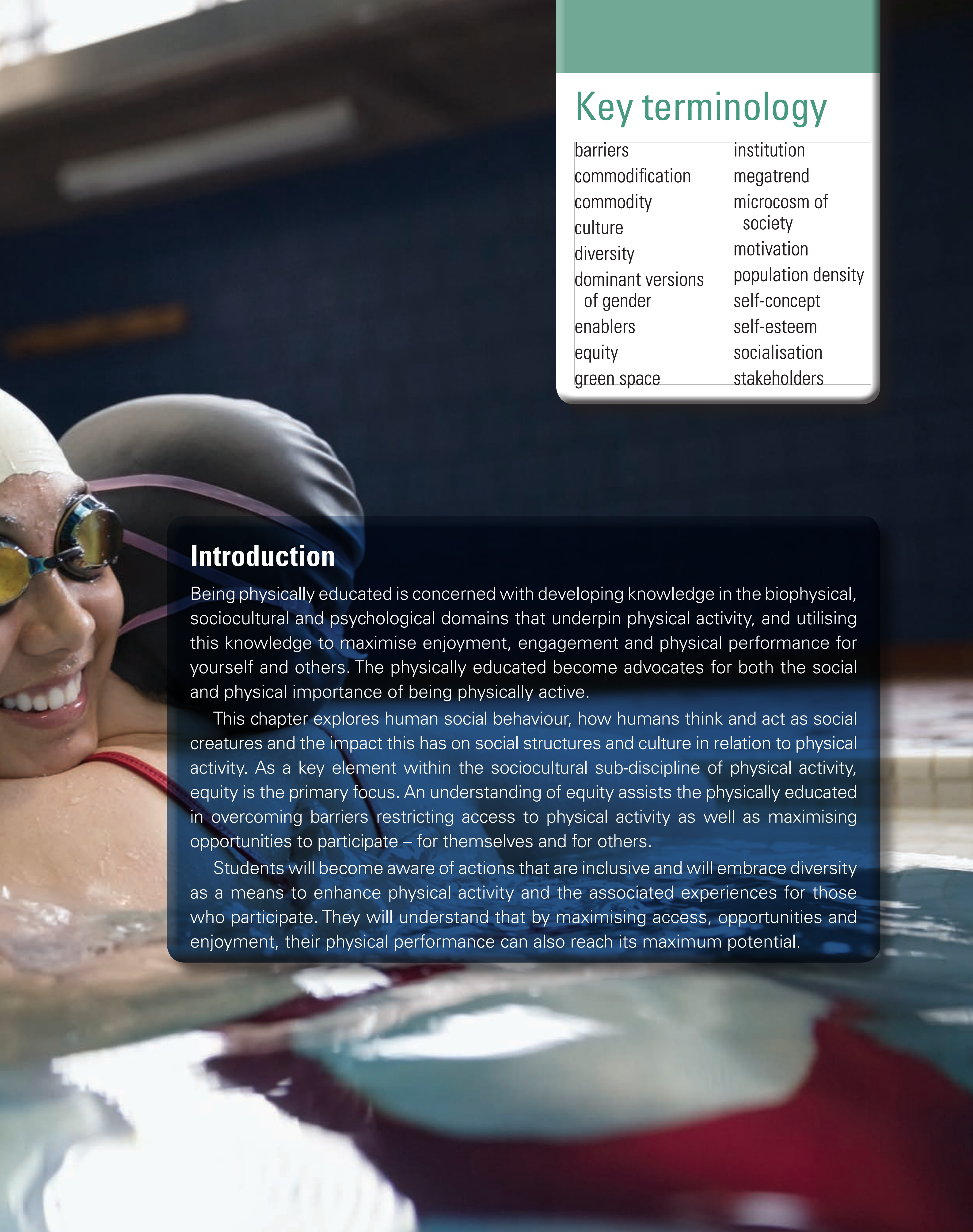

Key terminology

barriers
commodification
commodity
culture
diversity
dominant versions of gender
enablers
equity
green space
institution
megatrend
microcosm of society
motivation
population density
self-concept
self-esteem
socialisation
stakeholders

Introduction

Being physically educated is concerned with developing knowledge in the biophysical, sociocultural and psychological domains that underpin physical activity, and utilising this knowledge to maximise enjoyment, engagement and physical performance for yourself and others. The physically educated become advocates for both the social and physical importance of being physically active.

This chapter explores human social behaviour, how humans think and act as social creatures and the impact this has on social structures and culture in relation to physical activity. As a key element within the sociocultural sub-discipline of physical activity, equity is the primary focus. An understanding of equity assists the physically educated in overcoming barriers restricting access to physical activity as well as maximising opportunities to participate – for themselves and for others.

Students will become aware of actions that are inclusive and will embrace diversity as a means to enhance physical activity and the associated experiences for those who participate. They will understand that by maximising access, opportunities and enjoyment, their physical performance can also reach its maximum potential.

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Inquiry cycle – stage 1: Engage and understand

4.1 Equity, access and engagement

What is equity?

Human rights are at the heart of modern society and the global community. Human rights are entitlements that are inherent to all human beings, regardless of race, gender, nationality, ethnicity, language, religion or any other status that could be attributed to an individual. Human rights include basic liberties such as the right to life, and freedom from slavery, torture or unjust persecution. These rights are fundamental, and must be upheld globally without discrimination.

Aside from human rights, each society also has civil rights, sometimes referred to as civil liberties or civil freedoms. These are entitlements that are recognised by the society as fundamental to the fair and equal treatment of its people. For example, civil rights in Australia include freedom of expression, freedom of religion, freedom of speech, the right to security or privacy, and the right to fair treatment under the law.

Equity is a concept embedded in social justice, and is both a human and civil right. As such, it is reflected in Australian law, government policies and the cultural values of our nation. Equity is concerned with giving value to and celebrating personal, social and cultural differences in society. Equity deals specifically with the dignity, privilege and power to which every individual is entitled. It is a term closely related to equality, equal opportunity, inclusion and diversity.

equity concerned with giving value to and celebrating personal, social and cultural differences in society

As a **microcosm of society**, sport reflects the values and behaviours of the broader Australian society. As an **institution** of Australian society, sport is also bound by laws, government policies and the expectations of all Australians. Therefore, sporting institutes, governing bodies and affiliated people all have an obligation to embrace equity and behave in ways that will enhance equity for all.

microcosm of society a sub-section of society (such as sport, education or politics) that reflects the values, beliefs and behavioural norms of the broader society

institution a body or group that establishes rules and procedures for how the group should behave or operate, and actively promotes these regulations

In a sporting context, equity is concerned with access, inclusiveness and the provision of opportunities to all members of society. Sport England states:

> 'Sports equity' is about fairness in sport, equality of access, recognising inequalities and taking steps to address them. It is about changing the structure of sport to ensure that it becomes equally accessible to all members of society, whatever their age, gender, race, ethnicity, sexuality, or socio-economic status.

It is through the exploration of concepts such as access, inclusiveness and opportunities that equity can be enhanced, and through targeted interventions that sporting groups and individuals can overcome society's constructs that diminish equity.

Figure 4.1 Equity has been at the centre of many human and civil rights actions, particularly when practices and policies are seen to be discriminatory.

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Equity is concerned with giving value to and celebrating differences, ensuring individuals have dignity, privilege and power.

As a human right, equity is the responsibility of all Australians and is embedded in our laws, policies and behaviours.

Sport has an obligation to uphold and enhance equity for all Australians through its physical activity practices.

4.2 Access to physical activity

Access to physical activity is closely linked to equity in modern society. Access in this sense refers to the opportunity to participate. Historically, age, gender, race, ethnicity, sexuality or socioeconomic status may all have been factors that prevented members of society from engaging in physical activity or a specific sport. Consider the opportunities for females to engage in Australian Rules Football in the 1940s; for Indigenous Australians to play golf in the 1950s; for adolescents to participate in lawn bowls in the 1960s; or for homosexual males to engage in cricket throughout the 1980s.

As society's expectations around equity have grown, so too have our expectations around embracing diversity and inclusiveness. Sport in general, sporting bodies and sportspeople can no longer ignore or accept that people lack the opportunity to participate. All sporting **stakeholders** must now work towards embracing equity – finding ways within sport to value, include and celebrate the diversity of human differences. When physical activity groups increase equity, access to that activity increases for society members and participation levels increase. In contemporary Australia, physical activity works to increase equity and improve access for all society members for the betterment of sport and the broader society.

Figure 4.2 Sabrina Frederick-Traub of the AFLW's Brisbane Lions celebrates kicking a goal in the 2017 grand final.

stakeholders any person or group affected by the way something is organised or managed

Figure 4.3 The equity–access link

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Figure 4.4 Physical activity opportunities that are influenced by issues of access and inequity

Activity 4.1

Engage-in

Inquiry question: How do resources increase access to physical activity?

Engage and understand

1 Look in your PE storeroom to identify equipment that is seldom used, or gear for an activity in which you do not regularly engage. From the equipment discovered, participate for a lesson in an activity you would not normally do as part of your Physical Education subject.

Apply and analyse

2 At the completion of the lesson, discuss:

- **a** why you do not normally get to undertake this activity
- **b** what factors influence your access to these resources
- **c** how these resources could be made more accessible to you, your class and all students.

Evaluate and justify

Justify: Give reasons or evidence to support an answer, response or conclusion; show or prove how an argument, statement or conclusion is right or reasonable.

3 Reflect on your class discussion and write a brief recommendation that outlines how these resources could be made more available to students. Justify the purpose for doing so.

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Personal resources	Social resources	Community resources
The resources required by the individual that allow participation	The resources provided by others that support participation	The resources supplied by government, sporting authorities, clubs and schools required for participation
For example: • available disposable income • personal equipment • uniforms • transport • time • child care.	For example: • other participants • supportive family network • supportive friendship group • a competition to compete in • quality coaches and administrators • the number and quality of support staff to run a viable competition (i.e. volunteers, referees, canteen workers).	For example: • facilities within the area • facilities of appropriate standard • facilities that are financially accessible • funding support • a well-organised institute to oversee participation • an institute that promotes inclusive practices • appropriate media coverage.

Table 4.1 Access to the resources required for physical activity will affect the ability of individuals to engage.

Activity 4.2

Engage-in

Inquiry question: How does a lack of resources affect access to physical activity?

RECOGNISE & EXPLAIN · ANALYSE & SYNTHESISE · JUSTIFY · MAKE DECISIONS

Engage and understand

1 Organise a class excursion to a venue to undertake a physical activity that you cannot do at school. Venues to consider could include a tenpin bowling centre, indoor rock-climbing venue, lawn bowls club, squash, tennis or indoor cricket centre, trampoline centre, canoeing, kayak or paddleboard areas, or a pool for water polo. While undertaking the activity, consider the resources described in Table 4.1 and undertake a full audit of what resources are required to engage in this activity.

Apply and analyse

KEY COGNITION

Evaluate: Make an appraisal by weighing up or assessing strengths, implications and limitations; make judgments about the ideas, works, solutions or methods in relation to selected criteria; examine and determine the merit, value or significance of something, based on criteria.

2 Under the headings of personal, social and community resources list the barriers that are currently affecting your access to this activity.

(continued)

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Evaluate and justify

3 From your analysis, construct a PMI table identifying factors that affect your access to the physical activity undertaken.
4 Write a 200-word response that evaluates the importance access to resources has in determining the physical activities that are undertaken by an individual.

Activity 4.3

Check-in

1 Select two physical activities – one in which you engage regularly and one in which you have not participated before.
2 Using Table 4.1 on the previous page as stimulus, create a Venn diagram to compare and contrast the access to resources you have experienced for each activity.
3 For the activity in which you engage regularly, identify the three resources that have most significantly enabled your participation.
4 Provide an example for each resource category in addition to those in Table 4.1.

4.3 Engagement

It is important to remember that engagement in physical activity is a personal choice for each individual. The right to personal choice would be considered a civil right and a freedom that we enjoy in Australia. No matter what opportunities to access physical activity are afforded to individuals, there are some who will not take up these opportunities due to a broad range of personal factors, and who enact the personal choice to have limited participation in physical activity.

Activity 4.4

Engage-in

Inquiry question: What personal factors prevent engagement?

Engage and understand

1 STOP the class now … engage in 10 minutes of aerobics, dance or another similar activity as a class group. Use a suitable YouTube instructional video to provide your whole class with moves to follow – just ensure you are up and moving (as best as you can) for 10 minutes.

Apply and analyse

2 As a class, discuss:
   a What were people's initial response when told what they were doing? Who was keen to participate? Who was not?
   b To what level did people participate? Who worked for the full 10 minutes? Who gave it a go, then sat down? Who reluctantly tried? Who refused and sat out?
   c What was the level of enjoyment? Who loved it? Who hated it?

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Evaluate and justify

Critique: Review (e.g. a theory, practice, performance) in a detailed, analytical and critical way.

3 With a partner in a one-minute 'chat change', share the reasons behind your level of engagement.

However, in general it is true that reducing the factors causing inequity leads to increased access to, as well as more opportunities for, physical activity. With increased opportunities to participate in physical activity, more people will take up those opportunities and as a result engagement in physical activity will increase. Alternatively, by enhancing those factors that positively influence equity, opportunities and access also increase and lead to increased engagement.

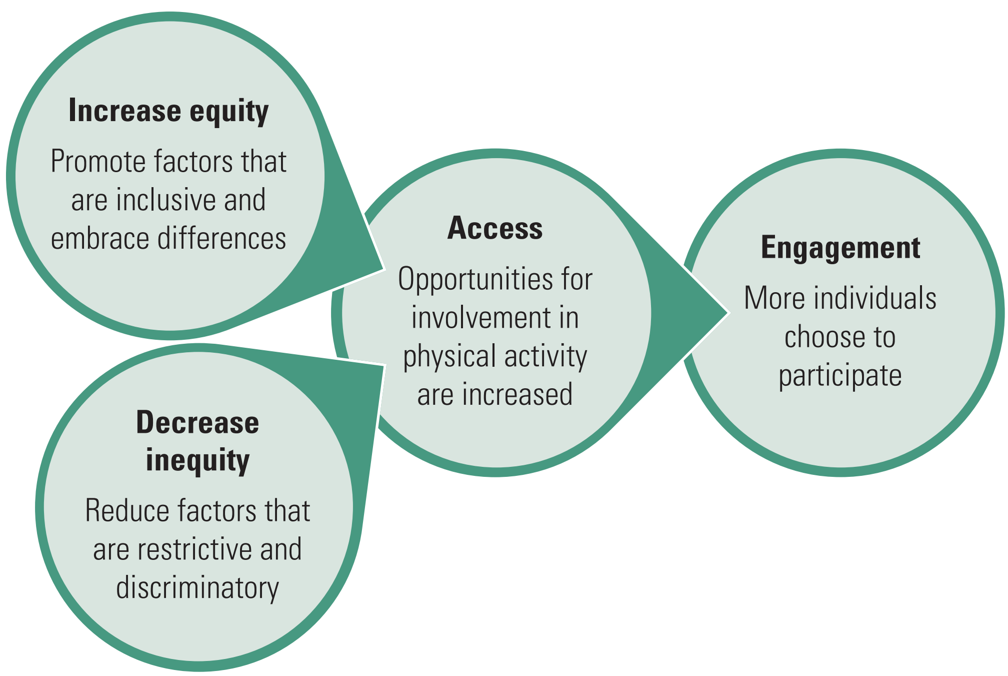

Figure 4.5 The equity–access–engagement link

Activity 4.5

Check-in

1 In your own words, explain why equity is an important issue in physical activity.

2 Think of two sports that you believe experience low engagement for a specific age, gender, ethnicity, ability or socioeconomic status. Justify your selection by outlining any inequity that may be present.

3 Identify two physical activities in which you would not engage, even if given the opportunity, and explain what is preventing your engagement. Consider personal preference, confidence, fear of failure or injury, or any other reason.

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4.4 Factors that affect equity and access

Equity and access are complex issues in modern society. By its very definition, equity is concerned with giving value to and celebrating personal, social and cultural differences. At times, equity is difficult to achieve, as each individual has unique circumstances in these three areas of difference. It is difficult to establish behaviours and policies that are inclusive of all when individuals display such diversity. However, while the factors that may influence equity will be significantly different for each individual, they can be categorised as personal, social, cultural and environmental, so that their impact can be evaluated and strategies to enhance equity and access can be devised.

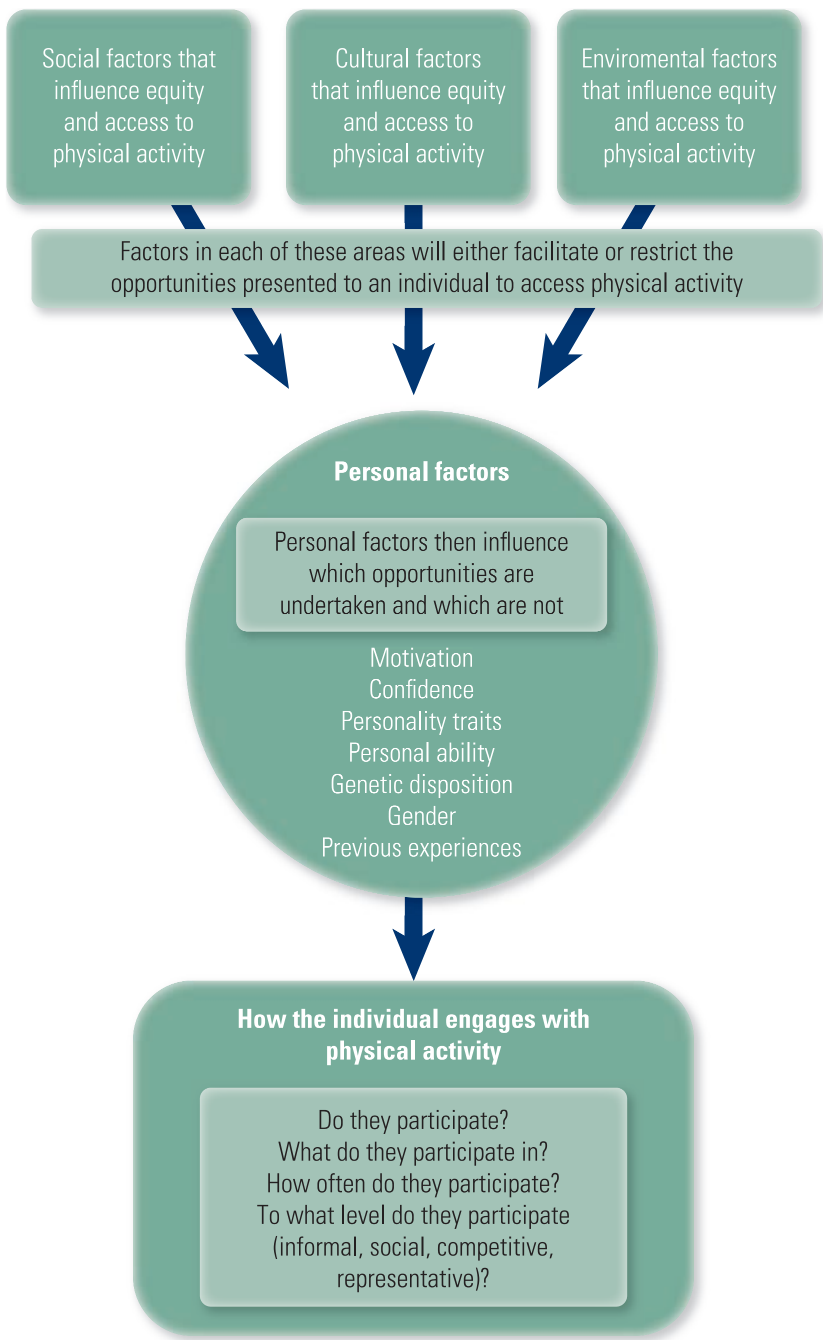

Figure 4.6 The many factors that affect equity can be grouped together, making the impact they have on access and engagement easier to investigate.

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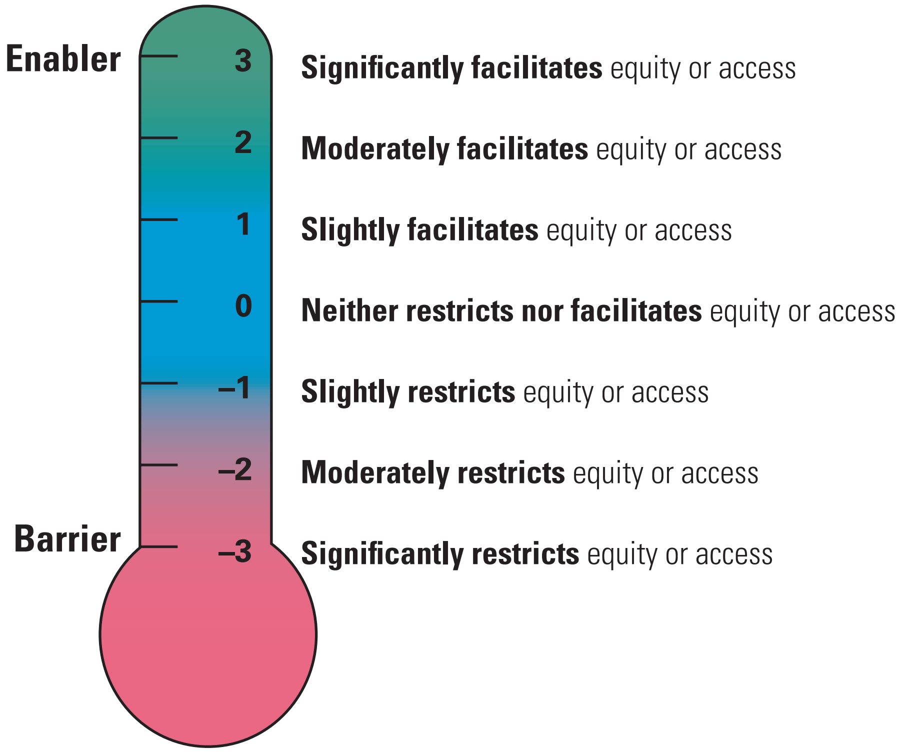

Figure 4.7 Equity and access enabler barometer: By applying some simple criteria to any factor, it is possible to identify areas that require attention if action to increase equity is to be considered.

When investigating equity and access to physical activity, it is important not only to identify the factors, but also evaluate the degree of influence for each contributing factor. Some factors may play only a minor role in the equity and access experienced by an individual, while other factors impact significantly. **Barriers** are factors that restrict or prevent access to physical activity. They diminish equity and reduce the chances of engagement. **Enablers** are factors that facilitate access and equity in physical activity. Enablers increase the chance of engagement. When exploring the degree to which individual factors influence access for an individual or group, it can be helpful to think of these as two ends of a continuum.

barrier a factor that restricts or prevents access to physical activity

enabler a factor that facilitates access and equity in physical activity

Activity 4.6

Check-in

1. Create a list of five physical activities in which you have participated at some stage in the last year.
2. Consider the activities on your list and identify five enablers to your access – that is, what things in your life helped you to participate.
3. Create a list of five physical activities in which you have not participated over the past year.
4. Consider the activities on your list and identify 10 barriers to your access – that is, what things in your life prevented you from participating.

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Activity 4.7

Engage-in

Inquiry question:

What barriers to physical activity participation do you face in your own life?

Engage and understand

1 Over the next two weeks, you (and everyone in your class) must participate in eight 20-minute HIIT training sessions or something similar. Three of these sessions will be done in Physical Education lessons, however, the remaining five must be done during your own time. To assist, you might consider using suitable instructional clips on the internet to guide your sessions.

2 Before you begin, identify any barriers that might prevent you from completing the required sessions and, where possible, put measures in place to reduce these barriers.

Apply and analyse

3 Complete the eight sessions within the fortnight period.

4 Reflect on the success of completing this task. Were all sessions completed? Were they a full 20 minutes' duration? Were they completed at appropriate intensity for the duration? Where you predicted a barrier, did it arise? Where you had a plan to limit barriers, did it work? Did other barriers present themselves?

KEY COGNITION

Analyse: Examine or consider something in order to explain and interpret it, for the purpose of finding meaning or relationships and identifying patterns, similarities and differences.

5 Using the reflection above, analyse the cause/s of any factors that you have identified as barriers to participating in these physical activity sessions.

Evaluate and justify

6 In a short statement, justify three main factors in your life that act as barriers to physical activity participation.

4.5 Personal factors that act as barriers and enablers for self and others in physical activity

Throughout life, every person is faced with choices on a daily basis, and the selections made both reflect their beliefs and values, and are demonstrated by their actions and behaviours. This is also true for physical activity. Each day, individuals make a choice to participate or not to participate in physical activity; to engage at high levels or be a low-level participant; to engage in training for improvement or to try out for representative teams, or to reject these opportunities. While social, cultural and environmental factors may provide a wide variety of opportunities to access physical activity, the individual chooses how those opportunities are utilised. There are many interconnected personal factors that influence the choices made about access to physical activity.

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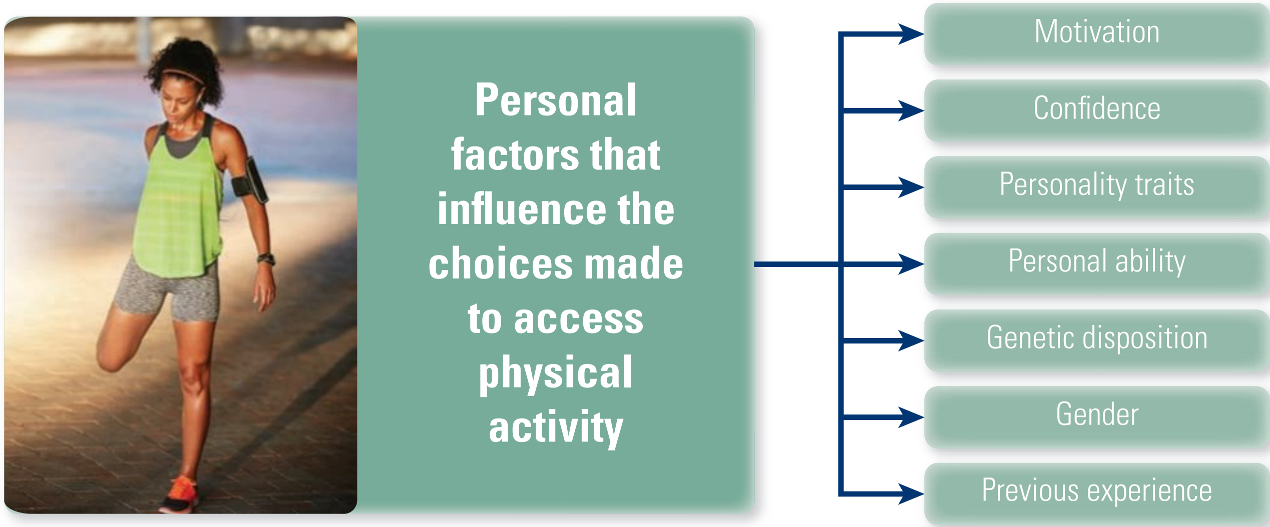

Figure 4.8 Many personal factors influence the choices made to access physical activity.

Activity 4.8

Engage-in

Inquiry question: To what extent do personal attitudes and values about physical activities affect engagement?

Engage and understand

1 Access the current version of the Physical Education syllabus and identify the physical activities that are outlined as possible study options.

2 Develop a five-point scale to rate how much you 'like' each activity listed and rate them using the scale – for example, 1 = dislike; 5 = extremely enjoyable.

3 Develop a five-point scale to rate how often you engage in each activity listed and rate them using the scale – for example, 1 = never engage; 5 = regularly engage.

Apply and analyse

Analyse: Examine or consider something in order to explain and interpret it, for the purpose of finding meaning or relationships and identifying patterns, similarities and differences.

4 Examine your 'like' and 'engage' rating for each physical activity and identify any generalisations that can be made from this primary data.

5 Acknowledge any anomalies – for example, 'I find Australian Rules Football enjoyable, but I rarely engage.'

Evaluate and justify

6 In a short statement, summarise the findings for this activity and justify any anomalies – that is, why do you not engage with Australian Rules Football even if you find it enjoyable?

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Activity 4.9

Engage-in

Inquiry question: To what extent do personal attitudes and values about Physical Education affect engagement?

RECOGNISE & EXPLAIN | ANALYSE & SYNTHESISE | EVALUATE | APPLY

Engage and understand

1 Engage in a variety of physical activities across a two- or three-lesson period – approximately five different activities would be ideal.

2 Following each activity, consider how you would currently rate your overall level of:

a effort in physical activity lessons – how hard you try

b engagement with improving physical skill – how much attention is paid to getting better.

3 Rate each of these factors on a 10-point scale.

Apply and analyse

KEY COGNITION

Analyse: Examine or consider something in order to explain and interpret it, for the purpose of finding meaning or relationships and identifying patterns, similarities and differences

4 As a class, collate this primary data in an appropriate format – for example, a table or a graph.

5 Discuss the data and any trends that emerge or inferences that can be made. For example, is there a link between effort, engagement and results? What might cause this?

Evaluate and justify

6 Consider the primary data you have identified for yourself. From the different factors that influence personal access to physical activity listed in Figure 4.8 on the previous page, identify two that you believe significantly contributed to the rating you made, and justify their selection.

Motivation

In Chapter 3, the psychological effect of *motivation* on performance levels for an athlete was explored. However, motivation also has a significant influence on a person's access to and engagement in physical activity. When motivation levels are elevated, a person is more likely to undertake opportunities to participate and engage in that specific activity. They are more likely to seek opportunities to improve their performance and persist with participation, even through periods of poor performance. Highly motivated people are also more likely to engage in opportunities that may bring about higher levels of competition – for example, trialling for representative teams. Conversely, when lower levels of motivation are present, it is far more likely that an individual will engage with lower effort levels. This results in performances that are below the person's potential, and they may see very little improvement or success when involved. Those with lower motivation are less likely to continue engagement in the physical activity and may actively avoid involvement, even if the opportunity to engage is presented.

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Activity 4.10

Check-in

1 Select a physical activity in which you have not yet had the opportunity to participate, but that you would be very motivated to try. Note why you are motivated to try this activity and what 'life factors' have prevented you from engaging in it so far. Be prepared to verbalise your response in a 30-second summary to a partner, a group or the class.
2 List physical activities that you are motivated towards.
3 From the activities identified, can you identify similar characteristics that show up as trends or preferences – for example, team sports, contact sports, non-competitive, social activities, fewer rules, self-directed, tactical, highly technical?
4 Explain the underlying causes of any preferences identified – for example, 'I am motivated towards team sports as I enjoy playing with friends.'

Figure 4.9 Motivation and confidence are inherently linked to opportunities and access for individuals in physical activity.

Confidence

Confidence is the level of belief an individual has that a task will be completed successfully or produce a favourable outcome. Confidence is a reflection of the trust an athlete places in the abilities, capacities or judgments upon which they must draw to be successful. When presented with a task, such as engaging in a new physical activity, confidence will dictate whether the person expects to be successful, both with initial attempts and in the long term. In this way, the level of confidence experienced will act as an enabler or barrier to physical activity participation. If confidence is low, the individual may be hesitant and not fully engage or give up early on. If confidence is high, the expectation of being successful can motivate performance and act as an enabler to enhance engagement.

While undertaking specific physical activities, confidence can affect a competitor's opportunities. For example, low confidence will be a barrier when it sees a player pass a basketball rather than shoot, even though they have an open shot at the basket. High levels of confidence act as an enabler within physical activity as players eagerly undertake opportunities where they believe a favourable outcome will result from their actions. Consider a player who volunteers to go full forward during an Australian Rules Football match when the designated player goes down injured. Confidence is also an important enabler for athletes seeking access to higher levels of competition. Generally, players will only trial for representative duties if they have some level of confidence that they may make the squad.

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Activity 4.11

Engage-in

Inquiry question: To what extent do successful previous experiences impact confidence levels?

Engage and understand

1 Engage in a physical activity for 30 minutes. At this point, stop the activity and set the scenario of a high-stress situation where a key action must be performed – for example:

- a specific movement sequence in sport aerobic that requires strength
- a set shot for a goal in Australian Rules Football from 35 m out on a slight angle
- a free throw to win the basketball or netball match
- a 2 vs. 1 situation to score in a touch football match
- a set point serve in the volleyball match
- a 1 m putt in golf
- a last bowl to draw shot in a lawn bowls match.

Everyone in the class will get one attempt at the selected scenario; however, prior to the attempt, make a quick mental check of your confidence level and what is influencing it.

2 Make your attempt.

Apply and analyse

3 After the attempt, note your thoughts and the success of the attempt. Add to your notes whether your confidence levels have gone up or down for the next time you find yourself in a similar scenario, and state whether this experience has been an enabler or barrier to future participation in the activity.

Evaluate and justify

Synthesise: Combine different parts or elements (e.g. information, ideas, components) into a whole, in order to create new understanding.

4 Referencing this activity, explain how confidence can be either a barrier or an enabler to physical activity.

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Activity 4.12

Check-in

1 Below are the physical activities from the current version of the Physical Education syllabus. For each activity, give yourself a confidence rating. Then assess how likely you would be to participate in the activity if you were given the opportunity to engage in a free 10-week program at school taken by expert coaches.

Activity	**Confidence rating** (how successfully you believe you would perform)				**Participation level** (the level at which you would undertake the free 10-week program)			
	Very unsuccessful	Unsuccessful	Somewhat successful	Very successful	Would not participate	Would try, but stop if not performing well	Would participate for 10 weeks	Would participate enthusiastically
Aerobic gymnastics (sport aerobics)								
Australian Rules Football								
Basketball								
Futsal								
Netball								
Soccer								
Touch football								
Duathlon, aquathlon, triathlon								
Swimming								
Track and field – jump								
Track and field – throws								
Track and field – track								
Badminton								
Tennis								
Volleyball								
Cricket								

(continued)

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Activity	Confidence rating (how successfully you believe you would perform)				Participation level (the level at which you would undertake the free 10-week program)			
Softball								
Archery								
Golf								
Lawn bowls								

2 There may be many reasons why you choose not to engage in a free physical activity program, and these may have nothing to do with confidence. However, from the list above, select one activity where there is a clear link between your low level of confidence and your reluctance to engage with the 10-week program. In approximately 50 words, describe how you have developed low confidence towards this activity. What factors have led you to believe you would not be successful?

Personality traits

Personality traits encompass a number of distinct, yet closely interconnected, personal factors that influence the equity experienced by and access to physical activity available to individuals. While each factor may contribute in different ways and to varying degrees, holistically these aspects tend to work together as enablers or barriers to influence the opportunities people have.

Enjoyment

From a sociological perspective, enjoyment can be considered the level of pleasure that is taken from engaging in or succeeding at physical activity. The level of enjoyment a person experiences from physical activity is generally influenced by:

- **their personal temperament** – does the nature of the activity itself suit what the person likes to do?
- **personal ability** – does a level of mastery bring about satisfaction when performing?
- **previous experiences** – have similar experiences been positive or negative?
- **confidence** – does the knowledge that the performer can be successful provide a feeling of joy?

When high levels of enjoyment are gained from participation in a physical activity, they act as an enabler, with opportunities eagerly being undertaken to access the activity. However, when a physical activity does not provide enjoyment for the participant, this acts as a barrier, with the likelihood of ongoing participation low. When opportunities to access an activity, to develop skills or to advance to higher levels are presented to a person experiencing low enjoyment, they may be declined.

Activity 4.13

Check-in

Source the physical activities identified in the current version of the Physical Education syllabus and place each along the enjoyment continuum below, based on how engagement currently makes you feel.

Distressed → Depressed → Displeased → Bored → Satisfied → Pleased → Happy → Delighted → Fantastic

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Temperament or preference

Many psychologists have researched how people develop their personality and the influence personality has on values, beliefs and behaviours. The work of experts such as Carl Jung and Isabel Briggs Myers (who with her mother Katharine Briggs developed the Myers–Briggs Type Indicator questionnaire) has developed knowledge about people's temperaments. Individual temperament determines the way an individual sees the world, approaches tasks and makes decisions. People with dissimilar psychological preferences will naturally have varying interests and views, behave differently and be motivated by different things. Put simply, people will naturally prefer certain physical activities over others, as the nature of the activity seems to suit what they like. For example, more outgoing athletes might like the team atmosphere of touch football or netball, while more introverted people may appreciate the solitude of archery.

Where there is alignment between the characteristics of an activity and the temperament of the athlete, temperament will work as an enabler to engagement. However, barriers form when personal preference and the characteristics of the activity do not match. As a result, a person may disassociate from the physical activity.

Self-concept and self-esteem

Self-concept is the mental self-image a person has; it includes physical attributes and abilities, as well as personality and intellectual ability. Two factors relating to self-concept will dictate whether this aspect is a barrier or enabler to equity and access:

self-concept the mental self-image a person has; it includes physical attributes and abilities as well as personality and intellectual ability

- **Sporting self-concept.** This is the general image the person holds of their ability as an athlete. Do they see themselves as 'sporty', 'athletic', 'coordinated' or 'competitive'? If a person has a sporting self-concept, and views themself as a 'sports person', they will be far more likely to engage in opportunities to participate in activities when they are presented. Those who view themselves as 'not sporty' will find this a barrier to participation.
- **Sport-specific self-concept.** This self-concept is linked to a specific activity. For example, does the person view themselves as a 'volleyballer'? If so, then they are more likely to engage in volleyball opportunities; however, those who view themselves as poor volleyball players will find this a barrier to volleyball access.

Activity 4.14

Check-in

1. Select a physical activity from those listed in the current version of the Physical Education syllabus that you believe your personality does not suit.
2. In 100 words, justify your selection. In your justification, provide clear evidence that links the disjoint between your personality and the characteristics of the activity. For example, 'I am not suited to archery as it requires a calm and relaxed approach to be successful, as well as the ability to carefully analyse each shot in order to make improvements for the next. I find it difficult to remain focused and concentrate, particularly when outdoors enjoying sport. I prefer more movement from an activity. I would struggle to control my body for long periods of time in order to demonstrate the consistency required from a good archery technique and be successful.'
3. Conduct some research into personality types and the work of Carl Jung and Isabel Briggs Myers. If possible, locate a simple temperament test to undertake online.
4. From the results of your test, are you able to make links between the outcome of the test and the type of activities you enjoy?

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Our self-concept develops in response to the cultural and personal stereotypes we hold about sport, physical activity and its participants, as well as in relation to our own abilities, preferences and body type.

Self-esteem is the way an individual feels about their own abilities. While self-concept may mean an athlete perceives they are a good runner but a poor swimmer, self-esteem will demonstrate how they feel about that view. Self-esteem is a complex issue, but can be viewed simply as continuum from low to high. A person with high self-esteem will view most aspects in their life positively. Whether they are a good runner or a poor swimmer, they will engage in opportunities to learn and continue to persist through poor performance and negative outcomes. This makes high self-esteem an enabler to physical activity. A person with lower self-esteem may approach physical activity with negative thoughts and the expectation of failure (low confidence). This will act as a barrier to participation.

self-esteem the way an individual feels about their own abilities, as demonstrated through their self-worth and self-respect

Activity 4.15

Check-in

1. Based on your knowledge of different physical activities, your own ability, skills, talents and body composition, select a physical activity to which you believe you would be most suited. This activity does not need to be one in which you have participated before. Justify your selection by outlining how your self-concept for this activity aligns with the 'stereotypical ideal player'.
2. Consider a physical activity you have studied. Do you believe your sport-specific self-concept for this activity is a barrier or an enabler to your participation, improvement and success? Justify your response.

Personal ability

Personal ability refers to the capacity an athlete has to produce successful performances of a selected physical activity. Where an athlete has engaged in a physical activity, the individual can make a judgment about personal ability level based on the success achieved in actual performances in training or games. Where a performer has no, or very little, actual experience of undertaking a physical activity, a judgment about personal ability may revert to experiences in other similar activities. This may reflect 'potential' ability rather than 'actual' ability. In either case, there is an inseparable link between personal ability (how well they perform) and self-concept (how they view themselves in relation to that activity). For example, a person with a high-level skill in badminton (ability) may view themselves as a good badminton player (self-concept). This acts as an enabler to access and opportunities for this performer. On the other hand, a player with low soccer ability may view themselves as a poor player, and this becomes a barrier to future participation in the game.

An athlete's ability will be governed by:

- their natural body structure and the level to which it has been trained to meet the movement demands of a specific activity
- the techniques and tactics learned, the level to which they have been refined and the expertise of the performer to adapt them to different physical scenarios

Figure 4.10 The belief in your ability acts as an enabler to future access and opportunities.

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Figure 4.11 Ability is an enabler for those who have it.

- the capability of the performer to analyse sporting situations and react with appropriate movements at appropriate times
- the aptitude to make effective decisions about how to move to bring about successful outcomes, without being distracted by unnecessary information from the performance environment.

Activity 4.16

Check-in

1. In which physical activity do you have the greatest personal ability? Justify your selection by providing an example of each characteristic discussed in this section (4.5) so far.
2. Identify a physical activity for which you possess low personal ability. Compare the level of engagement undertaken in this activity with the one selected in question 1.

Genetic predisposition

Another individual factor that influences equity and access to physical activity is genetic predisposition. Genetic make-up determines a person's body type, muscle type and bulk, as well as their height and length of limbs. These body features can be beneficial for specific physical activities when they facilitate the movements required by the activity. For example, taller athletes will have a natural advantage in activities like basketball, volleyball and high jump, while more muscular performers with a lower centre of mass may suit wrestling, and leaner athletes with the right muscle fibre type naturally do well in long-distance running.

Where there is a strong association between a person's body features and the physical attributes conducive to success for a physical activity, then genetic predisposition will act as an enabler. However, if a person believes they are not physically suited to an activity, genetic predisposition may act as a barrier, with the individual less likely to take up opportunities to participate in the activity.

Activity 4.17

Check-in

Genetic predisposition can be more beneficial to some physical activities. Consider the body features below and list three physical activities for each where that physical feature may provide a natural advantage:

- short
- tall and lean
- tall and muscular
- broad shoulders
- large arm span
- more explosive muscle fibres
- more endurance muscle fibres.

Gender

Despite many changes in society and within sport, gender continues to be a factor that influences equity and access in many areas. Gender is a social

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construction by which characteristics, roles and behavioural norms are delineated as being either masculine or feminine. Many of these attributes are based on cultural stereotypes founded in historical contexts. While some of these attributes may be outdated, they still exist in modern Australian society as they are embedded in our cultural upbringing. They extend to all aspects of society, including sport.

From a personal perspective, gender issues can be explored as a part of self-concept and its relationship with personal beliefs and stereotypes about being male or female. For example, males who view themselves as being traditionally masculine may find this a barrier to accessing a traditionally feminine activity such as aerobics or netball. Conversely, females who view themselves as being highly feminine may not allow themselves to engage in traditionally masculine activities that may be rough and aggressive. Essentially, individuals are more likely to participate in physical activities that are culturally acceptable for their gender and reflect the behavioural expectations of those around them. This concept will be explored in more detail later in the chapter.

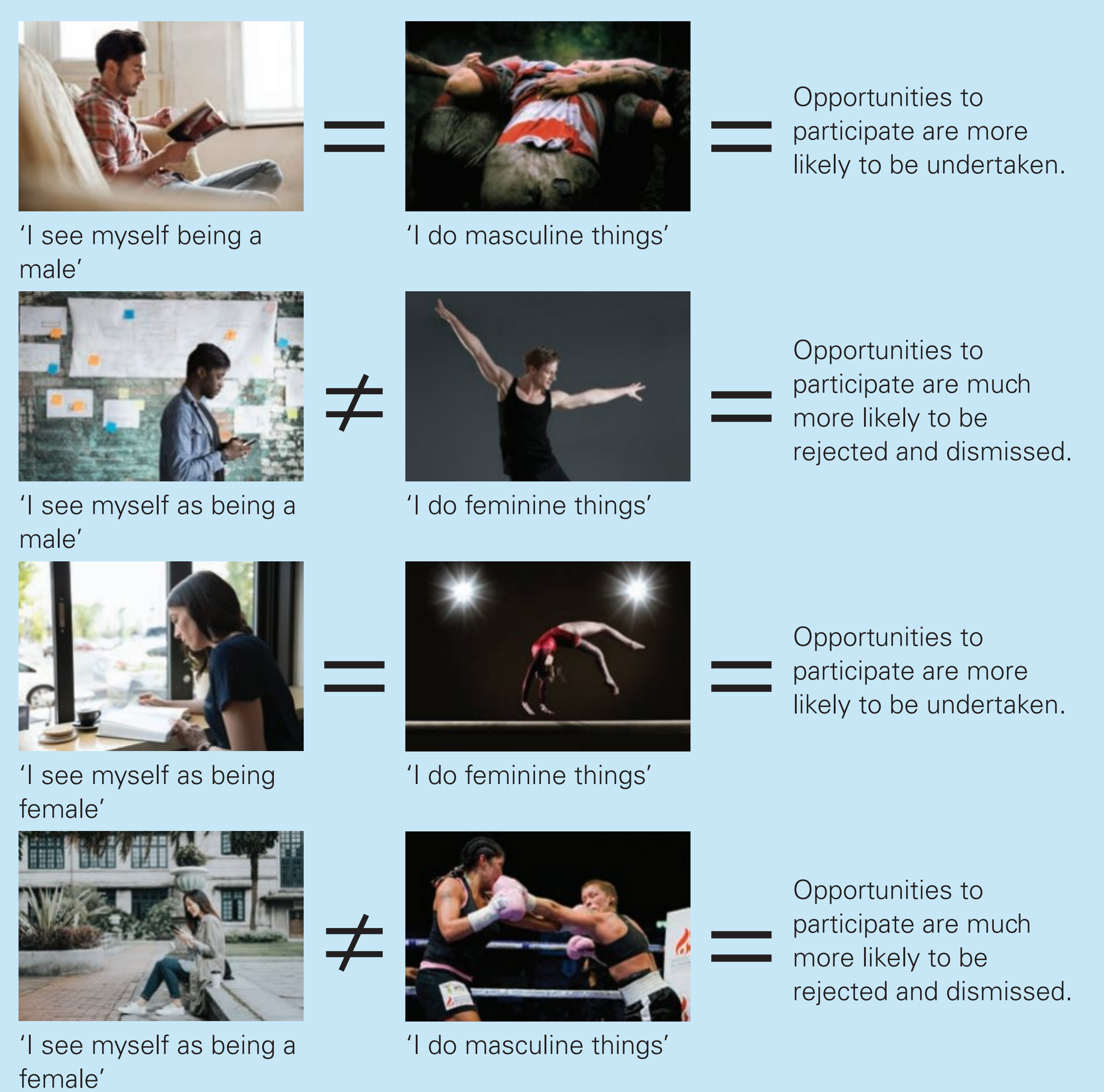

Figure 4.12 Self-concept will limit opportunities for an individual when there is a mismatch between how they want to be seen and their stereotypes about gender and physical activities.

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Activity 4.18

Engage-in

Inquiry question: To what extent does gender affect your physical activity engagement?

Engage and understand

1. Brainstorm a list of physical activities which stereotypically fit under the headings male, female and **gender-neutral**.
2. Decide on one physical activity from each category to engage in over the next three Physical Education lessons.
3. Engage in a different physical activity in the next three lessons, each time spending half the time in mixed-gender teams and the other half in male-only and female-only teams.

gender-neutral refers to characteristics, roles and behavioural norms that either equally share characteristics of being both male and female, or display characteristics of neither

Apply and analyse

4. Reflect on the experiences of the previous lessons. Consider:
   - **a** the level of enjoyment and engagement in each activity in relation to your own gender beliefs and the gender stereotype of the activity
   - **b** the construction of the team make-up and games – did you engage in and enjoy mixed situations or games specific to your sex? Did this change for different activities?

Evaluate and justify

Justify: Give reasons or evidence to support an answer, response or conclusion; show or prove how an argument, statement or conclusion is right or reasonable.

5. From the experiences in this activity, evaluate and justify whether your personal gender beliefs act as a barrier or an enabler to physical activities that are stereotypically associated with the opposite sex.

Previous experience in the physical activity

As mentioned earlier in the chapter, previous experience plays a significant role in developing enjoyment levels, sporting self-concept and an understanding of personal ability. It is simple to say that where previous experiences have been successful, positive and enjoyable, these will act as enablers to access and engagement. A player will seek out future opportunities to participate, enhance performance and reach their potential where possible. Barriers form for athletes as they accumulate negative previous experiences. This may see them engage less, quit the activity or refuse to take the opportunity to participate should it be presented to them.

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Activity 4.19

Check-in

Reproduce the table below. In the barrier and enabler columns, insert a personal example for a specific physical activity.

Personal factors that influence equity and access

Factor		A personal example of how this factor was a barrier	A personal example of how this factor was an enabler
Motivation	Intensity and direction of effort		
Confidence	Belief in a successful or favourable outcome		
Personality traits			
Enjoyment	Level of pleasure from participation		
Temperament or preference	The activities to which your personality is suited		
Self-esteem and self-concept	The type of athlete you see yourself as, and how you feel about it		
Personal ability	The level of performance an athlete can produce		
Genetic disposition	The link between body composition and movements required		
Gender	The impact of personal views on femininity or masculinity		
Previous experiences of physical activity	The impact of historical performances in the same or similar activities		

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Activity 4.20

Check-in

1 Describe a previous experience in a physical activity that acted as a barrier to future participation.
2 Explain how this experience made you feel. Did you quit, want to quit, put in less effort following the experience or was your confidence shaken? Or did you have a different reaction?

Activity 4.21

Engage-in

Inquiry question: To what extent do personal factors affect your access to and engagement in a specific physical activity?

Engage and understand

1 Reflect on the seven factors that have been identified as affecting personal access to and engagement in physical activity (see Figure 4.8 on p. 175).
2 Select any one of the physical activities in the current version of the Physical Education syllabus for the focused analysis to follow.

Apply and analyse

3 Make an evaluation for each personal factor by using the barrier-enabler barometer in Figure 4.7 on page 173. This will give you a 'score' between –3 and +3 for each factor. In making your judgment, consider:
   a the knowledge accumulated through the other activities in this section
   b your knowledge about your own values, beliefs and performances in the selected activity.
4 From this, identify the number one personal barrier and the number one enabler for the selected physical activity.
5 Add together the seven individual scores to get an overall result. Is the result a positive or negative number?

Evaluate and justify

Justify: Give reasons or evidence to support an answer, response or conclusion; show or prove how an argument, statement or conclusion is right or reasonable.

6 In a 300-word statement, justify whether personal factors have had an overall positive or negative influence on your access to the selected physical activity.

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4.6 The socialisation process

Every human develops as an individual in response to the social, cultural and environment context in which they are placed. As social participants, people learn about all aspects of life as they develop from infant to child to adult, including their values, attitudes and behaviours towards physical activity. The process by which an individual acquires these aspects from their surroundings is called **socialisation**. Socialisation allows an individual to conform to the behavioural norms and roles required for integration into a group or community. Humans must gain acceptance into a social group at a very basic level for survival: to gain the food, shelter and the support required for ongoing existence. At a psychological level, humans also require group acceptance to feel loved and valued and to obtain a sense of worth. Therefore, it is essential to acquire the necessary social skills and beliefs to 'fit in'.

socialisation the process by which an individual acquires knowledge, language, social skills and values from their surroundings

Figure 4.13 Behaviours such as showing concern for an injured player are learned through the process of socialisation.

Agents of socialisation

As an individual grows, they will encounter many elements within society that will shape their values, beliefs, attitudes and behaviours. Each of these elements will impact the individual in different ways to varying degrees, and will teach divergent life lessons. Any element within a society through which learning occurs as part of the socialisation process is referred to as a socialising agent, or **agent of socialisation**. An agent of socialisation may be an individual, group or organisation.

Due to the unique circumstances and experiences that shape each life, every individual will have a specific set of socialising agents. Some of these agents will have had a significant and profound influence on an individual's socialisation process, while others may have only a slight influence on the values, beliefs, attitudes and behaviours developed. Agents with which there is a strong relationship will play a significant role in learning. For example, a parent or sibling will make a significant contribution to the socialisation process. However, so too can a local soccer club with which an individual has developed a strong allegiance. Agents with which there is frequent contact will also be significant in shaping the individual. Consider the impact a teacher has on a student's socialisation when they see them every school day for a year. The school itself, with its rules, policies and curriculum, is also an agent of socialisation. As agents of socialisation establish personal beliefs, values and attitudes towards physical activity, they will work as enablers or barriers to physical activity.

agent of socialisation an element or section of a society through which learning occurs as part of the socialisation process

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Figure 4.14 Life experiences provide many agents of socialisation for individuals; each agent contributes to the values, beliefs, attitudes and behaviours developed by individuals in unique ways.

KEY MESSAGE
Socialisation is the process through which we learn the appropriate values, attitudes and behaviours to fit in.

KEY MESSAGE
Individuals, groups and organisations from which we learn social norms are called agents of socialisation.

KEY MESSAGE
Values, attitudes and behaviours concerning physical activity are acquired from the agents of socialisation in our lives.

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Activity 4.22

Check-in

1. Consider the values, attitudes and behaviours you have developed towards physical activity as a result of your life experiences to date.
2. Under the headings in the table below, list all the agents of socialisation that have contributed to your socialisation process regarding physical activity. As you construct your list, use larger writing to denote those that have had a more significant influence, and smaller writing for those that have played a minor role.

Individuals	Groups	Organisations

3. List five common behaviours concerning sportsmanship expected on a sporting field, which you have learned through the socialisation process.

The following boxes show three categories of external influences that affect equity and access to physical activity.

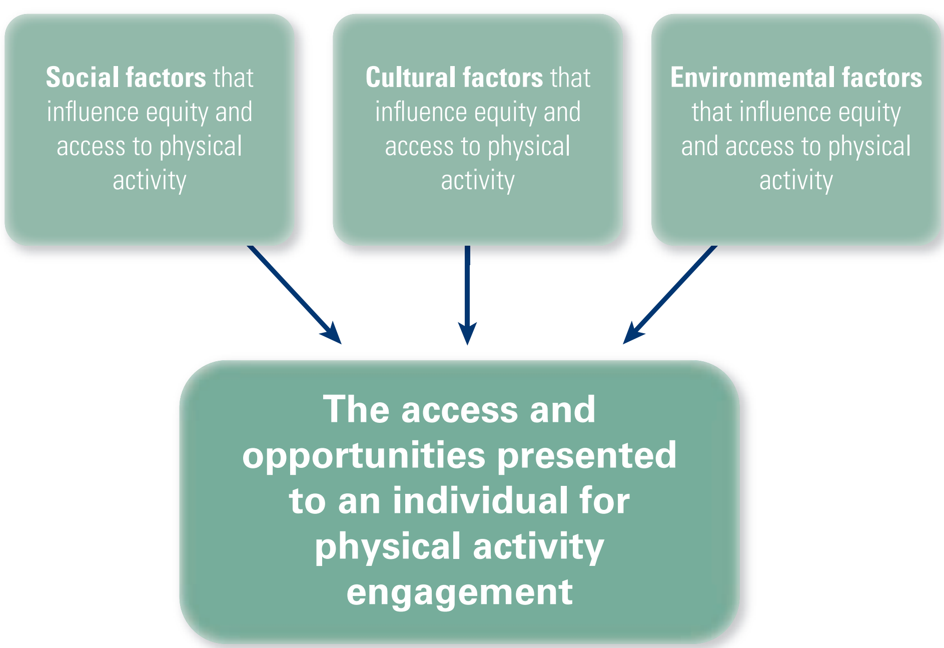

Figure 4.15 As an individual learns through the process of socialisation, they will experience many external influences that affect equity and access to physical activity.

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4.7 Social factors that act as barriers and enablers for self and others in physical activity

There are many social factors that act as barriers and enablers for self and others in physical activity. They include external factors that influence equity and access for self and others, parents and siblings, friends and peers, and teachers and coaches. The social construction of gender also plays an important and contested role, as do diversity and individual preference.

Figure 4.16 Individuals, groups and organisations are all agents of socialisation that can influence teens.

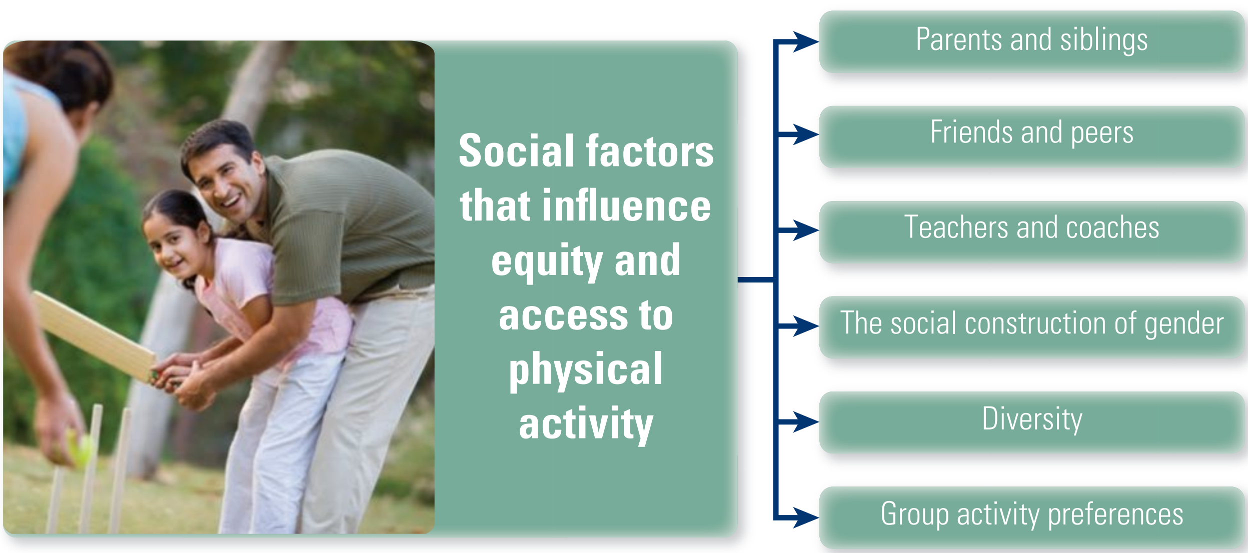

Figure 4.17 Social factors that can influence equity and access to physical activity

Parents and siblings

Parents exercise the most important influence on their child's equity, access and ability to engage in physical activities. For a young child, the family is responsible for making decisions about the type and scope of the child's activities. Parents organise opportunities for very young children to participate in formal and informal physical activities, and provide financial and emotional support to encourage their involvement. This could be as simple as an organised play date or as extensive as involving them in organised sport and providing the equipment and emotional support necessary for their involvement. The child also learns about sport participation through observation, imitation and modelling of parental involvement. By having one or both parents providing sporting opportunities, support and encouragement, and role modelling physical activity, children are more likely to participate.

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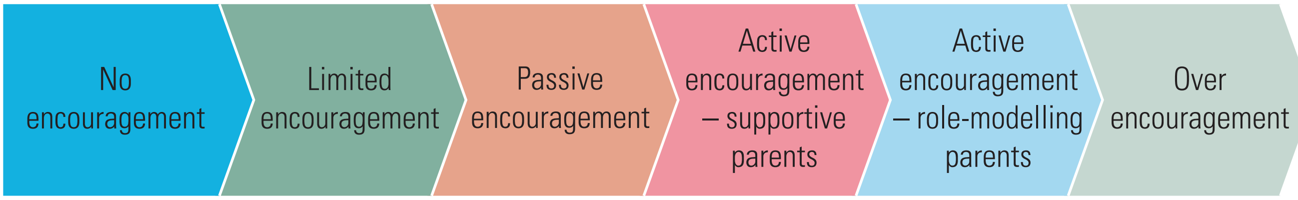

Figure 4.18 The values, attitudes and behaviours demonstrated towards physical activity by parents will generally be the most significant factor in establishing positive sporting behaviours for the rest of a child's life. Parents encourage sporting engagement in a wide variety of ways.

While it may not be true in all cases, in general the values, attitudes and behaviours demonstrated towards physical activity by parents will be the largest factor in establishing positive sporting behaviours for the rest of a child's life. The access and opportunities that parents present are a key barrier or enabler to physical activity engagement.

The socialisation process towards physical activity and the opportunity to engage in physical activity seem to be much stronger when children have siblings. This is due to the opportunities provided by 'having someone to play with'. Having at least one other person with whom to actively play will ensure that from a young age basic movement skills are being developed. As chasing, climbing, dodging and wrestling skills are developed, this may see young people acquire a more positive attitude towards their own physical abilities. These interactions also create pleasant experiences and a strong sense of enjoyment from physical activity, as a key enabler to physical activity access for an individual.

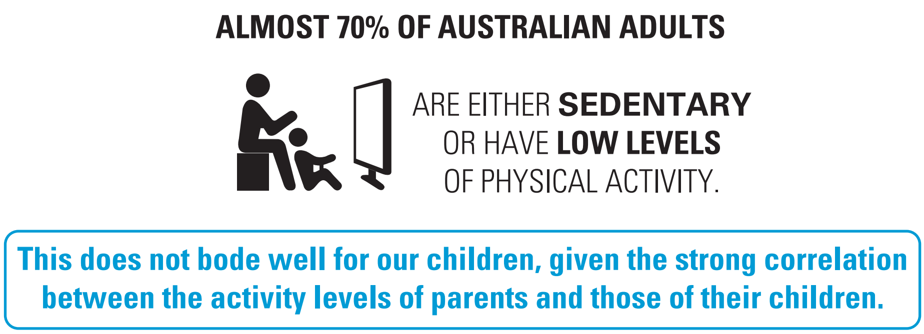

Figure 4.19 Australian children benefit from active, sporty parents.

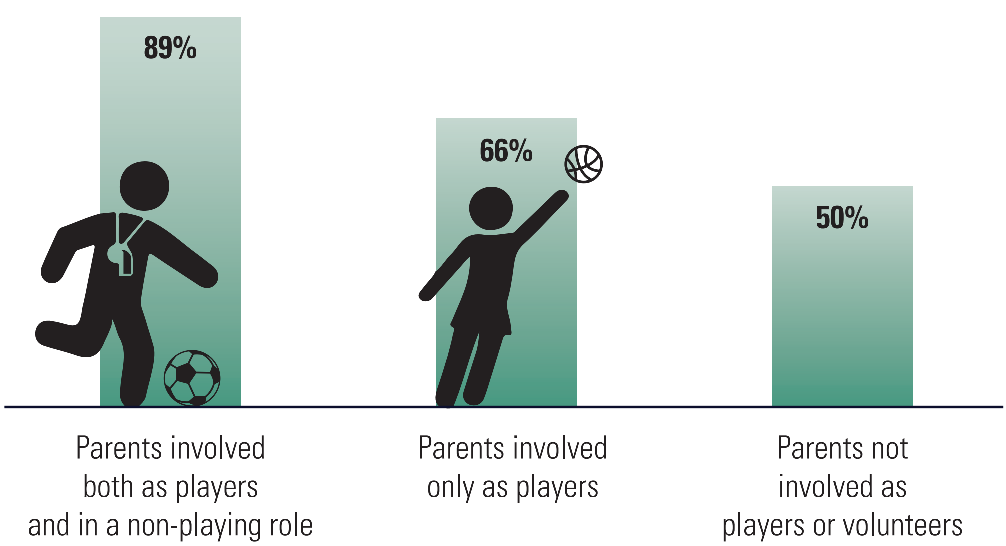

Figure 4.20 Child participation based on parent involvement

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Parents and siblings act as enablers to physical activity by providing resources, creating opportunities for engagement and instilling positive sporting values and behaviours. Barriers are created by parents and siblings when they display negative attitudes and behaviours towards physical activity or the importance of being active, or are discouraging about participation in specific activities.

It should also be noted that family groups that value and participate in specific sports tend to enable access to just one or two activities, thus creating barriers to others. For example, parents who value and have been involved in tennis and soccer may choose to involve their children in tennis during the summer months and soccer during the winter season. While this decision enables access to these activities, it creates barriers for their children's access to other physical activities.

Activity 4.23

Check-in

1. Interview your parents to identify the physical activities in which they engaged when they were younger, the level to which they participated and the overall value they place on involvement in physical activity. State any correlations between these areas and your own responses to these questions.
2. Conduct secondary research into the link between parent play and child play. Ensure your research is from a valid source and save the data for future use in class discussions and assessment tasks (be sure to record your source using an appropriate method of referencing).

Friends and peers

As children get older, friends and peer groups begin to have a greater influence over the development of attitudes and behaviour through the socialisation process. Between the ages of 10 and 14, the child shifts predominately to interactions with their peers for information and feedback regarding social norms. This transition is a significant step to adulthood, as a child begins to develop their own identity and social groups away from the family. As an individual moves away from the family to establish their own social group, they try to establish values, attitudes and behaviours that demonstrate conformity to the expectations of their peer group, thereby allowing them to gain peer acceptance.

With regard to physical activity, this may see individuals experience greater opportunities to access activities that are accepted and being undertaken by those within their peer group. For example, in Victoria a large percentage of 12-year-old boys participate in Australian Rules Football; as a result, a 12-year-old boy may experience more opportunities to participate in Australian Rules Football than an activity such as archery. The same 12-year-old boy in Queensland, however, may experience more opportunities to participate in Rugby League or soccer, as these are the more dominant activities undertaken by his peers. Physical activities with larger participation rates among peers will therefore be enablers for increased access, as participation in these traditional and stereotypical activities is one way to conform to the expectations of the peer group. The reverse can see peers create barriers when it comes to equity and access to physical activity. Imagine the captain of a Rugby Union team telling their peers that they will be quitting next season in order to pursue a spot on the synchronised swimming team. In this case, the player may fail to make the transition due to ridicule and exclusion from his peer group because he is not displaying the group's expectations for an adolescent male.

Teachers and coaches

Aside from family members, studies have reported that teachers and coaches play an influential role in generating interest in sport and physical activities. There is no denying that teachers and coaches constitute important social agents in the lives of young people. As such, the attitudes and behaviours they display are pivotal to shaping the values, attitudes and self-concept of young players.

Not only do they model behaviours, but their interactions will also guide the self-concept of the individuals within their teams and classrooms.

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Figure 4.21 Swimming is one of the most popular physical activities in Australia for any age group.

Positive interactions with a teacher or coach will be enablers to ongoing engagement and positive sporting attitudes, while negative experiences can create barriers to future involvement that may be very hard to overcome.

Activity 4.24

Engage-in

Inquiry question: What activities do my peers engage in?

Engage and understand

1 Conduct some secondary research into the physical activities most commonly being undertaken by adolescents in Australia.

Apply and analyse

2 Note three different sources of the secondary research found and collate the evidence discovered.
3 Conduct primary data-gathering for peers in your local area on the activities in which they engage by using the table on the following page to tally responses. Gather data about the physical activities in the current version of the Physical Education syllabus, as well as four other activities that were identified in your secondary research.
4 In order to assist in finding trends, use three different version of this table and survey: for your class, your friends and your peers. As a class, discuss the number of respondents required to ensure the validity of your data. You might also use two different coloured pens to tally – one for male responses and one for female responses.

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Friends

Physical activity	Outside school: Has never participated	Outside school: Rarely participates	Outside school: Occasionally participates	Outside school: Frequently participates	At school: Never	At school: Once or twice	At school: Regularly
Aerobic gymnastics							
Archery							
Australian Rules Football							
Badminton							
Basketball							
Cricket							
Triathlon							
Futsal							
Golf							
Lawn bowls							
Netball							
Softball							
Soccer							
Swimming							
Tennis							
Touch football							
Track and field							
Volleyball							
+ 1 from research							
+ 1 from research							
+ 1 from research							
+ 1 from research							

5 Present the data collected in an appropriate format to assist with analysis – for example, an appropriate graph type. Remember that you should have three tally tables to work from: data sets for class, friends and peers.

Analyse: Examine or consider something in order to explain and interpret it, for the purpose of finding meaning or relationships and identifying patterns, similarities and differences.

(continued)

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6 Analyse the primary data collected by doing the following:
- Identify the top two activities being undertaken by each group, both at school and away from school.
- Note any trends or inferences from the data – for example, are those activities that are most typically engaged in at school the same as those engaged in outside school – why or why not?
- Identify any factors that may be affecting the validity of data – for example, your location or availability of resources may naturally exclude some activities.

Evaluate and justify

7 In a short response, based on primary and secondary data, justify whether the physical activities in which you engage reflect those most commonly engaged in by your peers.

Activity 4.25

Check-in

1 Recall the best physical education teacher or coach you have had. In a short summary, outline the characteristics this person had as a teacher or coach that made them so effective.

2 Explain the positive influence this had on your engagement in physical activity and your own self-concept as an athlete. Ensure that you identify at least one specific example of a situation where they did or said something positive.

The social construction of gender

The role played by gender as a personal factor influencing equity in and access to physical activity has already been highlighted. However, personal beliefs and behaviours regarding gender and physical activity are heavily influenced by external factors, as gender is a social construct. While sex refers to the biological differences between males and females, gender refers to how society views characteristics, roles and behaviours as being either masculine or feminine. Gender is a sociological phenomenon that individuals learn through the socialisation process from their society and the people within it.

From an early age, individuals receive messages from society that display social norms and expectations for the accepted **dominant versions of gender**. For instance, a newborn may receive cards that depict gender-stereotyped roles, such as a boy fishing or a girl playing with a doll. Colours are also used to construct gender, with little boys in blue and girls in pink. While many parents now actively work to reduce these stereotypes, often they are reinforced on a much more subtle level, making them difficult to avoid. Research shows that baby girls are often showered with comments like, 'Aren't you a pretty little thing?' whereas baby boys receive comments like, 'Aren't you a big, strong boy?' So from birth, society is already imposing its interpretation of gender upon its members.

dominant versions of gender the most common and socially accepted ideas associated with being either male or female

Due to an increased focus on diversity in recent decades, gender stereotypes are increasingly being challenged. Alternative interpretations of gender have led to variations of how the terms 'femininity' and 'masculinity' are used. More recently, there has been an acknowledgement that many cultural attributes are gender-neutral – that is, many characteristics, roles and behavioural norms either share characteristics of

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Culturally feminine attributes	Culturally masculine attributes
Delicate Fragile Helpful Caring, compassionate and empathetic Emotional Cooperative Weak Clean and tidy Pretty Reactionary Less skilled	Physical Aggressive Isolated and non-emotional Competitive Strong Dynamic Sweaty and dirty Rough Proactive Skilled
Sport characteristics	**Sport characteristics**
Non-contact Distance maintained between participants Limited running space Set positional areas No running with the ball Strict dress requirement	Speed Strength Endurance Agility Physical contact, tackling and violence Risk-taking Open field

Table 4.2 Gender attributes and how they appear in sport

being both male and female or display characteristics of neither. In reality, the vast majority of people are not totally masculine or totally feminine, but instead display social characteristics of both.

Despite this increased awareness of gender diversity, it is still true that due to the pressure to conform and the satisfaction gained from being accepted, people tend to favour behaving in ways that meet the expected gender stereotypes. As a result, males – particularly those who display masculine qualities – will experience greater access and opportunities to activities that are considered masculine by society. Conversely, females will experience the same in relation to feminine activities. Where there is alignment between a person's gender and the social expectations for the physical activities in which they engage, the social construction of gender acts as an enabler, and as a barrier when those around the individual see a disjoint between their gender and the activity they wish to undertake.

Gender-neutral physical activities are those that, through their movements and rules of play, contain characteristics that may be both masculine and feminine, or characteristics of neither. These activities are typically enjoyed by both sexes. Consider swimming, volleyball, badminton, tennis, golf, and track and field. All these activities appear to be gender-neutral in Australian society, so gender is not typically a barrier to access.

Diversity

Diversity encompasses the visible and invisible differences that exist between people, while equity is concerned with giving value to and celebrating those differences. It is widely

diversity the visible and invisible differences that exist between people, such as gender, culture, race, ethnic origin, physical and mental ability, sexual orientation, age, economic class, language, religion, nationality, education and family/marital status

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Activity 4.26

Engage-in

Inquiry question: Do I have a preference for activities that display gender-stereotyped characteristics?

Engage and understand

1. Identify the physical activities from the current version of the Physical Education syllabus and individually place them on a continuum from feminine to masculine, with neutral in the middle. Use Table 4.2 on the previous page to guide your placements.
2. Once completed, share ideas as a class and, where needed, seek clarification. Use Table 4.2 to guide your placements.
3. Select 10 more physical activities not in the syllabus and conduct some primary research into the gender stereotypes relating to these activities that exist in your class. This can be done using a simple data collection method. Consider writing the activities on a large sheet of paper and using different coloured sticky dots (e.g. red = feminine; blue = masculine; green = gender-neutral). Students place the appropriate coloured dot next to the physical activity based on how they perceive that activity.
4. From the list, select one activity that is considered gender-neutral.

Apply and analyse

5. In the performance environment, engage in the activity for part of a lesson, then stop and divide the class into boys and girls. Using the sport characteristics in Table 4.2, each gender group must change the rules or playing conditions so the activity more closely reflects the characteristics of their gender. Spend some time developing the activity – it might look quite different from the original activity.
6. In the following lesson, have each gender play the activity they designed and collect data on enjoyment and engagement using a simple scale. In the second half of the lesson, engage in the activity designed by the opposite gender and again collect data on enjoyment and engagement.
7. Analyse your own personal data, looking at preferences between the three activities. As a class, collate data and identify and trends or anomalies.

Evaluate and justify

Synthesise: Combine different parts or elements (e.g. information, ideas, components) into a whole in order to create new understanding.

8. In a short response, synthesise the data collected in the activity to answer the inquiry question at the top of this activity. In doing so, identify any physical activities where this might act as a barrier to engagement.

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acknowledged that diversity provides a society with many cultural, social and economic benefits. It has been a long-held view in Australia that diversity through multiculturalism is a significant factor in the development of our nation, and that it plays a significant role in all areas of our society.

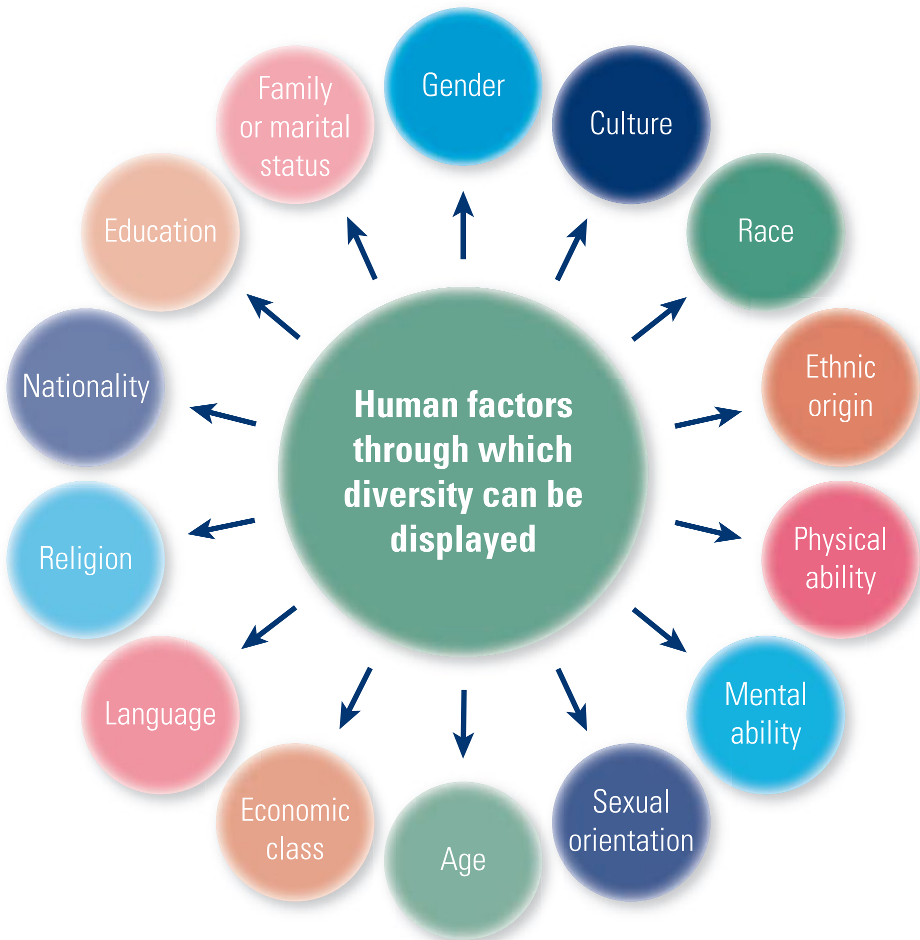

Figure 4.22 A wide variety of biological and social factors make humans different from one another.

Activity 4.27

Check-in

1. Select five factors from Figure 4.22 that make people different. For each, provide an example of a physical activity or sport that demonstrates inclusive practices – for example, wheelchair basketball or competitions with varying ability level grading.
2. From the same figure, select three factors. For each, explain how this can be a barrier for a specific sport. For example, when English is a second language, it may be difficult for some individuals to be included in team sports at large clubs, like netball.
3. It is widely accepted that inclusivity of diversity will enhance physical activity. Use an example to explain why this is true.

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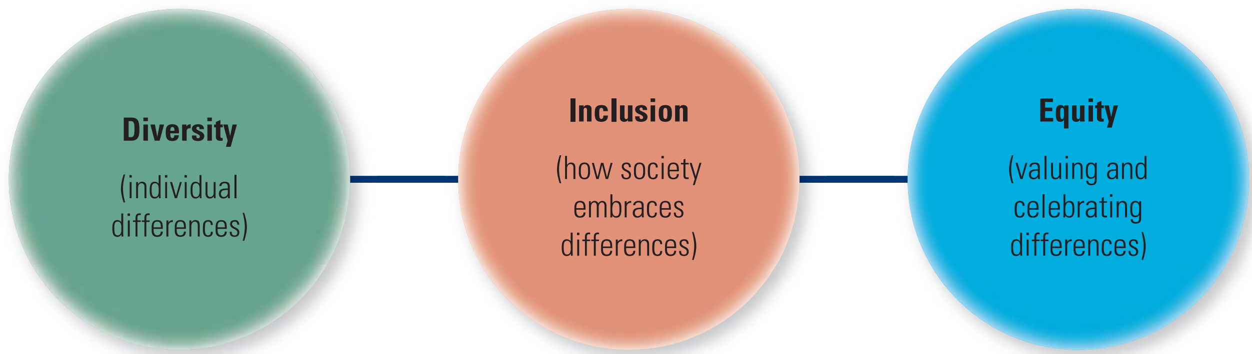

Figure 4.23 Inclusion and inclusive practices form the link between the diversity of individuals and increasing the equity they experience.

The link between equity and diversity is inclusion. Social inclusion is concerned with how a society embraces individuals or groups of people, despite the factors that make them different. Social inclusion works to remove the barriers that exclude and the discriminatory aspects that discourage involvement in society. It must be noted that social inclusion is not integration or assimilation, where individuals might be expected to adapt in order to conform to established social beliefs and behaviours; rather, social inclusion is concerned with how society itself must change in order to cater for the differences of the individuals within it.

Diversity can act as an enabler to equity and access when social inclusion supports the participation of society's members. This is particularly true when the contribution of the individual or group would assist in the development of the activity or society in general. For example, it is now common for Australians to value the contribution female players make to Australian Rules Football. This was evident with the first season of the AFLW (Australian Rules Football League for female players) in 2017. The public support and media exposure for this competition was seen by many as a celebration of female athleticism and skill. However, diversity still works as a barrier when the differences of individuals cannot be accounted for, or members of society are reluctant to accept those differences. For example, strictly practising Mormons would not be able to participate in activities on a Sunday. How would club members react if it were suggested that Sunday matches were no longer being held to support the beliefs of the Mormon faith?

Group physical activity preferences

Earlier in this chapter, the influence that peers have on equity and access for an individual was discussed. Essentially, as a social influence, the values and attitudes peers have about physical activity, along with what they do, will influence the individual. To explore this social factor further, it is relevant to investigate the preferences of the social group or peers of an individual. It stands to reason that where a higher percentage of peers prefer to participate in physical activity generally, or a specific physical activity, this will act as an enabler for a person within that peer group. If many teenagers are playing touch football, it is much more likely that a specific teenager will conform to the dominant social ideal for the peer group and also take up the sport. On the other hand, where the preferences of a social group do not support participation in physical activity or a specific activity, barriers are formed for an individual. This can be very evident for children and adolescents during the school years, where friendship groups may prefer to sit during lunch rather than play on the oval. This makes it difficult for a person within the group to be active.

Figure 4.24 shows adult participation in sporting clubs by age. Sporting clubs are not the main choice for participation in sport or physical activity in Australia for adults aged 18 years and over.

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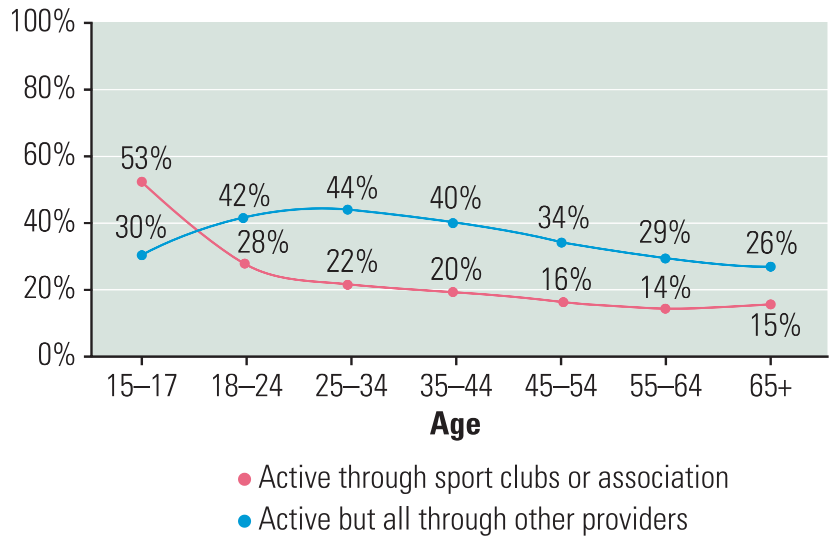

Figure 4.24 Adult participation in sporting clubs by age

Children organised out of school hours Top 20 activities	Population estimate	% of population
Swimming	1 378 967	30.0
Football/soccer	674 094	14.7
Australian Rules Football	366 462	8.0
Gymnastics	341 200	7.4
Netball	332 018	7.2
Dancing (recreational)	329 003	7.2
Basketball	300 622	6.5
Tennis	280 239	6.1
Cricket	256 930	5.6
Athletics/track and field	203 873	4.4
Rugby league	126 754	2.8
Karate	121 877	2.6
Dance Sport	106 901	2.3
Hockey	76 922	1.7
Touch football	76 039	1.7
Lifesaving surf	65 986	1.4
Fitness/gym	59 282	1.3
Rugby Union	57 429	1.2
Taekwondo	49 261	1.1
Martial arts	47 279	1.0

Table 4.3 Top 20 activities organised for children outside of school hours

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	Population estimate	% of population
Adult men		
Walking (recreational)	3 189 754	32.8
Fitness/gym	2 785 040	28.6
Athletics/track and field	1 728 674	17.8
Cycling	1 387 756	14.3
Swimming	1 261 924	13.0
Football/soccer	884 972	9.1
Golf	836 606	8.6
Cricket	571 010	5.9
Tennis	537 917	5.5
Bushwalking	520 642	5.3
Adult women		
Walking (recreational)	5 207 654	52.3
Fitness/gym	3 532 574	35.4
Swimming	1 591 001	16.0
Athletics/track and field	1 386 353	13.9
Cycling	914 858	9.2
Yoga	742 136	7.4
Netball	562 698	5.6
Bushwalking	537 419	5.4
Pilates	441 642	4.4
Tennis	408 873	4.1

Source: Sports participation data from the Australian Government Australian Sports Commission and VicHealth

Table 4.4 Top 10 activities for adult men and adult women

Inactive	Somewhat active	Active
22%	31%	47%

Figure 4.25 Activity levels of young adults

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Activity 4.28

Check-in

1 Conduct a class poll to collect primary data on what physical activity your peers currently engage in, for how long and to what level.
2 Identify trends among the class or friendship groups.
3 Rank class engagement for those activities in the current version of the Physical Education syllabus, then consider the following:
   - Is there a difference for males and females on the preference list? If so, infer why.
   - Are there links between primary and available secondary data on engagement? If not, why not?
   - What might explain any differences between primary and secondary data?
4 Investigate the data presented in Figure 4.24 (on p. 201) and do a 3:2:1 protocol:
   - three facts (about what your peers are engaging in)
   - two inferences (about how this data may impact your engagement as either an enabler or barrier)
   - one projection (how these data might impact you in the future).
5 Undertake research to find additional secondary data about the physical activity preferences of your age group (your peers) in relation to the activities identified above. Consider the amount, type and level of engagement.
6 Consider the primary and secondary data collected. Do they match? If not, why not? What local factors might be influencing the primary data?

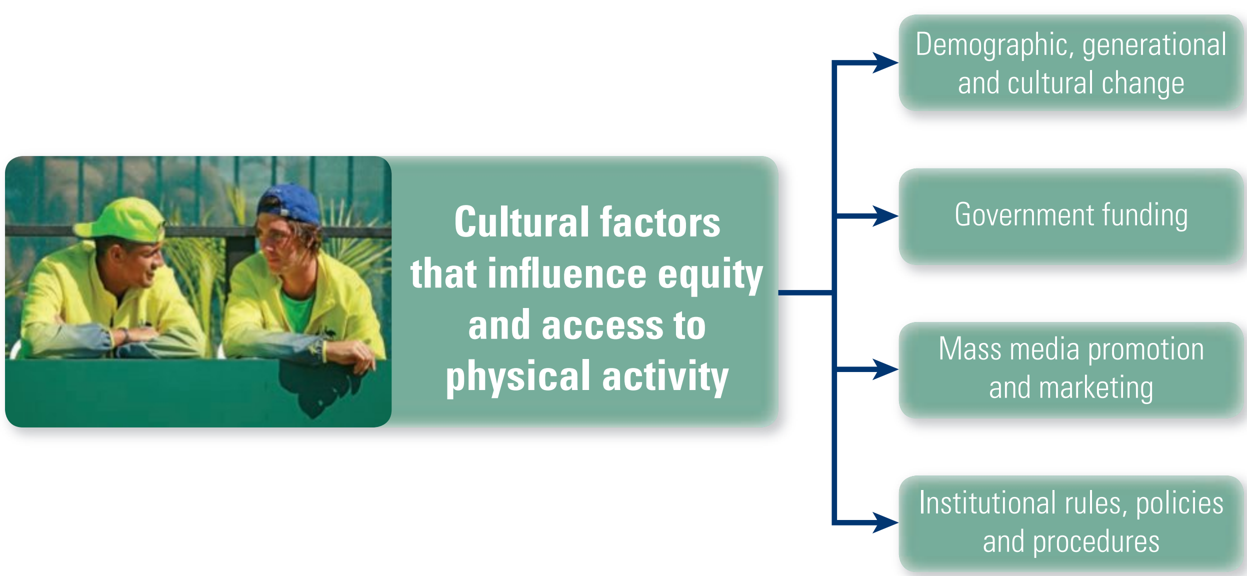

Figure 4.26 While there are many elements of any culture that will influence the equity and access to physical activity for its population, within Australia some cultural elements have a significant influence in these areas.

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4.8 Cultural factors that act as barriers and enablers for self and others in physical activity

As each person and social group exists within a broader society, it is logical that the surrounding culture that exists will also have a significant influence on the physical activity undertaken by the members of that society. A **culture** can be defined as the values, beliefs, customs and behavioural norms of a group or population. Here, the group or population is much bigger than the social group or peers of an individual, and includes the full spectrum of people within a society. As they are representative of a much larger proportion of the population, cultural elements are significant because they represent the defining characteristics of a society – they reflect what makes our population 'Australian'.

culture the values, beliefs, customs and behavioural norms of a group or population

In Australian culture, sport and sporting success have always played a significant role. Historically, sport has been a source of national pride and has helped to establish a national identity. As a result, the cultural values, customs and behaviours that relate to sport and physical activity have a strong influence on individual Australians. As these values, customs and behaviours are considered culturally significant, they are passed from generation to generation through the socialisation process. Yet, while many of these cultural elements act as enablers to access and equity in physical activity, some do create significant barriers that are difficult to overcome.

Demographic, generational and cultural change

It has previously been outlined that the physical activity preferences of a social group will influence the personal equity and access of an individual. As each person or social group exists within a broader society, then it stands that cultural trends will also have a significant influence on the physical activity undertakings of the members of that society.

Demographics relate to the characteristics that are particular to a sector of a population. They are typically used when gathering and analysing statistical data. By understanding the demographics of our Australian population, trends of what is culturally significant can be identified. Trends concerning physical activity engagement also establish where enablers and barriers to equity and access exist. Where cultural trends are positive towards physical activity and the types of activities undertaken, access is enabled. However, if engagement for a specific demographic was below normal, this may indicate that discriminatory practices were creating barriers and a more inclusive approach may be needed to increase equity.

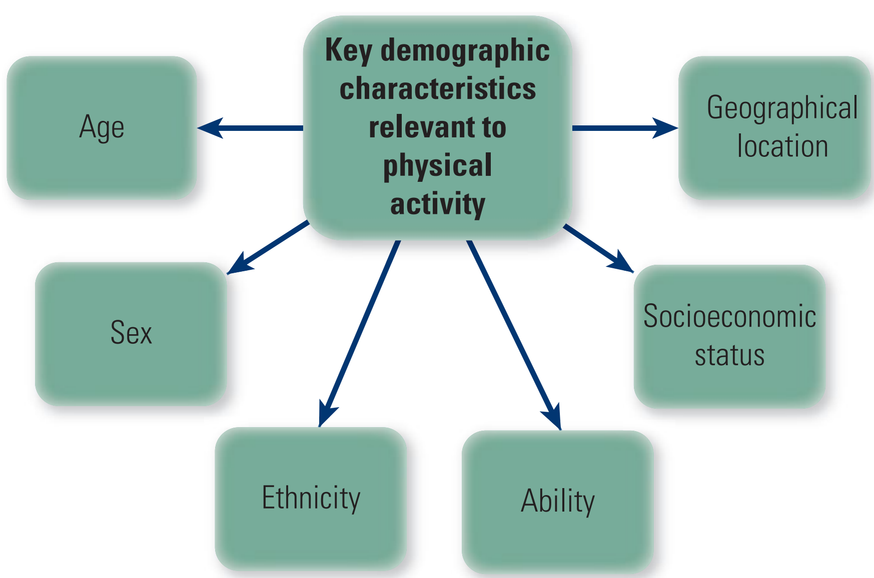

Figure 4.27 Understanding the physical activity practices of various population sectors assists in understanding where cultural enablers and barriers for the Australian population may exist.

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Activity 4.29

Engage-in

Inquiry question: Why do generational trends exist for participation in physical activity?

RECOGNISE & EXPLAIN | ANALYSE & SYNTHESISE | EVALUATE | JUSTIFY

Engage and understand

1 Undertake some secondary research to identify the types of activities that are popular among different age groups other than your own – for example, under 10, 25–50, over 50.

2 For each age range, identify a popular activity that you can undertake for a lesson (or part lesson) with your class. For example:

- under 10: Tiggy, cat and mouse, duck-duck-goose
- 25–50: a fitness training session in a popular style
- over 50: walking, swimming, hiking, fishing, golf, tennis, lawn bowls.

Apply and analyse

3 After each activity, collect class data on the enjoyment and engagement of participants in the activity.

4 As a class, identify the characteristics of the activity and the impact this might have on engagement for different age groups.

Evaluate and justify

KEY COGNITION

Consider: Think deliberately or carefully about something, typically before making a decision; take something into account when making a judgment; view attentively or scrutinise; reflect on.

5 Consider the activities undertaken at different life stages and complete the table below.

Life stage	Typical physical activities	What characteristics are present in these activities?	Factors that affect engagement
Child (under 12)			
Adolescent (12–19)			
Adult (20–39)			
Middle-aged (40–60)			
Seniors (over 60)			

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Barriers and enablers can also work generationally within a population. When investigating specific age groups within a population, each tends to engage in different activities. As a person ages, their ability and preference for physical activity change, and this is reflected in the participation data for our population. As with all other elements, this is an enabler to physical activity access when the individual's activity of choice matches a culturally accepted activity for their age. It is more difficult to engage in an activity when trying to step outside of your generational expectations. For example, how many 65-year-old Moto-X riders are still competing in Australia?

AusPlay captures a wide variety of activities, and a distinction is made between sport-related activities

	Age 6–13	(000s)	%	Age 14+	(000s)	%	Total age 6+	(000s)	%
1	Swimming	1198	48.8	Swimming	1949	10.1	Swimming	3147	14.4
2	Soccer	1194	48.7	Cycling	1419	7.3	Cycling	2343	10.8
3	Cycling	924	37.7	Hiking/ bushwalking	847	4.4	Soccer	1790	8.2
4	Athletics/ track and field	778	31.7	Aerobics	623	3.2	Dancing	1303	6.0
5	Basketball	748	30.5	Soccer	596	3.1	Basketball	1088	5.0
6	Dancing	743	30.3	Dancing	560	2.9	Hiking/ bushwalking	1079	5.0
7	Cricket	631	25.7	Tennis	471	2.4	Tennis	961	4.4
8	Netball	503	20.5	Netball	343	1.8	Cricket	959	4.4
9	Tennis	490	20.0	Basketball	340	1.8	Athletics/ track and field	874	4.0
10	Gymnastics	444	18.1	Cricket	328	1.7	Netball	846	3.9
11	Australian Rules Football	438	17.9	Martial arts	242	1.3	Aerobics	698	3.2
12	Hiking/ bushwalking	232	9.5	Body surfing	231	1.2	Australian Rules Football	622	2.9
13	Rugby League	229	9.3	Surfing	211	1.1	Gymnastics	569	2.6
14	Softball	218	8.9	Australian Rules Football	184	1.0	Martial arts	457	2.1
15	Martial arts	215	8.8	Volleyball	133	0.7	Rugby League	339	1.6
16	Volleyball	189	7.7	Gymnastics	125	0.6	Body surfing	335	1.5
17	Baseball	165	6.7	Horse riding	122	0.6	Surfing	330	1.5
18	Field hockey	144	5.9	Rugby Union	113	0.6	Volleyball	322	1.5
19	Rollerblading/ skating	127	5.2	Rugby League	110	0.6	Softball	271	1.2
20	Horse riding	119	4.9	Field hockey	103	0.5	Field hockey	247	1.1

Source: Adapted from Roy Morgan, *The Top 20 Sports Played by Aussies Young and Old(er)*, 2018.

Table 4.5 Top 20 sports and activities by regular participation rate

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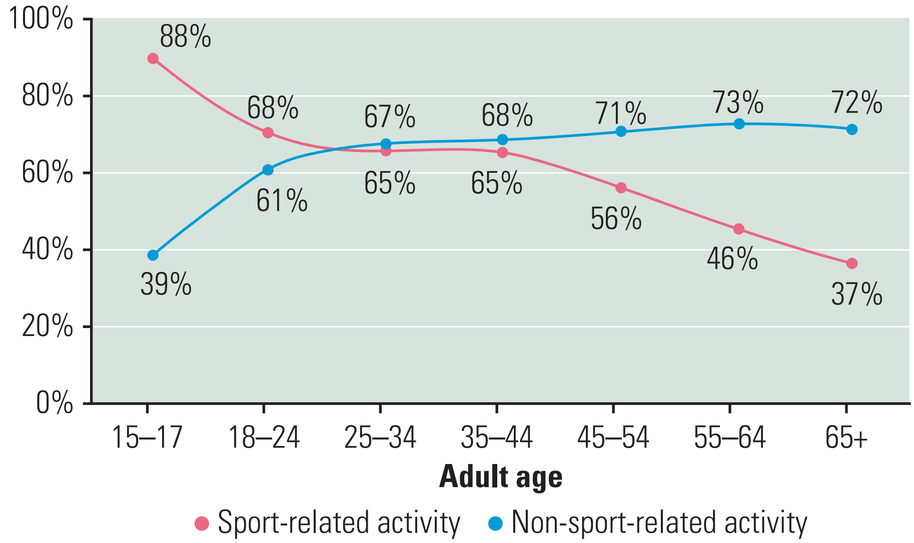
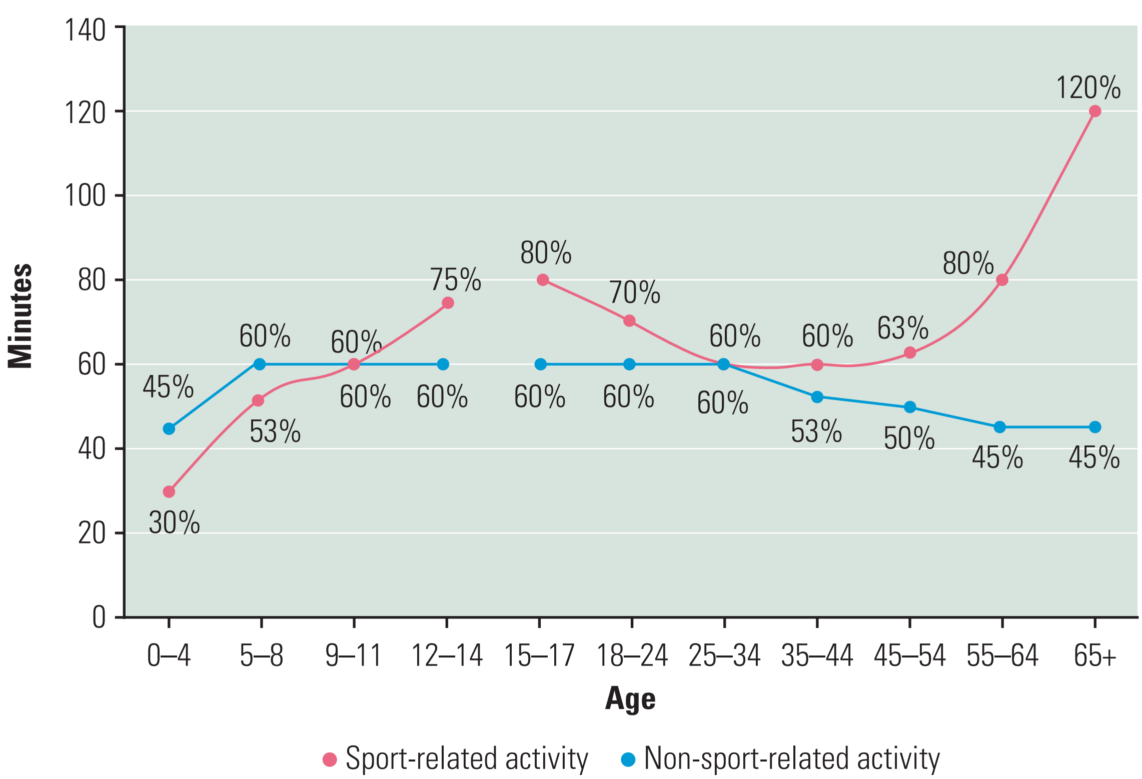
(e.g. team sports, athletics, golf) and non-sport related physical activities (e.g. gym memberships, bushwalking). Over 17 million Australians aged 15 or over (87 per cent) participated in a sport or physical activity in the last 12 months.

Women are more likely than men to participate in sport or physical activity for physical and mental health reasons and to lose or maintain weight. Men are more motivated by fun/enjoyment and social reasons than women.



Source: Adapted from Australian Sports Commission, *AusPlay Participation Data for the Sports Sector Summary of Key National Findings October 2015 to September 2016.*

Figure 4.28 Adult participation by age



Source: Adapted from Australian Sports Commission, *AusPlay Participation Data for the Sports Sector Summary of Key National Findings October 2015 to September 2016.*

Figure 4.29 Median duration of activities for children and adults

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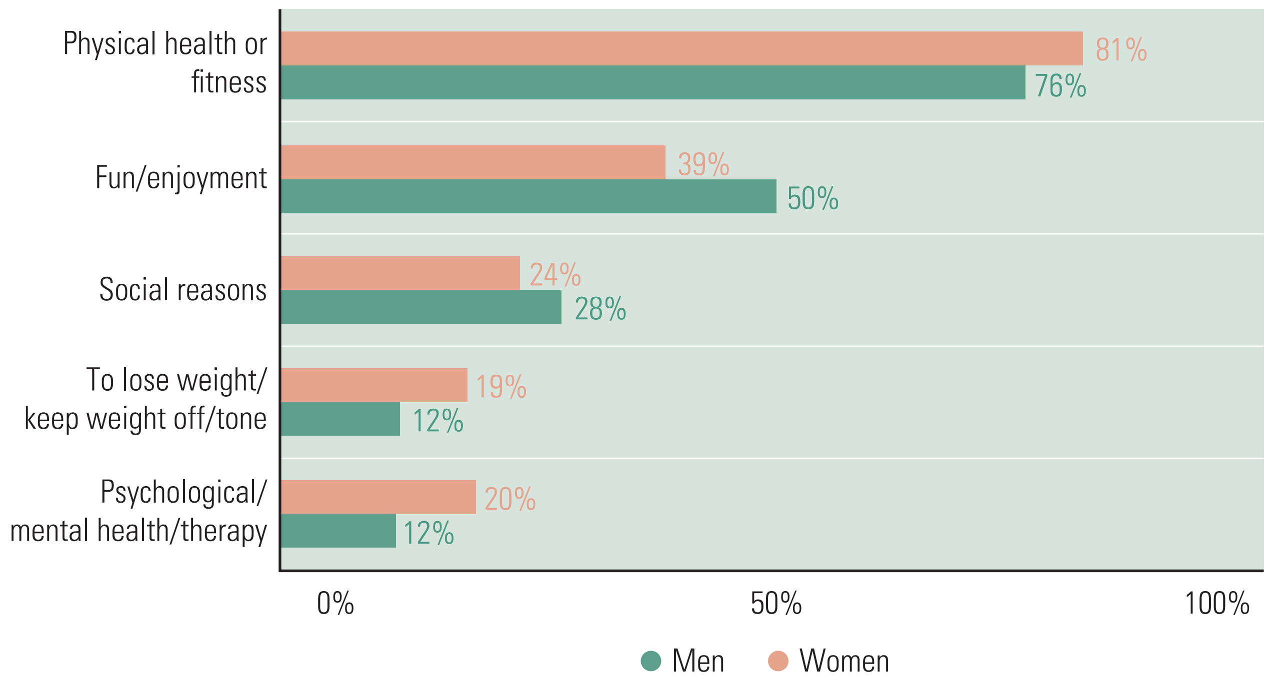
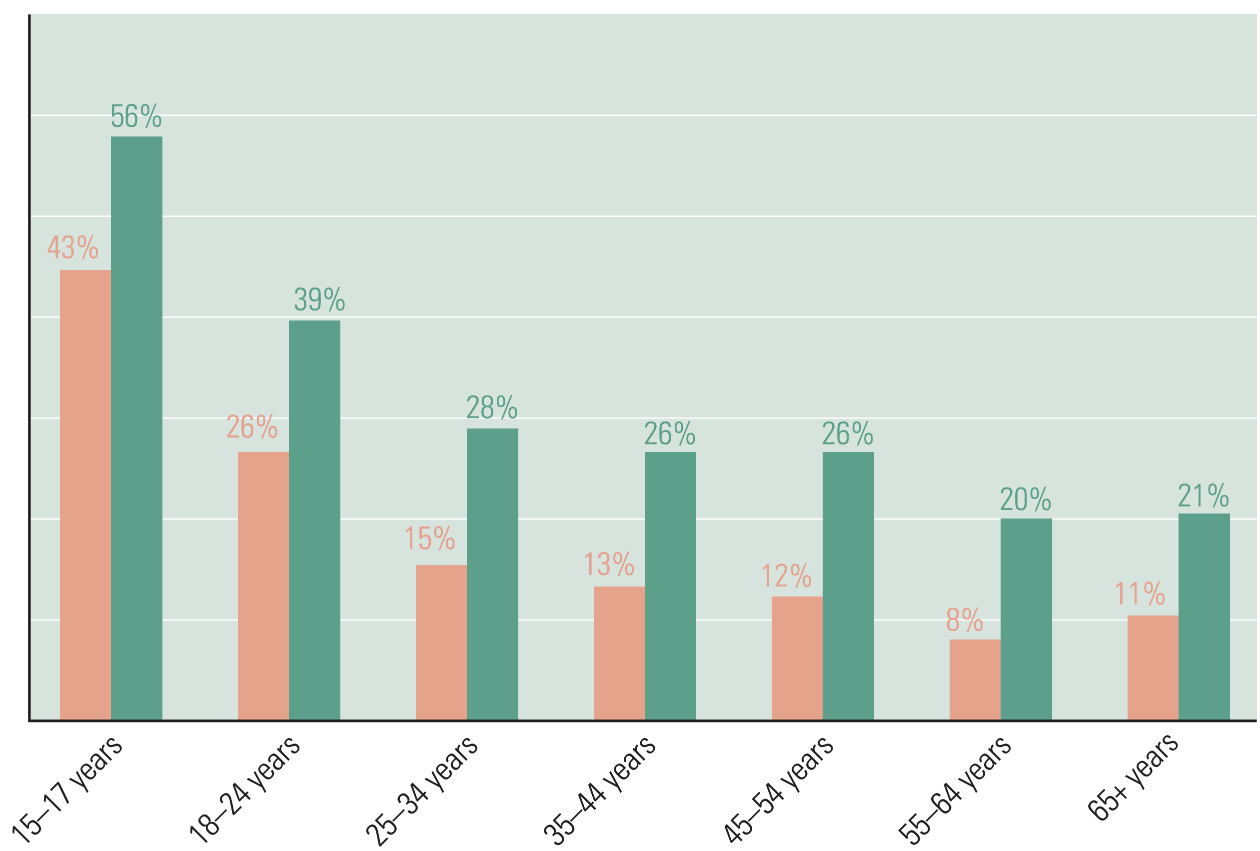


Source: Adapted from Australian Sports Commission, *AusPlay Participation Data for the Sports Sector Summary of Key National Findings October 2015 to September 2016.*

Figure 4.30 Adult top 5 motivations for participation by gender



Source: Adapted from Australian Sports Commission, *AusPlay Participation Data for the Sports Sector Summary of Key National Findings October 2015 to September 2016.*

Figure 4.31 Participation in club sports (Adults 15+)

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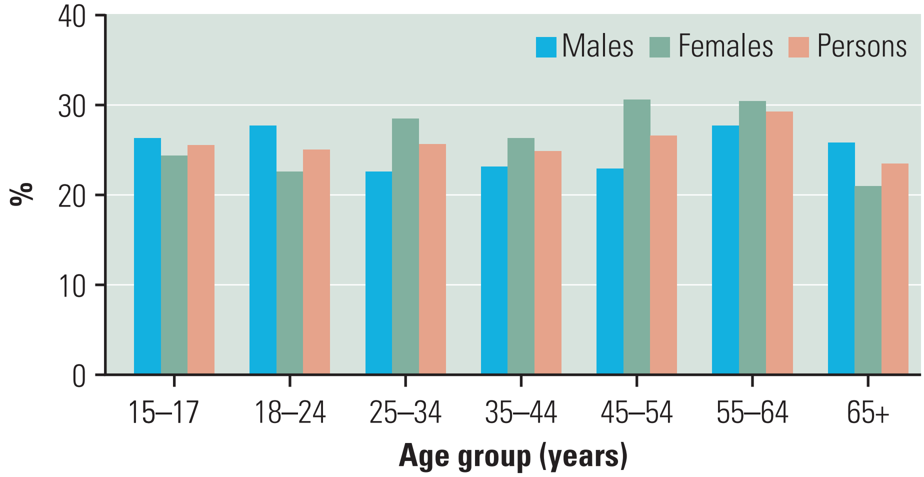

Source: Adapted from Australian Sports Commission, *AusPlay Participation Data for the Sports Sector Summary of Key National Findings October 2015 to September 2016*.

Figure 4.32 Participation in club sports (Adults 15+)

	Number (000)			Participation rate %		
	2005–06	2009–10	2011–12	2005–06	2009–10	2011–12
Country of birth						
Australia	7878.1	8319.7	8868.9	68.3	66.4	67.4
Total born overseas (a)	2664.0	2788.1	3049.8	59.6	56.4	59.1
Main English-speaking country	1241.6	1231.7	1381.0	72.4	66.4	69.5
Non-main English-speaking country	1442.4	1556.4	1668.8	51.6	50.5	52.5
State or territory of usual residence						
New South Wales	3438.4	3584.8	3809.3	64.1	62.7	65.1
Victoria	2611.9	2854.1	3010.3	64.8	64.6	66.1
Queensland	2070.6	2152.0	2231.0	67.1	62.1	61.9
South Australia	805.8	804.6	831.5	65.8	61.7	62.3
Western Australia	1100.2	1151.4	1252.7	70.5	65.4	66.5
Tasmania	248.9	256.7	280.0	65.2	64.4	69.0
Northern Territory	64.7	91.3	89.9	58.3	71.5	66.0
Australian Capital Territory	201.5	215.1	232.0	79.5	77.1	80.3

Source: Adapted from Australian Sports Commission, *Participation in Sport and Physical Recreation, Australia*.

Table 4.6 Participation in sport and physical recreation by country of birth and state/territory

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	Women N = 521				Men N = 890		
	Sport	%	HELPA	Position	Sport	%	HELPA
1	Lawn bowls	9.0	No	**1**	Golf	26.0	Yes
2	Golf	8.0	Yes	**2**	Lawn bowls	16.0	No
3	Tennis	8.0	Yes	**3**	Tennis	6.0	Yes
4	Dancing	3.0	Yes	**4**	Sailing	4.0	Yes
5	Martial arts	2.0	Yes	**5**	Cycling	3.0	Yes
6	Netball	2.0	Yes	**6**	Shooting sports	3.0	No
7	Croquet	1.0	No	**7**	Cricket (outdoor)	2.0	Yes
8	Canoeing/kayaking	1.0	Yes	**8**	Motor sports	1.0	Yes
9	Cycling	1.0	Yes	**9**	Touch football	1.0	Yes
10	Horse riding/ equestrian/ polo cross	1.0	Yes	**10**	Martial arts	1.0	Yes
11	Tenpin bowling	1.0	Yes	**11**	Dancing	1.0	Yes
12	Swimming	0.9	Yes	**12**	Swimming	1.0	Yes
13	Sailing	0.6	Yes	**13**	Field hockey	0.90	Yes
14	Rowing	0.5	Yes	**14**	Table tennis	0.90	Yes
15	Squash/racquetball	0.5	Yes	**15**	Australian Rules Football	0.80	Yes
16	Ice/snow sports	0.5	Yes	**16**	Archery/bow hunting	0.70	Yes
17	Shooting sports	0.5	No	**17**	Croquet	0.70	No
18	Bocce	0.4	No	**18**	Football/soccer (outdoor)	0.70	Yes
19	Softball	0.3	Yes	**19**	Bocce	0.60	No
20	Athletics/track and field	0.2	Yes	**20**	Canoeing/kayaking	0.60	Yes
21	Boxing	0.2	Yes	**21**	Orienteering	0.60	Yes
22	Field hockey	0.2	Yes	**22**	Squash/racquetball	0.60	Yes
23	Badminton	0.2	Yes	**23**	Ice/snow sports	0.50	Yes
24	Basketball	0.2	Yes	**24**	Tenpin bowling	0.50	Yes
25	Motor sports	0.2	Yes	**25**	Badminton	0.40	Yes

Source: Adapted from Australian Sports Commission, *Active and Healthy Ageing Through Sport*, 2015.

Table 4.7 Top 25 club-based sports in adults aged 50+ years by gender

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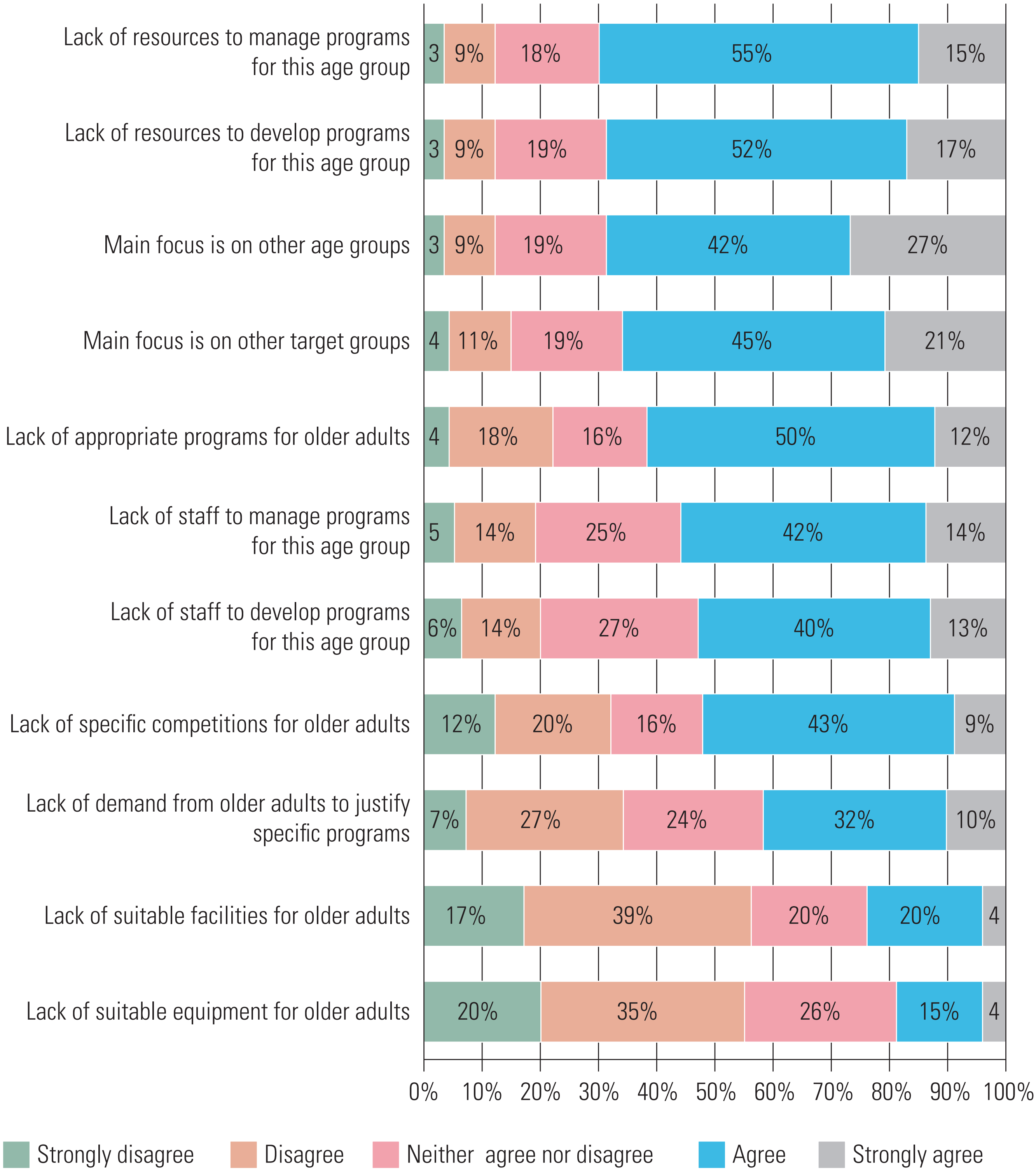

Source: Adapted from Australian Sports Commission, *Active and Healthy Ageing Through Sport*, 2015.

Figure 4.33 Findings from a survey where respondents were asked to rate organisation barriers to increasing sport participation in older adults

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Activity 4.30

Check-in

1 For each data set presented on pages 206–11, identify what the data are representing and make one generalisation that can be inferred.
2 From the data presented on pages 206–11, identify five statistical facts or trends and explain how each one might be a barrier or enabler to engagement for a specific demographic.
3 Undertake secondary research to locate two sources that provide statistical information in relation to physical activity for each of the following demographical characteristics: age, sex, ethnicity, ability, socioeconomic status and geographical location. Save the information and reference the source for future activities and assessment tasks.

From a cultural perspective, physical activity, sport and leisure have been undergoing significant cultural changes for at least the last 70 years. Triggered by the increasing mechanisation and automation of labour-intensive tasks, technological innovations throughout the 1930s, 1940s and 1950s first began to reduce the physical effort required in the workforce, a trend that is still continuing. Where life was once physically demanding and people were naturally physically fit and active, towards the end of the 1900s it became easy to live a sedentary lifestyle. Statistical data showed Australians were unhealthy, inactive and overweight. Less inclined to be involved in physical activity, many Australian adults were passing these attitudes on to their children through socialisation, and concern is that this will lead to a decline in life expectancy. Fortunately, action at all levels of community to highlight the importance of physical activity has seen a steady increase in activity, and in some cases trends are now showing positive movement for engagement.

As a result, the ways in which our population chooses to be active are changing. Where traditional organised sport was once the choice of physical activity, now the following trends are evident:

- Older Australians who previously were less active are undertaking less structured and more informal activities to remain physically and socially active.
- Adults who are time-poor and not able meet the regular demands of weekly organised sport look for activities that fit around their busy lifestyle and suit their needs.
- Children engage in activities that are less structured and competitive, and that simply meet their enjoyment and motivational requirements.

It is fair to say that Australians are currently experiencing a change to the activities that are culturally acceptable during leisure and recreational time. This continues to act as an enabler for those activities that are culturally favoured, and as a barrier to those where engagement rates are low or declining.

Emerging megatrends: A change in physical activity preference guiding demographics and cultural change

Societal change over the past 20 years has resulted in a transformation in the way many Australians incorporate physical activity into their lives. Participation rates in traditional organised sports are changing, with a movement towards fitness and a holistic approach to healthy living, and as a result is also changing the demographics of physically active Australians.

Research by the Australian Sports Commission has shown that our population is increasingly engaging in more flexible, non-organised physical activity, with younger Australians moving towards new lifestyle and adventure sports. As social, technological and commercial factors continue to influence physical activity, it is likely that these **megatrends** will continue well into the future.

megatrend represents an important pattern of social, economic or environmental change

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Activity 4.31

Engage-in

Inquiry question: What are the features of the fitness activities that are emerging in our culture?

Engage and understand

1 Over the next three lessons, undertake three different fitness sessions of approximately 30 minutes – for example, a HITT session, boot camp, spin or cross fit. If possible, use an instructor to conduct your session or travel to a suitable venue outside of school. Use fitness tracking equipment that you may have available to track heart rate, distances travelled and calories burnt.

Apply and analyse

2 After each activity:

- compare any fitness data gathered
- collect class data on the enjoyment and engagement of participants in the activity.

3 After all three sessions, identify the characteristics of the activities and what might make them appealing and accessible to adults.

Evaluate and justify

Justify: Give reasons or evidence to support an answer, response or conclusion; show or prove how an argument, statement or conclusion is right or reasonable.

4 In a 150-word statement, justify why the types of activities experienced in this activity may be increasingly popular among adults.

Megatrends in Australian sport and physical activity include:

- more highly individualised sport and fitness activities that can be tailored to the individual and their needs
- the move of extreme, adventure and alternative sports to the mainstream, drawing from participation rates in traditional organised sport
- an increased appreciation and understanding of the broader benefits of sport to communities by individuals, groups, the corporate sector and government
- age groups naturally participate in different activities, an ageing population changes the demographics of the sports played and how Australians engage with physical activity
- as Asia continues to grow on the international stage, new opportunities may open up for Australia, both on the sports field and in the sports business environment
- market forces exerting greater pressure on sport in the future. In all sectors of sport and physical activity, commercial interests from participants, industry organisations and external forces will continue to drive change that will influence engagement trends.

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1	Wearable technology
2	Body weight training, using minimal equipment, making it more affordable
3	High-intensity interval training (HIIT)
4	Selecting educated and experienced fitness professionals
5	Strength training
6	Intentional designed group training
7	Exercise as medicine
8	Yoga
9	Increase in qualified personal training professionals
10	Exercise and weight loss focus

Table 4.8 Top 10 recent trends in the fitness industry

Activity 4.32

Check-in

Megatrends result from the accumulation of smaller trends or changes in social behaviour, making significant societal trends appear. Keeping the megatrends discussed on the previous page in mind, explain the impact (positive or negative) on physical activity access or engagement of the following:

- a move to a more casual workforce with longer trading hours
- less disposable income available to families
- busier lifestyles with more to do
- increased promotion of physical activity through the health and education systems
- more research-based activities where science underpins activities
- freedom and personal choice, which bring satisfaction into our lives
- a greater range of physical activities in which to engage
- a move away from competitive sport for social aspects and enjoyment
- a need to achieve fitness results quickly and track progress.

The role of government funding

Government policy and funding significantly influence the equity and access of Australians to physical activity. Each of the three levels of Australian government works for the betterment of physical activity, with billions of dollars spent annually on the sport and recreation industry. The allocation of this money will enable access and participation for some, while for others barriers will remain. However, physical activity is widely accepted as an important facilitator in achieving many health and community objectives, so government funding will be ongoing.

While there is significant government funding available for physical activity, there are always more projects than can be funded. This ensures governments must prioritise and allocate funding appropriately, with decisions that are justified and transparent.

While governments endeavour to allocate funds equitably, they may employ different concepts of

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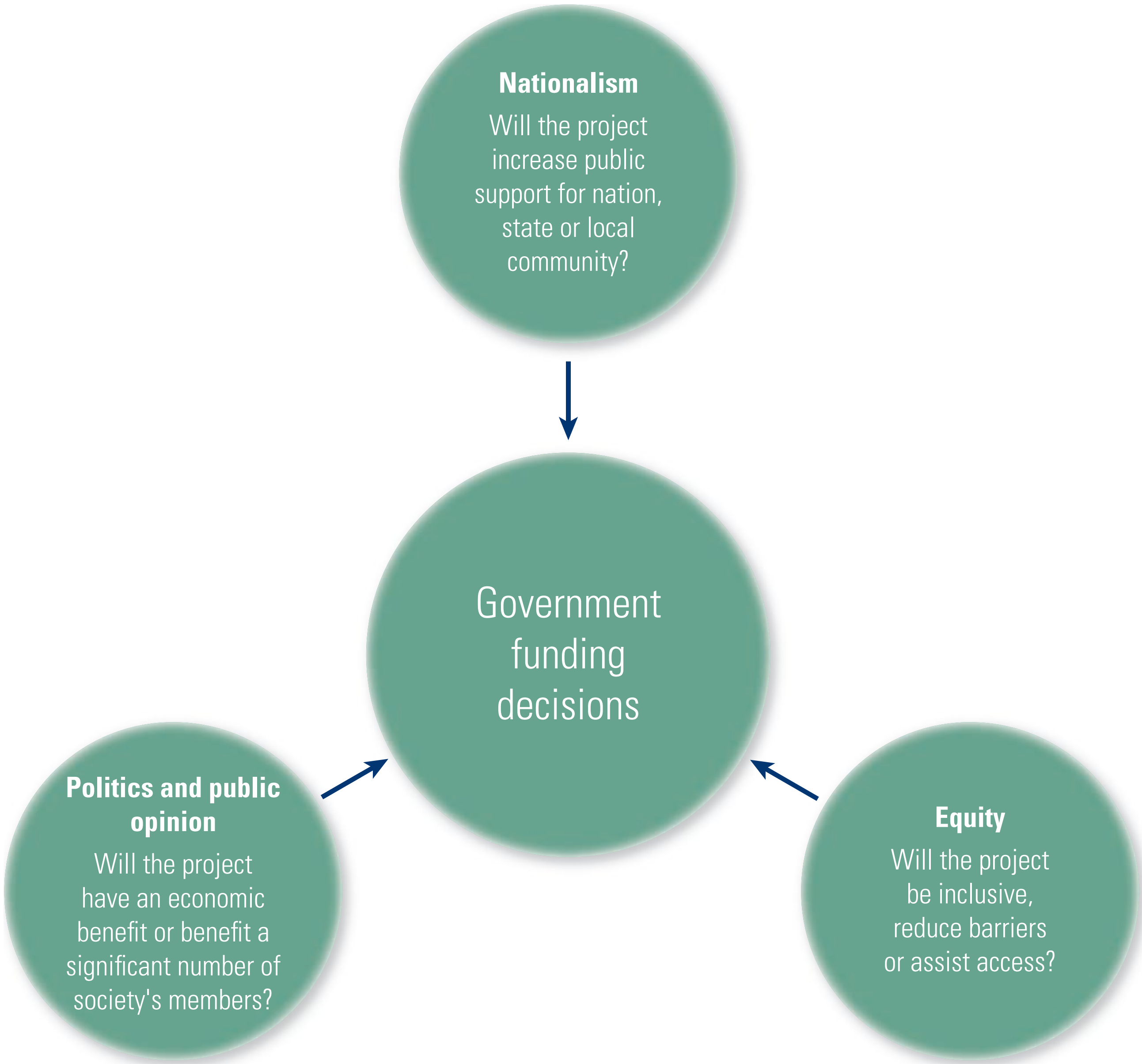

Figure 4.34 Funding decisions need to consider a broad variety of factors

equity in order to rationalise difficult decisions. For example:

- **equity as equality** – Will the decision benefit every individual equally (or the largest possible number)?
- **equity as need** – Will the decision address an issue where some are disadvantaged?
- **equity as inclusivity** – Will the decision increase participation or engagement?
- **equity as demand** – Will the decision meet the requirements of those most frequently involved?
- **equity as market equity** – Will the decision produce a financial benefit?
- **equity as efficiency** – Will the decision be good value for money?

These different 'interpretations' of equity are not just specific to government decision-making – all organisations responsible for the allocation of funds will struggle with exactly how to distribute financial resources equitably. For government decision-making, which involves large sums and affects significant numbers of people, funding allocation is problematic. While some in the community will be pleased, many will be disappointed with where and how government funding is spent.

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Level of government	General objectives for funding	Major methods (departments) to achieve objectives	General purpose for objectives
Federal government	• Increase participation in sport, physical activity and leisure activities	• Development of the Australian Sports Commission to oversee the distribution of funds and provide strategic guidance and leadership for sporting activity in Australia. Divisions of the ASC oversee: – sports participation – high-performance sport (AIS) – sport management – corporate/commercial services • Funding to state and local governments	• Maintain the health of the population through engagement in physical activity • Meet the population's demand for physical activity and maintain public support • Provide athletes with the opportunities and resources to develop their athletic skills to an elite level • Increase nationalism through improved sporting performance and international success
State government	• Provide funding to support infrastructure development • Develop sporting programs and initiatives to increase access, engagement and the quality of physical activity	• Meet objectives primarily through the Department of National Parks, Sport and Racing, and in conjunction with other government departments such as the Department of Infrastructure, Local Government and Planning and the Department of Agriculture and Fisheries • Maintain the Queensland School Sport Associations • Support state sporting bodies, such as the Royal Life Saving Society Queensland	• Provide facilities and resources for physical activity as a way to develop participation and a sense of community • Maintain the health of the population through increased engagement in physical activity • Meet the demands of the population and maintain public support and confidence
Local government	• Sport and recreation infrastructure and maintenance • Initiatives and funding for local clubs and participants	• Councils will have individual departments, people and decision-making processes to oversee the distribution of resources and the development and implementation of initiatives	• Provide facilities and resources for physical activity as a way to develop participation and a sense of community • Maintain the health of the population through engagement in physical activity • Assist local clubs to maintain a diverse range of activities that meet the needs of community members • Assist local participants to maintain engagement and reach higher levels of involvement • Meet the demands of the population and maintain public support and confidence

Table 4.9 As each level of government has its own portfolios and areas of responsibility, each level contributes to physical activity funding in different ways.

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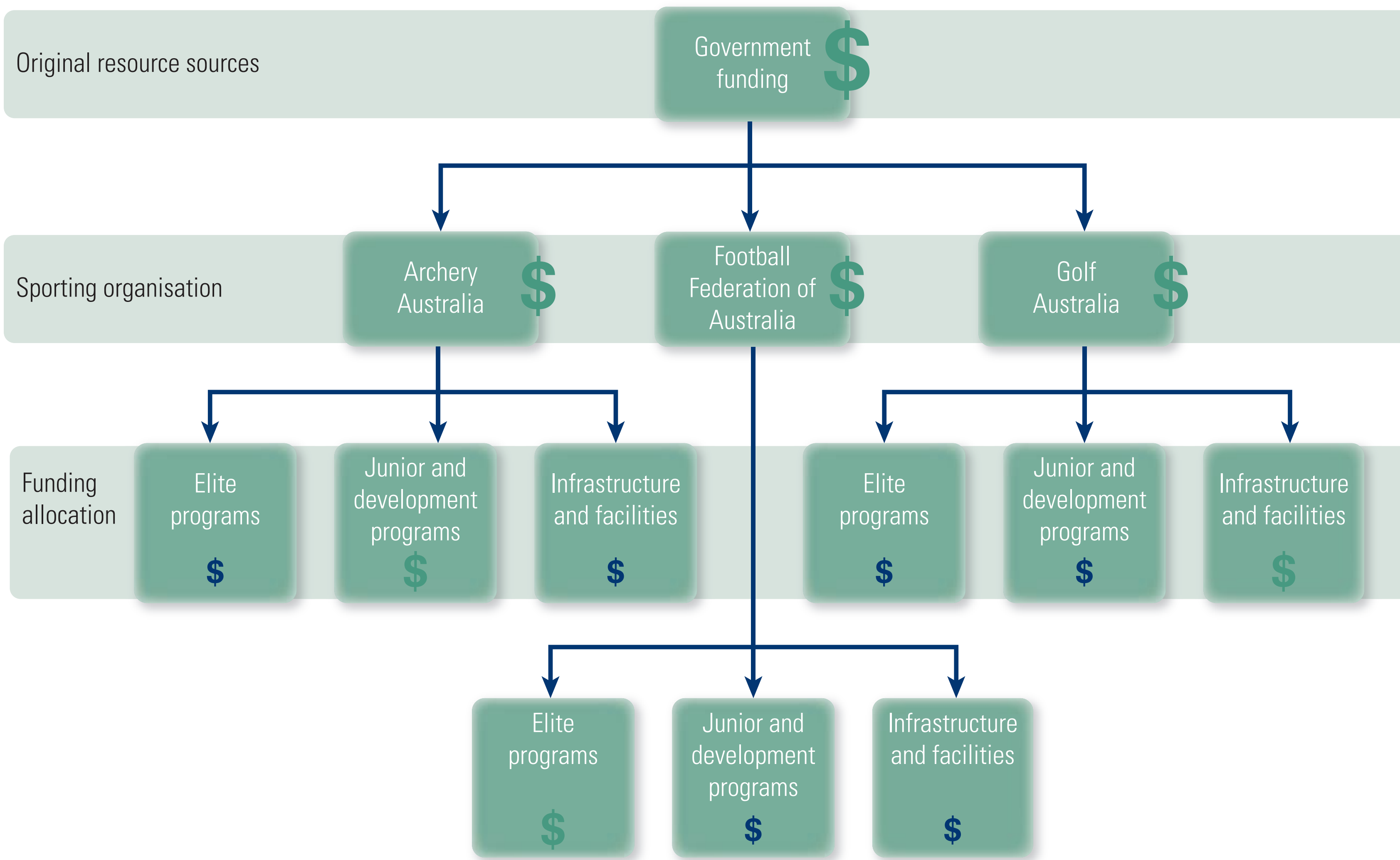

Figure 4.35 A simple funding model that demonstrates how the flow of money can be channelled into different aspects of sport, resulting in some receiving more advantages than others.

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Mass media promotion and marketing of physical activity

The mass media are a diversified collection of technologies used by outlets to communicate information or data to a large audience. Figure 4.36 displays the process of **commodification** of physical activity and sport in the marketplace. When the value of a commodity is high or is increasing, the media act as an enabler, providing an individual with access and exposure to that commodity. Where the value of the commodity is low or is declining, the media will be a barrier to access and engagement.

commodification
the process of transforming a product, person or service to increase its value and potential to make a profit

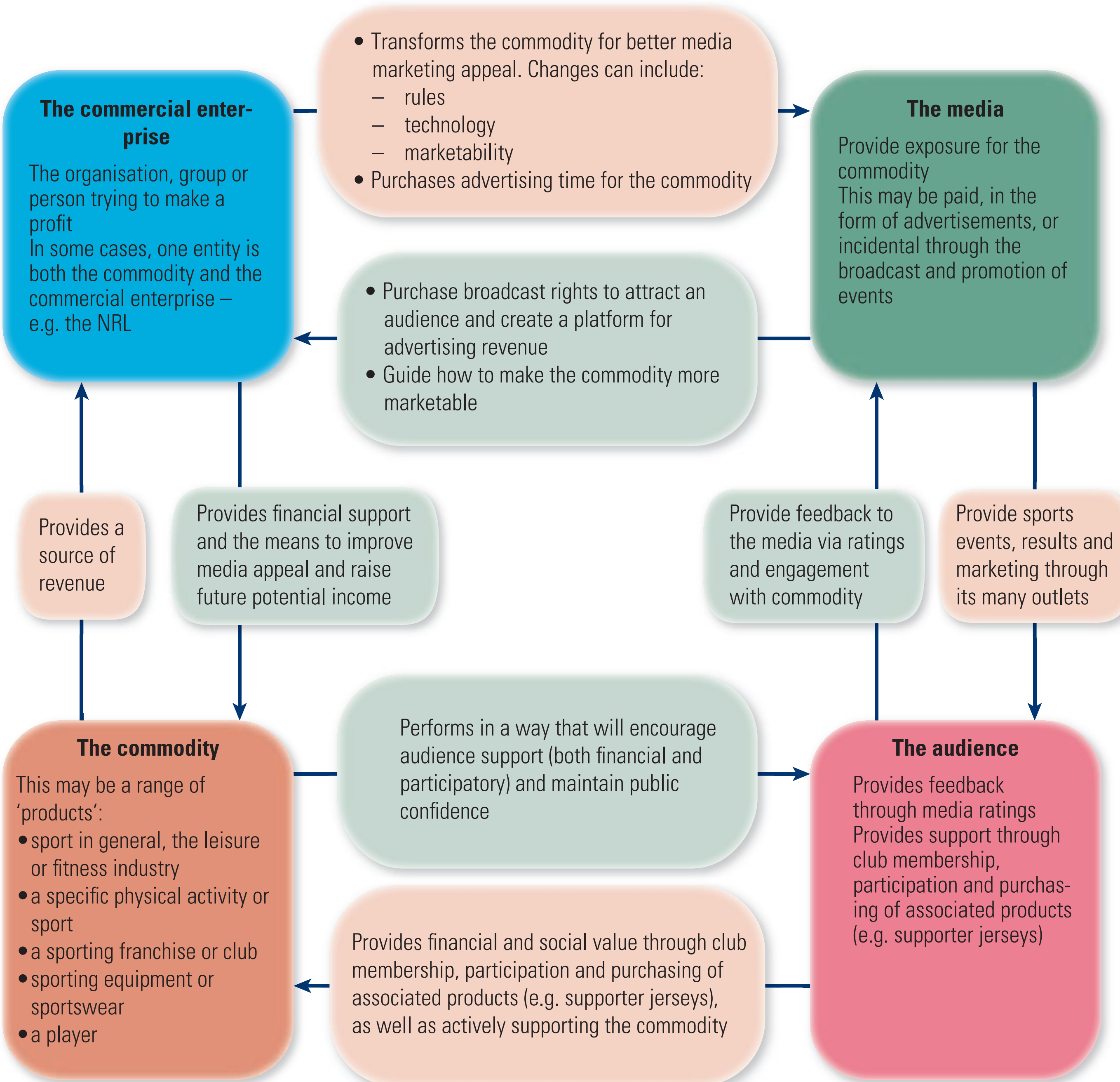

Figure 4.36 Commodification of physical activity and sport in a modern, media-centred marketplace

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Activity 4.33

Check-in

1. Under the *Right to Information Act 2009* the Queensland Government is required to make public the funding allocation for various programs, including those related to sport and physical activity. Access this information by searching for the Queensland Government's Sport Funding website and look for Approved Funding Applicants.
2. Scan the various organisations and the funding they received. Which physical activities seem to be most frequently represented? Which received the five largest funding grants?
3. Select one specific project that received funding and undertake some further secondary research into its purpose and who benefited.
4. Scan the Queensland Government Funding web pages. Is there any funding that may suit a local club, your school or yourself?
5. Using a specific example, explain how government funding acts as an enabler for some within in the community, while for others it may reinforce barriers.

While there is now a vast array of media through which information can be communicated, those more relevant to equity and access in physical activity transmit sporting events, results or marketing related to physical activity, sporting events or its participants. Traditionally, these technologies include television, newspapers, magazines and radio. However, through the live-streaming of events, real-time updates and pop-up advertisements, the internet is now also an important medium for physical activity.

Where physical activity is viewed as entertainment, it has monetary value and is a **commodity**. For the commercial enterprises that own or are involved with the commodity, there is no doubt that adding value to the product of 'sport' is essential. What is displayed through the media plays a big role in the modern socialisation process. What messages do the images in Figure 4.37 on the following page send to young females about beach volleyball as a sport, and women's sport in general?

How physical activity is presented to the audience through television includes aspects such as the amount of coverage given, the timeslots for the coverage, live or replayed coverage and the quality of the coverage (number of cameras, technology utilised, the quality of commentary). It would also include the images themselves, the build-up and advertising surrounding the event and the entertainment that surrounds the broadcast. For print media, it would include aspects such as column space, number of images included and placement within the publication. For an audience, each of these aspects is sending a message about the worth of the commodity: that high-quality media coverage must be reflective of a commodity that is of high value to society. Therefore, when an activity receives high levels of media exposure, this acts as an enabler for an individual through increased access.

commodity a product that has value and thus can be bought, sold or traded

In a reflection of Australian society, currently three (largely male) sports – AFL, NRL and cricket – dominate TV exposure, accounting for more than half of all televised sport. Although participation rates in these activities do not support the disproportionate media coverage they receive, they are great 'spectator sports'. Olympic sports, and other sports at which Australians perform successfully at an international level, receive very limited TV exposure outside the Olympic Games and major international championships. Although this exposure is limited, there is a national interest in our sporting success. On a global stage, activities like football (soccer), tennis, golf, F1 motor racing and boxing all have significantly higher interest levels, but varying success through the Australian media. The influence of US culture, the quality of competition and the coverage provided also see a growing fan base for sports like basketball

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Figure 4.37 The sports images shown in the media reflect and reinforce social values, stereotypes and standards.

and American gridiron, despite engagement within Australia being negligible.

The big three commercial sports are receiving more than A$4 billion for multi-year TV rights deals, and this significantly increases their financial strength and reinforces their cultural significance. By contrast, most other sports are experiencing flat or declining TV exposure and rights deals, with the media coverage of women's sport, for example, falling from 11 per cent of total sports coverage to 8.7 per cent over the past decade.

Television airtime is dominated by commercial sporting codes, and there is a strong correlation between broadcast volume and sponsorship revenue.

This two-tiered trend in the commercialisation of Australian sport is expected to continue. Greater wealth generated by some sports will allow them to attract a growing share of participants and future fans, adding further to their commercial attractiveness. This in turn acts as an enabler to access, with individuals experiencing more opportunities. Smaller sports – many of which have high rates of female participation and contribute to our international sporting success – will increasingly be squeezed out, with potentially negative impacts on the diversity of the Australian sports sector. For individuals, this will negatively affect access and create barriers to engagement.

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Commercial			Broader sports			
Tier 1	**Tier 2**	**Tier 3**	**Foundation**	**National iconic**	**Emerging**	**Supported**
AFL NRL Cricket	Tennis Soccer Rugby Union	Golf Basketball Netball	*Tier 1* Athletics (including running) Canoe/kayak Cycling Rowing and sailing Skiing and snowboarding Swimming *Tier 2* Diving Hockey Shooting Triathlon Water polo *Prospective* Equestrian Gymnastics	Badminton Archery Beach volleyball Boxing Judo Modern pentathlon Taekwondo Volleyball	Bowls Motorcycling Motorsports Squash Weightlifting Surfing Surf lifesaving	Basketball Bocce Fencing Ice racing Karate Lacrosse Softball Touch football Orienteering Polo cross Pony club Skate Table tennis Tenpin bowling Wrestling Water skiing, wakeboarding BMX

Table 4.10 Segmentation of sports based on commercial characteristics

Commercial sports

- Tier 1 – commercial sports with significant Australian television rights deals
- Tier 2 – commercial sports with television rights deals
- Tier 3 – commercial sports with TV coverage but no rights deal

Broader sports

- Foundation – sports with a record of achieving multi-medal or consistent team medals at Olympics, Paralympics, world championships or Commonwealth Games level.
- Emerging – sports likely to achieve a top eight finish and with an outside medal chance at the next Olympic Games, or likely to achieve a medal at the next Paralympic Games.
- National iconic – sports with gold medal success at the Commonwealth Games or culturally significant sports with gold medal success at world championships.
- Supported – sports that receive grants from the Australian Sports Commission.

How the media market physical activity and sports participants is also essential to the formation of public opinion and attitudes towards sport in general, specifically activities and players. What the media display and how they market physical activity influence the values, attitudes and beliefs held by the audience. Such portrayal can guide the decisions of parents and peers with regard to the types of activities undertaken and the frequency with which they engage in them. On a personal level, the media help to create personal stereotypes with regard to the people who play sport, and this influences an individual's self-concept about their own physical abilities and suitability for activities. This makes the mass media a significant agent of socialisation in Australia.

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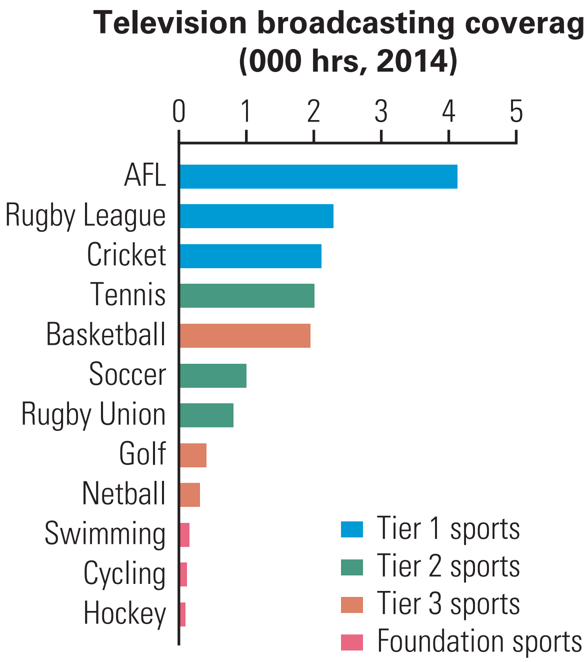

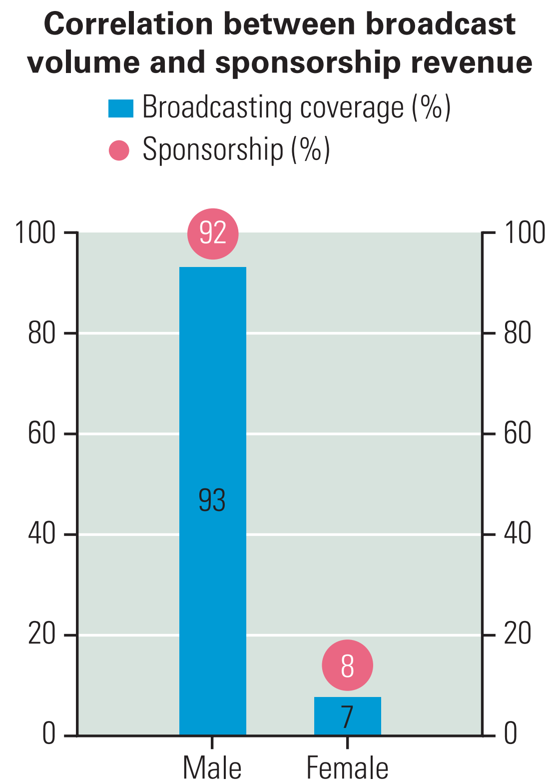

Source: The Boston Consulting Group, *Intergenerational Review of Australian Sport 2017*.

Figure 4.38 Television airtime is dominated by commercial sporting codes.

KEY MESSAGE

The 'messages' the media transmit to their audience establish values, attitudes and behaviours about physical activity.

KEY MESSAGE

Activities with high media exposure will increase in value, creating opportunities for individuals in these activities.

KEY MESSAGE

Activities with low media exposure will struggle commercially, and this creates barriers on many levels.

Activity 4.34

Check-in

1. Use an example to explain the link between media coverage, sponsorship and the economic value of a specific physical activity.
2. Undertake some research and use a Venn diagram to compare and contrast the media coverage and messages transmitted by the media for netball and Australian Rules Football.
3. Access the list of physical activities in the current version of the Physical Education syllabus. Consider the media coverage of the activities listed. Why do you believe there are so many activities in the syllabus that have little cultural value as demonstrated through the media?

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Institutional rules, policies and procedures

Society is full of written and unwritten rules that influence the equity of and access to physical activity for Australians. Institutions associated with physical activity create and propagate rules, polies and procedures designed to oversee the effective operation of physical activity and the appropriate behaviours of its participants. While policies may be overt and written for all to follow, routine practices are more covert and surface in the behaviours and attitudes of the members of the institution. Some routine practices are so entrenched that they present as serious barriers to participation for some members of society, to the extent of being considered discriminatory.

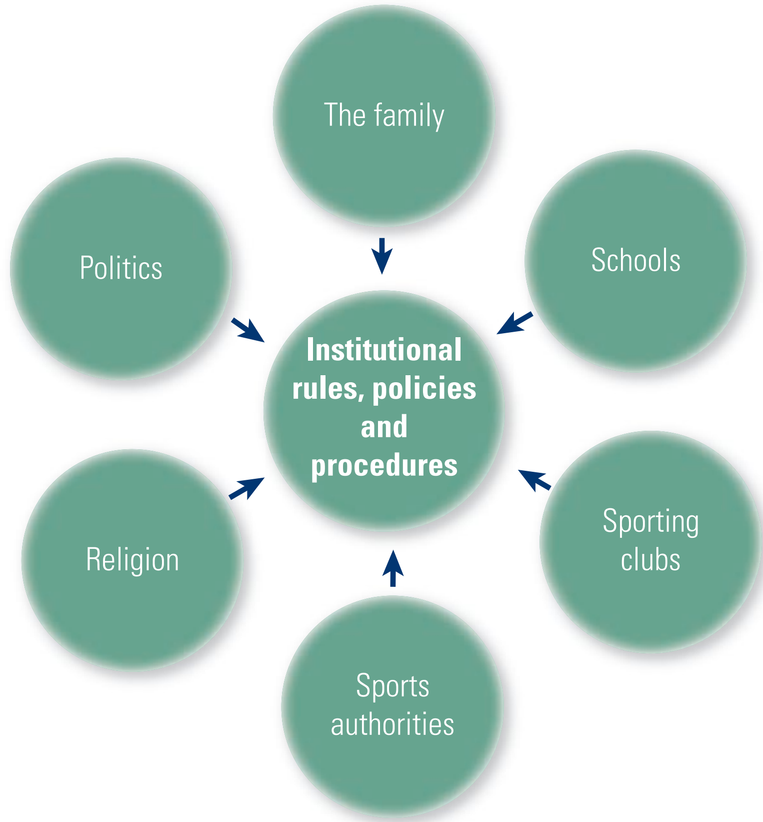

Figure 4.39 The rules, policies and procedures of major institutions influence the equity experience and access to physical activity of Australians.

Activity 4.35

Engage-in

Inquiry question: How do the training and playing times set by institutions impact effective engagement?

Engage and understand

1 As a class, select the physical activity in which you will participate.

2 Negotiate a training time that suits everyone to conduct a training session outside of class time (before or after school or during a break).

3 Conduct the session at the agreed time and location.

Apply and analyse

4 Review the attendance rate for the training session.

5 Collect primary data for two groups of students: those who attended and those who did not.

- **a** For those who attended, consider why they were able to do so. What made it possible?

(continued)

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b For those who did not attend, consider what barriers prevented them from attending? Was it the time, other priorities, a lack of interest, a combination of these or something else?

Evaluate and justify

Justify: Give reasons or evidence to support an answer, response or conclusion; show or prove how an argument, statement or conclusion is right or reasonable.

6 In a 100-word statement, justify a response to the inquiry question for this activity using the data collected.

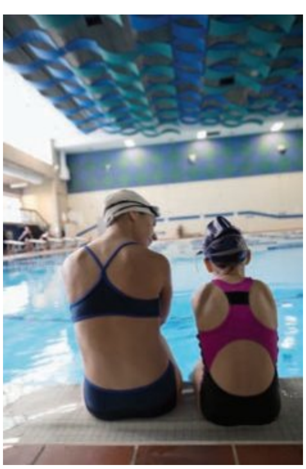
Institution	Rules, policies, procedures may include	Example
The family Families are the foundation institutions in society. While their rules and procedures may not be written in stone, they can be arbitrary and at the discrimination of the parents. Each family develops its own 'way of doing things'.  **Figure 4.40** The routine practices of the family enables access to specific physical activities	Where physical activity is prioritised in life	'If you don't finish your assignment, you are not playing this weekend.' *(Barrier)*
	How much physical activity will be engaged in	'Get outside and do something – you've been on that chair all day.' *(Enabler)*
	When activity can be engaged in	'I am not getting up at 4.30 am just so you can do swimming training.' *(Barrier)*
	Allocation of financial resources	'Sorry but we can't afford another lot of registration fees and new uniforms.' *(Barrier)*
	Who can engage in what physical activity	'You can't play netball; your brother and sister are doing soccer and we can't get to both.' *(Barrier)*
	What activities are supported	'Isn't softball a bit girly? Why don't you stick with cricket like your brother?' *(Barrier)*
	What clubs or players are supported	'The house is covered in maroon for State of Origin.' *(Enabler)*
	Freedom of choice	'You can do whatever you like – just pick what you want to play.' *(Enabler)*
	Effort, commitment and persistence	'You just started tennis; you are not quitting until the season is finished.' *(Enabler)*

Table 4.11 Institutions influencing equity of and access to physical activity

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Institution	Rules, policies, procedures may include	Example
	Tradition	'I played touch football and so did your sisters; how about you just try it?' *(Enabler)*
While the 'rules' here are generally spoken, an individual can also infer these messages from the actions of others in the family without the rules and procedures being stated specifically. This can be the difference between a family 'expectation' and a family 'influence'.		
Schools 'School rules' are generally thought of as a way to maintain order within the institution. However, it is clear that many rules, policies and procedures exist within schools (and other institutes associated with education) that impact upon equity and access to physical activity.	The size of classes (Education Queensland – policy)	Maximum senior class size of 25 *(Enabler or barrier)*
	Subjects offered and when they are taught in relation to other subjects (school – procedure)	Physical Education is offered at the same time as Biology, Health and Physics. *(Enabler or barrier)*
	The required implementation of the current version of the Physical Education syllabus (QCAA – policy)	Each unit of work must be at least 55 hours. Must select activities only from those in the syllabus. Physical activity assessment is only a minor contributor to overall result. *(Enabler or barrier)*
	What is a required prerequisite for further study (TAFE or university – procedure)	Physical Education is not a requirement for an Engineering degree. *(Enabler or barrier)*
	What is a specific prerequisite for a career (individual employers)	Physical activity is not a requirement for attaining a sales and marketing job. *(Enabler or barrier)*
	Students pay a subject fee for Physical Education (school – procedure)	$230 per year subject fee for course. *(Barrier)*
Figure 4.41 Simple access to lunchtime equipment at school is an enabler for physical activity.	The organisation of resources (school – procedure)	The main sporting complex is not available for volleyball when Physical Education is scheduled. *(Barrier)*
	The offering of physical activities (school – procedure)	The school does lawn bowls and does not offer archery. *(Enabler or barrier)*

Table 4.11 *(continued)*

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Institution	Rules, policies, procedures may include	Example
	The level to which activities are engaged in	The school is a school of excellence in touch football, with appropriate staffing and resourcing to maintain this. *(Enabler or barrier)*
	The distribution of resources (school – procedure)	The Sport Department has a budget of $33 000, while the Arts Department receives $8000. *(Enabler)*
	Who is 'allowed' to play	No hat – no play rule *(Barrier)*
	The additional extra-curricular offerings (school and school sporting organisations procedure)	Lunchtime access to gym is available. *(Enabler)* No equipment is handed out during break. *(Barrier)* There is no Futsal offered for interschool sport by the district school sport organisation. *(Barrier)* There is no senior interschool sport offered. *(Barrier)* The school does not engage in the Champion Basketball School of Queensland Competition. *(Barrier)*
While school rules, policies and procedures are not designed to hamper access to physical activity, sometimes they do place barriers in the way of participation for many students.		
Sporting clubs Clubs form as the result of a common interest among a group of people. As a result, these people may also share similar values and attitudes. As a club develops its rules, policies and procedures these values and attitudes may work their way into its operations. However, when rules, policies and procedures develop from a one-dimensional perspective, they	Resources	Money this year will be spent on upgrading facilities and we can no longer offer free come-and-try clinics. *(Barrier)*
	Coaching	The athletics club is going to pay for five parents to become qualified at the start of this season so our athletes can get better assistance. *(Enabler)*
	Administration	The archery club will pay to have a person write and submit grants to government so that we can get the fields upgraded. *(Enabler)*
	Fundraising	As parents are not supporting the fundraising initiatives required, next year a $80 fundraising levy will be charged. *(Enabler or barrier)*

Table 4.11 *(continued)*

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Institution	Rules, policies, procedures may include	Example
may lack consideration for diversity – favouring people with a similar view to those already associated with the club, while disadvantaging others who are outside this demographic.	Behaviours of players, officials and parents	Developing a code of conduct – for example, any disrespect to a referee will invoke a minimum two-week suspension. *(Enabler)*
	Expectations for players, officials and parents	Players who do not attend training will not start the match. *(Enabler or barrier)*
 **Figure 4.42** Investing in coach development in clubs can help players develop skills and increase enjoyment.	Club constitution	Golfers must be members to participate in competitions; membership can only come through an application, endorsement from current members and payment of fees. *(Barrier)*
For some sporting clubs and organisations, what is displayed and tolerated can be different from what is written in a code. For example, does a club enforce policies about drinking, or does it tolerate players drinking prior to matches or to excess. This can sometime give rise to a negative 'club culture', where anti-social behaviours are acceptable 'behind closed doors' if individuals do not abide by the set expectations.		
Sports authorities These governing bodies oversee the administration of a sport as a whole. Their rules, policies and procedures mandate and guide competitions, participation and funding to advance the image of the sport.	Competition structure	Clubs must organise age-based, not ability or weight-based competitions. *(Enabler or barrier)*
	Funding structure	How much money stays with a club at the grassroots, vs. how much goes to higher bodies for administration and elite-level development. *(Barrier)*

Table 4.11 *(continued)*

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Institution	Rules, policies, procedures may include	Example
 **Figure 4.43** Age-based competitions can cause barriers for younger children where a large difference in size may be apparent.	Policy development	Develop codes for diversity, participation, standards of behaviours, which are then set as guidelines for clubs. *(Enabler or barrier)*
	Activity development	Come-and-try days – targeted programs for minority participation groups *(Enabler)*
	Activity marketing	How much is spent on advertising and what image is presented. *(Enabler or barrier)*
	Activity marketplace	Do we target new participants, advertise to existing clients or try to get into schools through becoming an acknowledged Queensland school sport? *(Enabler or barrier)*
	Activity rule development • To be more inclusive • To make a better spectacle (increased marketability) • For safety	Let us change the timeout rule to two minutes instead of one minute, 20 seconds; this will allow for more advertising during the telecasts of our elite matches. *(Enabler)*
Religion When religious groups set expectations for their followers, a conflict can result, particularly when an individual's faith is more valued than the value they put on physical activity participation.	Set times for worship	Sundays are a time for deep reflection and connection to the religious faith; therefore it is inappropriate to engage in activities that detract from this on this day. *(Barrier)*
	Dress or personal adornment expectations	Hair must not be cut and is worn long; it should be covered by a turban. *(Barrier)*
 **Figure 4.44** Strict religious dress rules for some Muslim females present an institutional barrier to engagement in many physical activities.	Dietary guidelines	In order to demonstrate faith, you must not eat between sunrise and sunset during Ramadan. *(Barrier)*

Table 4.11 *(continued)*

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<table>
<tr><th>Institution</th><th>Rules, policies, procedures may include</th><th>Example</th></tr>
<tr><td rowspan="3">Politics
Government oversees the development of laws and sets policy for social stability and change to advance the population. Many government rules, policies and procedures impact on physical activity equity and access.

Figure 4.45 Funding allocation policies for facility development affect access to physical activity at all levels.</td><td>The development of a just, equitable and inclusive society</td><td>Anti-Discrimination Act
Equal Opportunity Act
Other laws
Federal, state and local policies
(Enablers)</td></tr>
<tr><td>The development of a healthy society</td><td>Federal, state and local policies and funding associated with health and physical activity
(Enablers)</td></tr>
<tr><td>Distribution of wealth</td><td>• Creation of the Australian Sports Commission (including the Australian Institute of Sport)
• Funding policies and decisions concerning resources, activity development and school funding (Enablers)</td></tr>
</table>

Table 4.11 *(continued)*

Activity 4.36

Check-in

1 Using three examples outlined in Table 4.11, explain how the rules, policies and procedures of an institution act as enablers to equity and access.
2 Using three examples outlined in Table 4.11, explain how the rules, policies and procedures of an institution act as barriers to equity and access.
3 Select one institution that has a major influence over equity and access to physical activity. Conduct further research into the specific rules and routine practices that influence equity and access. Present your findings as a mind map with examples that enable on the left and examples that are barriers on the right.

(continued)

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> **4** The current version of the Physical Education syllabus has mandated 20 possible activities to study along with rules about how and when these can be studied. Explain how this enables access to some activities while creating barriers to others for Physical Education students. Hypothesise what 'criteria' might have been used to select these activities.

4.9 Environmental factors that act as barriers and enablers for self and others in physical activity

population density a measure of the number of people who make up a population in a defined area

The Australian environment provides a unique situation for participation in physical activity. With our country straddling the Tropic of Capricorn, Australians enjoy both tropical and sub-tropical conditions that support many outdoor activities. In addition, Australia is a large land mass with a relatively low population, resulting in low **population density**. A low population density ensures there is plenty of outdoor space available for physical activity, even within populated areas. Australia's environmental conditions, coupled with adequate space, are optimal for a population that values and enjoys the outdoors and the leisure, recreational and sporting opportunities this brings.

Figure 4.46 Councils and developers look for opportunities to provide green space and areas within the community to enable the population to be physically active.

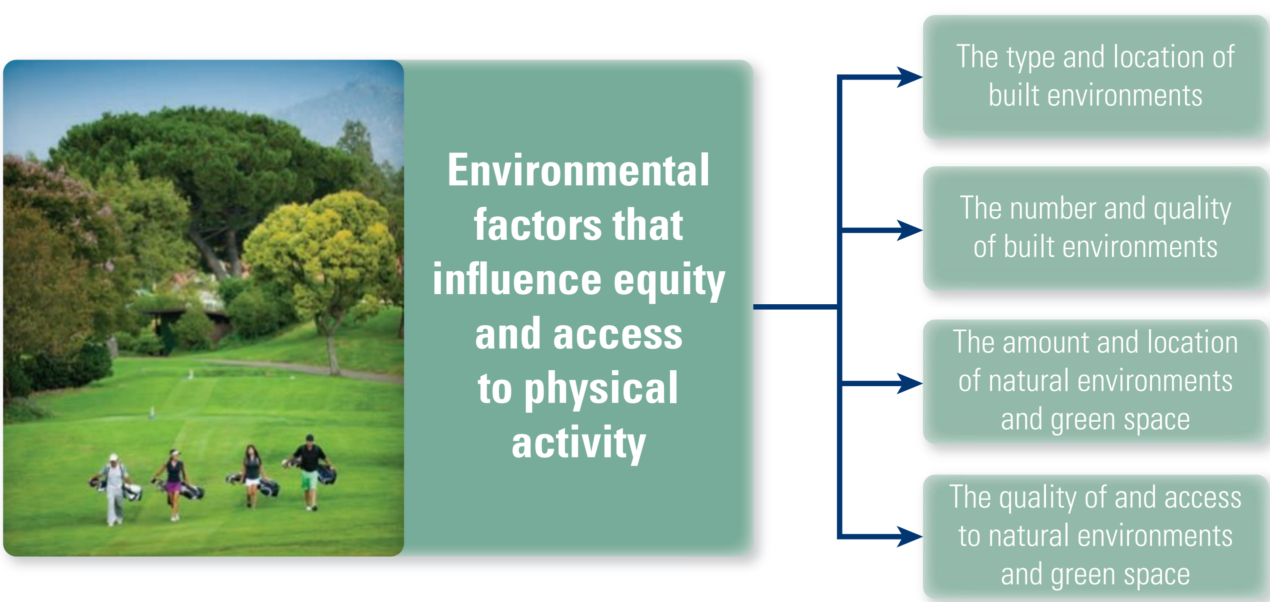

Figure 4.47 Environmental factors that influence the equity of and access to physical activity experienced by an individual

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Activity 4.37

Check-in

1 Brainstorm a list of recreational, leisure and sporting activities that are enabled through the weather conditions experienced in Australia. Group each activity based on how much damage is caused to a totally natural environment in order to have the necessary facilities to participate. Use the following headings: Minimal environmental change required; Moderate environmental change required; Considerable environmental change required.

2 Identify three other countries that are situated on the Tropic of Capricorn and research the top sports participated in by the citizens of these countries. Are there similarities between the activities in these countries and those that are popular in Australia? Can any similarities be attributed to environmental factors?

Activity 4.38

Engage-in

Inquiry question: How does the Australian environment act as an enabler for specific physical activities?

Engage and understand

1 Over a number of lessons, organise to participate in three different physical activities: one that can be conducted indoors; one that requires an outdoor court or restricted area; and one that is played on a large, open field.

2 Collect some primary data from the class by way of surveying the types of environments in which students like to participate – for example, indoors, natural, oval/field.

Apply and analyse

3 Before commencing each activity, take note of the time of day, temperature, wind conditions, humidity and general condition of the playing areas (hard, grassy, purpose built).

4 Engage in the activities as fully as possible.

5 Collect primary data for each activity on the levels of motivation and enjoyment experienced.

Evaluate and justify

6 From the data collected, infer the impact the environment has on participation in physical activity participation. Present your inference in an appropriate format, referring to the data that formed it.

(continued)

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Justify: Give reasons or evidence to support an answer, response or conclusion; show or prove how an argument, statement or conclusion is right or reasonable.

7 From your current knowledge, what role did the Australian environment play in the development of Australian Rules Football in this country? Justify your evaluation in a 100-word response.

Built environments

Built environments have been constructed specifically for engagement in physical activity. This refers to facilities such as stadiums, indoor and outdoor courts, school halls, skate or water parks, community pools, ovals or tracks. These environments are constructed as a result of funding, whether through different levels of government, local clubs and groups, private businesses or individuals.

Communities usually develop these facilities in response to popular demand. Local councils generally build and maintain resources that engage the largest percentage of their population. This presents barriers for less-popular activities, particularly if they also require expensive facilities. Consider the financial commitment to build and fit out a purpose-built indoor facility for gymnastics. Members of rural or isolated communities also experience inequities due to a lack of funding. In smaller areas, councils and sporting groups must frequently compromise and prioritise facility development. For example, a local council may need to decide between maintaining Rugby League fields and change facilities, building a skate park and repairing the community pool.

Natural environments and green space

Natural environments occur inherently in nature. As with built environments, the abundance and quality of these environments will serve as either an enabler or a barrier to the physical activities that use these environments. For many, the enjoyment of these physical activities comes from being in a natural and unspoiled environment. Consider how important an 'untouched' environment is to bushwalking, snow skiing, surfing or snorkelling on a reef. Again, governments and organisations work to preserve the natural features of such spaces.

However, for most physical activities conducted in a natural environment, there must be a trade-off between retaining a truly unspoiled environment and providing the facilities required for the activity. For example, the construction of bushwalking trails or mountain bike tracks, or the setting of anchor points for outdoor rock climbing all require some manipulation of the natural environment. Even within urbanised areas, councils work to maintain areas of natural vegetation for recreational purposes and plan to provide **green space** for community members.

green space an area of grass, trees or other vegetation set apart for recreational or aesthetic purposes in an otherwise urban environment

Figure 4.48 Getting in touch with the natural environment can be an important factor that influences personal enjoyment.

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Activity 4.39

Check-in

1 Place all the physical activities from the current version of the Physical Education syllabus on the following continuum based on the type of environment they require.

Natural environment *(Totally unspoiled)*	Natural environment *(Minor adjustments)*	Built environment *(Oval)*	Built environment *(Indoor)*

2 For each factor below, provide one specific physical activity as an example of how the environment can act as a barrier to engagement in physical activity, and one activity that demonstrates how it can act as an enabler. Present your response as a table.

- **a** Australia's climate
- **b** Australia's low population density
- **c** the types of facilities built within the environment
- **d** the number of facilities built within the environment
- **e** the quality of facilities built within the environment.

3 Using a mapping search engine, such as Google Maps or Google Earth, investigate the natural and green space in your local area. Count the number of natural spaces (natural bushland) within 1 km and then 5 km of your house. Do the same for green space (allocated parks or ovals).

Activity 4.40

Check-in

Select one physical activity from the current version of the Physical Education syllabus and evaluate the significance of all factors presented in this chapter that influence your equity and access to physical activity by creating a table:

- with each of the four key factor categories – personal, social, cultural and environmental
- that has row for each factor that has been identified within each category (review each section of this chapter to identify these)
- that has a column to rate the level of influence each factor has (use the equity and access barometer in Figure 4.7 (on p. 173) to make this judgment)
- that has a column for a specific example from your life indicating how that factor acts as an enabler
- that has a column for a specific example from your life to show how that factor acts as a barrier.

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Inquiry cycle – stages 2 & 3: Apply and analyse; Evaluate and justify

In this section, you will be required to use the knowledge and understandings established about equity in physical activity to investigate factors that affect access, equity and engagement, and propose strategies to limit barriers and increase enablers in different contexts.

4.10 Diverse equity strategies: Factors affecting access, equity and engagement

Activity 4.41

Engage-in

RECOGNISE & EXPLAIN | ANALYSE & SYNTHESISE | EVALUATE | JUSTIFY | MAKE DECISIONS

Inquiry question: What factors influencing equity and access are most significant for your school population?

Engage and understand

1. In the first part of this chapter, key personal, social, cultural and environmental factors were presented that affect equity and access. List the headings and key factors identified for each of these categories.
2. As a class, create four groups and allocate a category to each group. Construct a survey to gather primary data on how each area is affecting equity and access. Each group must contribute 10 questions about its area to the survey. The goal of the survey is to identify common barriers to access and engagement.
3. Collate the questions and publish on a digital platform in order to survey as many respondents as possible. Remember to add key questions to highlight various demographics – age, sex, current level of participation.

Apply and analyse

4. Have students (and the broader community if possible) complete the survey.
5. Export the data gathered from the digital platform and have each group review the data for its area to identify patterns and trends with regard to barriers and enablers.

Evaluate and justify

KEY COGNITION

Make decisions: Select from available options; weigh up the positives and negatives of each option and consider all the alternatives to arrive at a position.

6. From the data gained, decide on five factors that tend to create barriers to access for local individuals or groups. Retain these data for use in the Active Investigation activities that follow, to assist in justifying any engagement strategies you develop.

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Personal factors affecting access, equity and engagement

Activity 4.42

Active investigation

Inquiry question: How realistic is personal preference as a strategy for enabling physical activity?

Engage and understand

1 Select any three physical activities that you would undertake in your next Physical Education lesson if you could wave a magic wand and do them – any activity at all.

2 Now select three activities in which you will engage over the next two Physical Education lessons. You will need to consider constraints such as facilities, equipment and teacher monitoring. Your activities must be approved by your teacher. You can choose to do individual activities or combine in small groups to play games. You can play competitive matches or participate informally with modified rules and spaces.

Apply and analyse

3 Undertake the three activities you have identified over the next two lessons. You can allocate even time to all of them or do some more than others, but this is your chance to do the activities you want, to the level you wish.

4 After the lessons, reflect on the level of enjoyment and engagement by rating each activity and noting the factors that influenced these. For example, 'Heightened enjoyment as I could stop and start as I pleased.' Link the factors noted from the class to the factors that affect equity and access.

5 Identify barriers that prevented higher level of participation during the lessons, or that shaped the decisions about the activities you would do – for example, 'I wanted to do Australian Rules Football but I did not have enough other players and the teacher was not qualified to oversee the game.'

Evaluate and justify

KEY COGNITION

Synthesise: Combine different parts or elements (e.g. information, ideas, components) into a whole, in order to create new understanding.

6 Personal preference is an enabler to physical activity engagement when individuals feel they have a choice about what and how they engage. In a 200-word response, and referencing the primary data collected during this activity, explain the barriers faced when providing personal preference as a strategy to increase access.

7 Present two recommendations that may help to limit any of the barriers identified in schools.

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Activity 4.43

Active investigation

Inquiry question: Does acknowledging differences in personal attitudes and values enhance engagement in physical activity?

Engage and understand

1 Engage in a physical activity for a lesson, then collect data from each individual on the following using a simple 1–5 scale:

- **a** enjoyment of activity
- **b** level of engagement and effort
- **c** value or worth they hold for the activity.

2 Collect primary class data on the most important aspect of engaging in physical activity – that is, what class members value most from their physical activity engagement. This might be:

- **a** high-level competition
- **b** rewards
- **c** fun
- **d** acknowledgement
- **e** inclusiveness.

3 In the following lesson, use the data gathered above to change the playing environment of your physical activity. Consider:

- **a** high-level competition (class rankings, competitiveness – knock-out competition)
- **b** rewards (competition with a prize, consider an 'A' and 'B' grade competition, random draws for prizes)
- **c** fun (change the rules, time, scoring system)
- **d** acknowledgement (everybody who reaches a certain level gets something – perhaps a prize, achievement certificate or recognition, or goes on parade)
- **e** inclusiveness (vary the organisation of rules/team structure/scoring so that everybody gets involved – for example, allocate a different scoring system so lower level students are worth more points if they score, or girls must touch the ball before a shot can be taken).

This could be done once for one aspect above or done five times, each time using a different strategy and then reflecting.

Apply and analyse

4 After engaging in each modified game, gather further primary data on the same three areas identified in task 1.

5 Analyse the data, looking for trends, specifically between the modified activity undertaken and students who identified this as an important feature for engagement in task 2.

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Evaluate and justify

Evaluate: Make an appraisal by weighing up or assessing strengths, implications and limitations; make judgments about the ideas, works, solutions or methods in relation to selected criteria; examine and determine the merit, value or significance of something, based on criteria.

6 In a 150-word statement, evaluate how effective catering for individual attitude is for enhancing engagement in physical activity.

Social factors affecting access, equity and engagement

Activity 4.44

Active investigation

Inquiry question: To what extent do peer preferences influence effort and engagement in physical activity?

Engage and understand

1 From earlier in the chapter, review the personal factors that affect the choice to access physical activity (consider confidence, self-concept and previous experience). Also look at the influence peers have on engagement as a social factor.

2 Select an activity in which to engage during the next two lessons based on majority rules.

3 Engage in the activity for the next two lessons, allowing people to sit out or engage as they want throughout.

Apply and analyse

4 Make notes on your own personal levels of enjoyment and engagement for the two lessons undertaken.

5 Identify any personal factors that contributed to your level of engagement.

6 Identify the positive or negative role your peers played in your level of engagement.

Evaluate and justify

7 Did the method of activity selected demonstrate equity? Why or why not?

Evaluate: Make an appraisal by weighing up or assessing strengths, implications and limitations; make judgments about the ideas, works, solutions or methods in relation to selected criteria; examine and determine the merit, value or significance of something, based on criteria.

(continued)

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8 Evaluate and justify how engaging the lessons were for you.
9 Identify links between the role played by peers in this activity and their role in physical activity engagement within the general population.

Activity 4.45

Active investigation

Inquiry question: To be formulated as part of the investigation

Engage and understand

1 As a class, select a specific physical activity for this investigation.
2 Think, pair, share to present strategies to modify the performance environment or rules, or provide constraints that would increase equity for the class group. With regard to equity, consider targeted strategies that embrace one of the following:
   a abilities within the activity – how the activity can be changed to be inclusive of all ability levels
   b enjoyment levels of the activity – how the activity can be changed to be more enjoyable for all participants
   c attitudes about the activity – how the activity can be changed to enhance the way the activity is viewed by the class.

   This may require some secondary research into strategies different sports use in these areas that could be modified for your class.
3 As a class, decide on one strategy to be implemented for each of the above categories.
4 Word an inquiry question that reflects what you intend to find out from implementing the selected strategy, and devise a method to collect primary data on the effectiveness of the strategy.

Note: this investigation could be undertaken with your own class, or three groups could be allocated an area each, develop their own strategy and simultaneously implement it with different junior Health and Physical Education classes to gauge its effectiveness for others.

Apply and analyse

5 Engage in the activity and collect pre- and post-data.
6 Analyse the data gathered to assess the effectiveness of the strategy used with regard to the area of equity it was trying to enhance.

Evaluate and justify

Justify: Give reasons or evidence to support an answer, response or conclusion; show or prove how an argument, statement or conclusion is right or reasonable.

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7 Justify what this investigation has established with regard to the inquiry question written earlier.
8 Make one recommendation on how the strategy could be improved to enhance the equity experienced by participants.

Cultural factors affecting access, equity and engagement

Activity 4.46

Active investigation

RECOGNISE & EXPLAIN | ANALYSE & SYNTHESISE | EVALUATE | JUSTIFY | MAKE DECISIONS

Inquiry question: Can removing institutional barriers increase ongoing engagement in physical activity?

Engage and understand

1 As a class, identify barriers that currently exist within the rules and routine practices of your school that prevent students from participating in lunchtime play for a specific physical activity.
2 Think, pair, share to develop a strategy to reduce these barriers and provide students with the opportunity to engage with the activity.
3 In the planning of your strategy, consider how to make the activity itself more engaging, how timing may be a factor and how to effectively promote your strategy.

Apply and analyse

4 Implement your engagement strategy, collecting pre- and post-data. Consider:

Pre-strategy:

- how much they have played before
- how much they value the activity
- how much they think they will enjoy being involved.

Post-strategy:

- whether they would do the activity again
- how the activity could have been better
- whether they like the activity more now
- whether they would be more likely to get involved in the future.

Note: you could split the class in half and have one group work with a popular sport (e.g. basketball) and one that is not so common (badminton/tennis/archery).

5 Consider collecting data from a sample of students in the school who did not attend to ascertain why they had been absent.

(continued)

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6 Analyse the data gathered to assess the effectiveness of the strategy for increasing engagement.

Evaluate and justify

Justify: Give reasons or evidence to support an answer, response or conclusion; show or prove how an argument, statement or conclusion is right or reasonable.

7 In a 300-word statement, justify the effectiveness of your strategy as a one-off event to decrease institutional barriers. Predict whether your strategy was able to increase ongoing engagement for the activity, and identify any strengths or weaknesses that would apply if your strategy were to become an ongoing event.

Activity 4.47

Active investigation

Inquiry question: How can effective equity strategies for engagement be developed within schools?

Engage and understand

1 For a specific physical activity that can be undertaken at school, identify a specific demographic (age, sex or ability) for which secondary data indicate there are access barriers.

2 Design a survey to collect primary data on the level of participation for students at your school and the barriers that may be hampering their engagement.

Apply and analyse

3 Undertake secondary research to design an equity strategy that is inclusive of students and encourage participation through the removal of identified barriers for the identified demographic.

4 Implement your equity strategy, collecting relevant pre- and post-data that will allow you to judge the effectiveness of your strategy.

Analyse: Examine or consider something in order to explain and interpret it, for the purpose of finding meaning or relationships and identifying patterns, similarities and differences.

5 Analyse the primary and secondary data collected to evaluate the effectiveness of the equity strategies in achieving a determined outcome.

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Evaluate and justify

6 In 500 words, do the following:

  a Using evidence from primary and secondary data on the barriers faced by your selected demographic, justify the development of your equity strategy.

  b Justify the maintenance or modification of your equity strategy based on evidence collected through implementation.

Environmental factors affecting access, equity and engagement

Activity 4.48

Active investigation

Inquiry question: What significance does the environment have on engagement in physical activity?

Engage and understand

1 Break a lesson into three segments and organise the class to participate in three different physical activities: one that is conducted indoors; one that requires an outdoor court or restricted area; and one that is played on a large, open field.

2 Before you begin the activities, take note of the time of day, temperature, wind conditions, humidity and general condition of the playing areas (hard, grassy, purpose built).

Apply and analyse

3 Engage in the three activities as fully as possible.

4 For each activity, collect primary data on the level of motivation, enjoyment and engagement of each student.

5 Analyse the data gathered, looking for trends. Consider the validity of your data by allowing for the external factors identified above.

Evaluate and justify

Consider: Think deliberately or carefully about something, typically before making a decision; take something into account when making a judgment; view attentively or scrutinise; reflect on.

6 Consider the primary data gathered and infer the impact the type of environment has on physical activity participation. Present your inference in an appropriate format, referring to the experiences that informed it.

7 Explore the participation rates of and the activities undertaken by teenage Australians. Group these activities together according to the types of environments in which they are undertaken. Link this secondary statistical data to your inference above.

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Activity 4.49

Active investigation

Inquiry question: What strategies can enhance access to natural areas or green space in your local area?

Engage and understand

1. Identify a natural area or allocated green space within walking distance of your school.
2. Over a series of lessons, undertake in-class excursions to explore this area and, where possible, engage in a variety of activities that can be undertaken within it.

Apply and analyse

3. As a class, use a SWOT analysis to evaluate the quality of the space identified and its ability to meet the physical activity needs of the surrounding community. Identify strengths, weaknesses, opportunities and threats.

Evaluate and justify

Appraise: Evaluate the worth, significance or status of something; judge or consider a text or piece of work.

4. In a 200-word statement, appraise the value of the space to the community. Consider how much it is being accessed, what activities are undertaken there, what barriers exist that may affect its use and whether it is being utilised effectively.
5. In 100 words, outline a proposal that would increase access to the area based on current engagement and perceived barriers. Consider improvement to facilities and a wider variety of activities, better local publicity or starting an activity group to use the space.

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Chapter summary

- Sports equity is about fairness in sport, equality of access, recognising inequalities and taking steps to address them; it is about changing the structure of sport to ensure that it becomes equally accessible to all members of society.
- Increased equity in physical activity provides greater access for individuals, providing more opportunities to engage at all levels.
- Many personal factors influence engagement with physical activity and the level to which an individual participates.
- The process by which an individual acquires the values, attitudes and behaviours that are acceptable to society is called socialisation.
- Social factors act as enablers or barriers to equity and access in physical activity when those around an individual either facilitate or restrict the opportunities presented to the individual.
- Parents play an essential role early in life by creating positive physical activity attitudes and behaviours, while in adolescence and throughout life, peers are a major influence.
- Access to physical activity increases when physical activity is inclusive of all individuals and the diverse range of factors that make them different.
- Cultural factors that influence equity and access to physical activity include the types of activities undertaken by the Australian population and how people engage with sport and recreation.
- Trends in Australian physical activity are showing a change in the type and amount of physical activity being undertaken.
- The distribution of government funding works as both an enabler and a barrier for individuals, depending on the benefit they experience.
- The media promotion and marketing of physical activity will serve as a barrier to those activities that suffer from poor media exposure.
- Policies, rules and routine practices of institutions need to reflect high levels of equity and create access for individuals; however, this can be difficult to achieve, given the diversity of individuals.
- The location, quantity and quality of the environments required to undertake physical activity act as an enabler or barrier to access to physical activity.

Chapter review

Multiple-choice questions

1 Sports equity is about:

A fairness in sport, equality of access and taking steps to address inequalities.

B increasing policies and procedures for individuals to adhere to.

C reducing access to individuals who show unacceptable behaviours and attitudes.

D reducing diversity and restricting multiculturalism.

2 Increasing access to physical activity does NOT include:

A more opportunities to participate.

B increased understanding of gender equity.

C increased opportunities to succeed.

D increased opportunities to develop skills.

3 A personal factor that influences physical activity engagement is:

A personality traits.

B friends.

C individual access to coaches.

D an individual's family.

4 Agents of socialisation are:

A clubs and other facilities that provide areas for players to meet.

B those through which an individual learns their values, attitudes and behaviours.

C barriers to physical activity that restrict the number of available participants.

D people who enable access to physical activity.

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5 A social factor that enables access to physical activity is:
  - **A** a good self-concept about sporting ability.
  - **B** positive gender stereotypes across society.
  - **C** accessing local clubs.
  - **D** having an effective coach.

6 Diversity and equity are linked through:
  - **A** inclusion.
  - **B** gender.
  - **C** socialisation.
  - **D** ethnicity.

7 The routine practices and rules of a school could be classified as which type of factor influencing equity and access?
  - **A** Personal factor
  - **B** Social factor
  - **C** Cultural factor
  - **D** Environmental factor

8 The media:
  - **A** present role models to positively influence the socialisation process.
  - **B** reflect the physical activities most valued by their audience.
  - **C** enable access and opportunities for all physical activities.
  - **D** by saturating an individual's life, act as a limiting factor in the socialisation process.

9 Which of the following is not a type of natural environment or green space?
  - **A** A local park with recreational equipment
  - **B** Natural bushland
  - **C** A swimming pool
  - **D** A golf course

10 An enabler to physical activity is a factor that:
  - **A** increases equity by allowing for the diversity of individuals.
  - **B** decreases the language in policies that is exclusionary to individuals or groups.
  - **C** provides greater opportunities to engage in physical activity.
  - **D** all of the above.

Short-answer questions

1 Explain why equity is an important consideration in contemporary Australian physical activity.

2 Select one personal factor that has significantly negatively affected your engagement in a specific physical activity and provide examples to demonstrate how this factor has acted as a barrier for you.

3 Select an attitude that you have towards physical activity and use examples from your own socialisation process to highlight how this attitude has developed for you.

4 Using one example from a sporting club and one from school, explain how policies and rules can be used to enhance equity.

5 Select a physical activity and evaluate the impact that environmental factors have had on your opportunities for engagement.

Extended-response questions

1 Use primary and secondary data to justify the selection of any three factors that have acted as significant barriers to accessing a specific physical activity in your local area.

2 Select either social or cultural factors that influence equity and access. Evaluate the selected factors and justify those that have acted as a significant enabler to one of the physical activities in the current version of the Physical Education syllabus.

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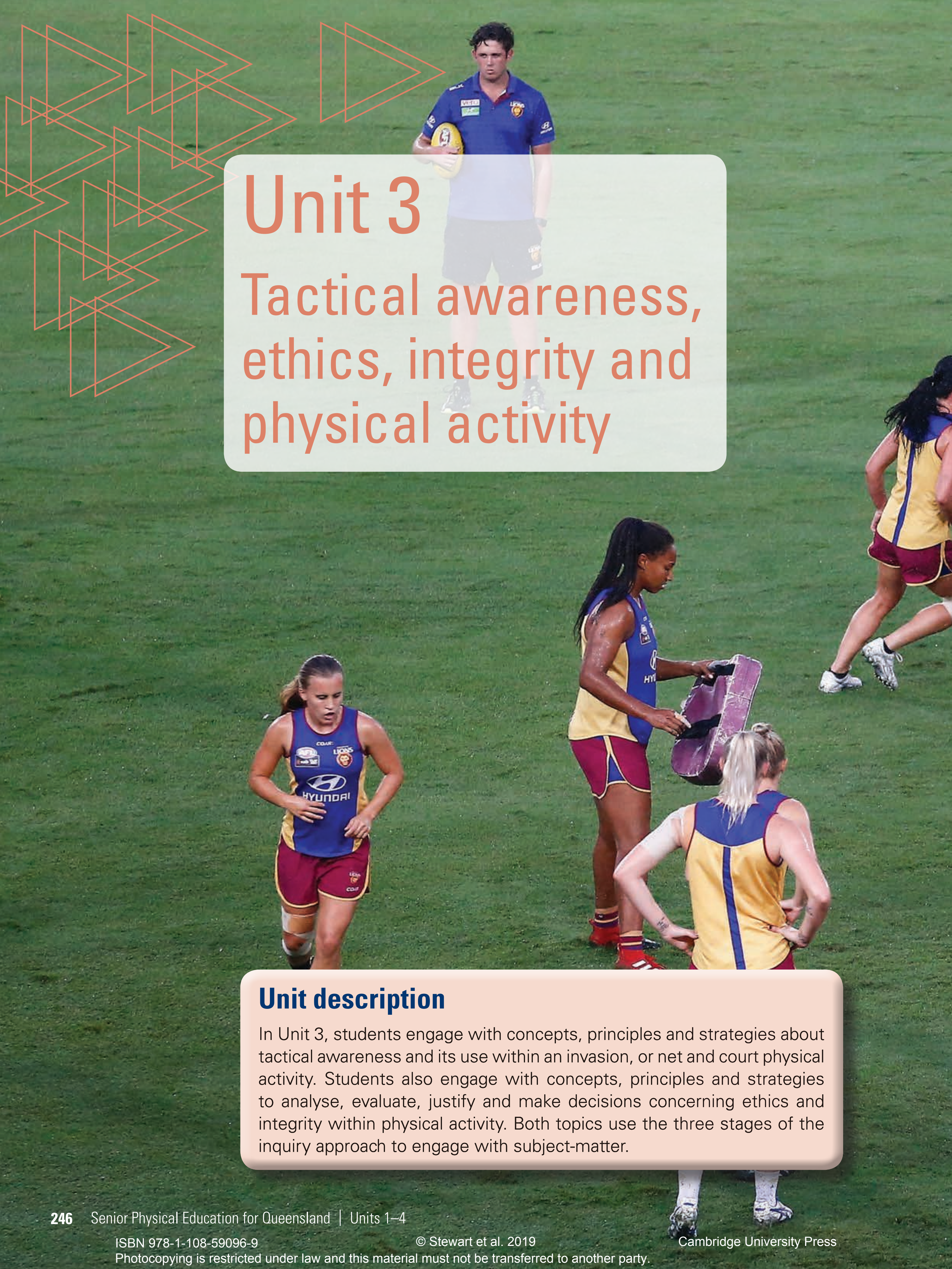

Unit 3

Tactical awareness, ethics, integrity and physical activity

Unit description

In Unit 3, students engage with concepts, principles and strategies about tactical awareness and its use within an invasion, or net and court physical activity. Students also engage with concepts, principles and strategies to analyse, evaluate, justify and make decisions concerning ethics and integrity within physical activity. Both topics use the three stages of the inquiry approach to engage with subject-matter.

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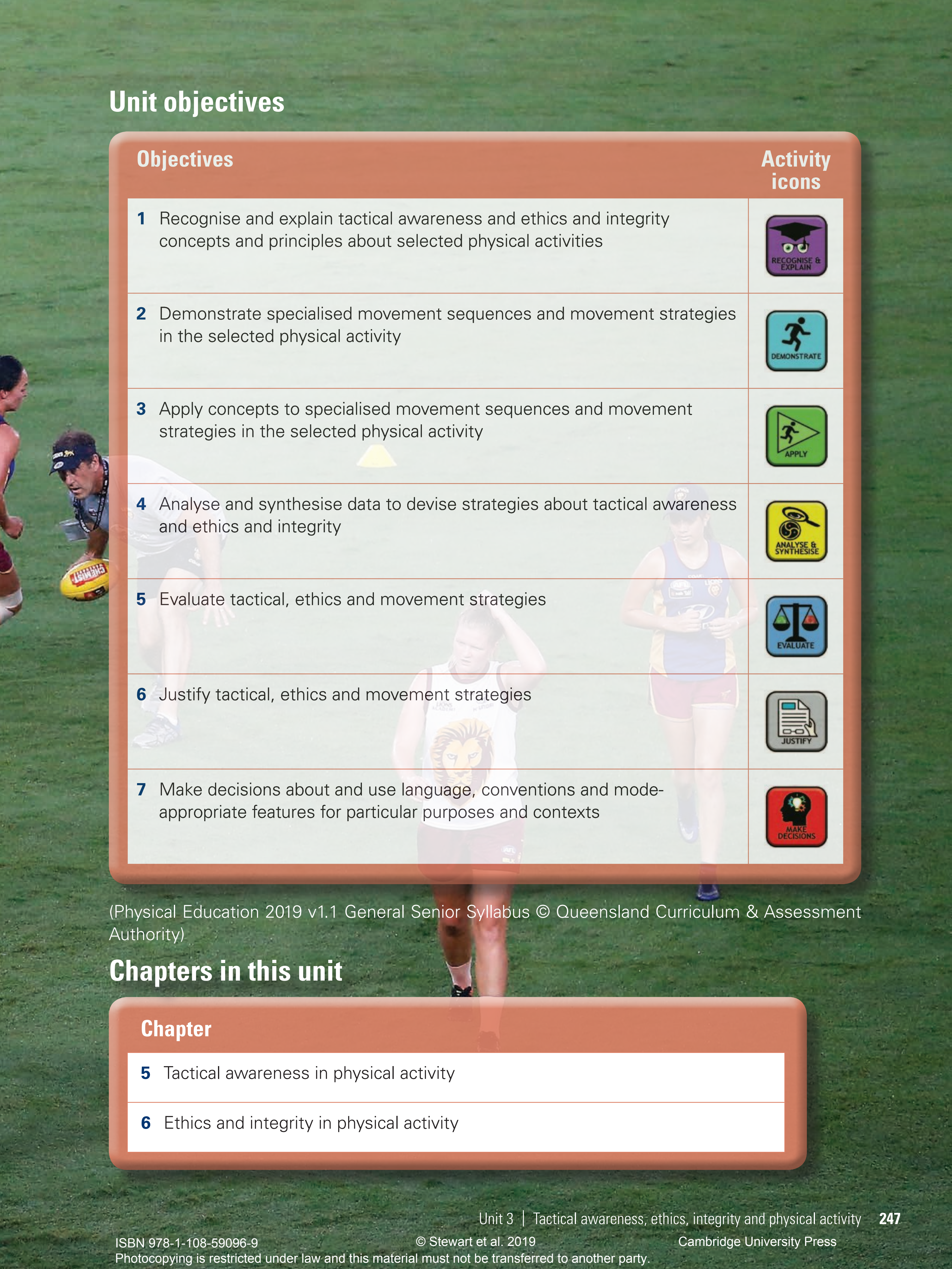

Unit objectives

Objectives	Activity icons
1 Recognise and explain tactical awareness and ethics and integrity concepts and principles about selected physical activities	RECOGNISE & EXPLAIN
2 Demonstrate specialised movement sequences and movement strategies in the selected physical activity	DEMONSTRATE
3 Apply concepts to specialised movement sequences and movement strategies in the selected physical activity	APPLY
4 Analyse and synthesise data to devise strategies about tactical awareness and ethics and integrity	ANALYSE & SYNTHESISE
5 Evaluate tactical, ethics and movement strategies	EVALUATE
6 Justify tactical, ethics and movement strategies	JUSTIFY
7 Make decisions about and use language, conventions and mode-appropriate features for particular purposes and contexts	MAKE DECISIONS

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Chapters in this unit

Chapter
5 Tactical awareness in physical activity
6 Ethics and integrity in physical activity

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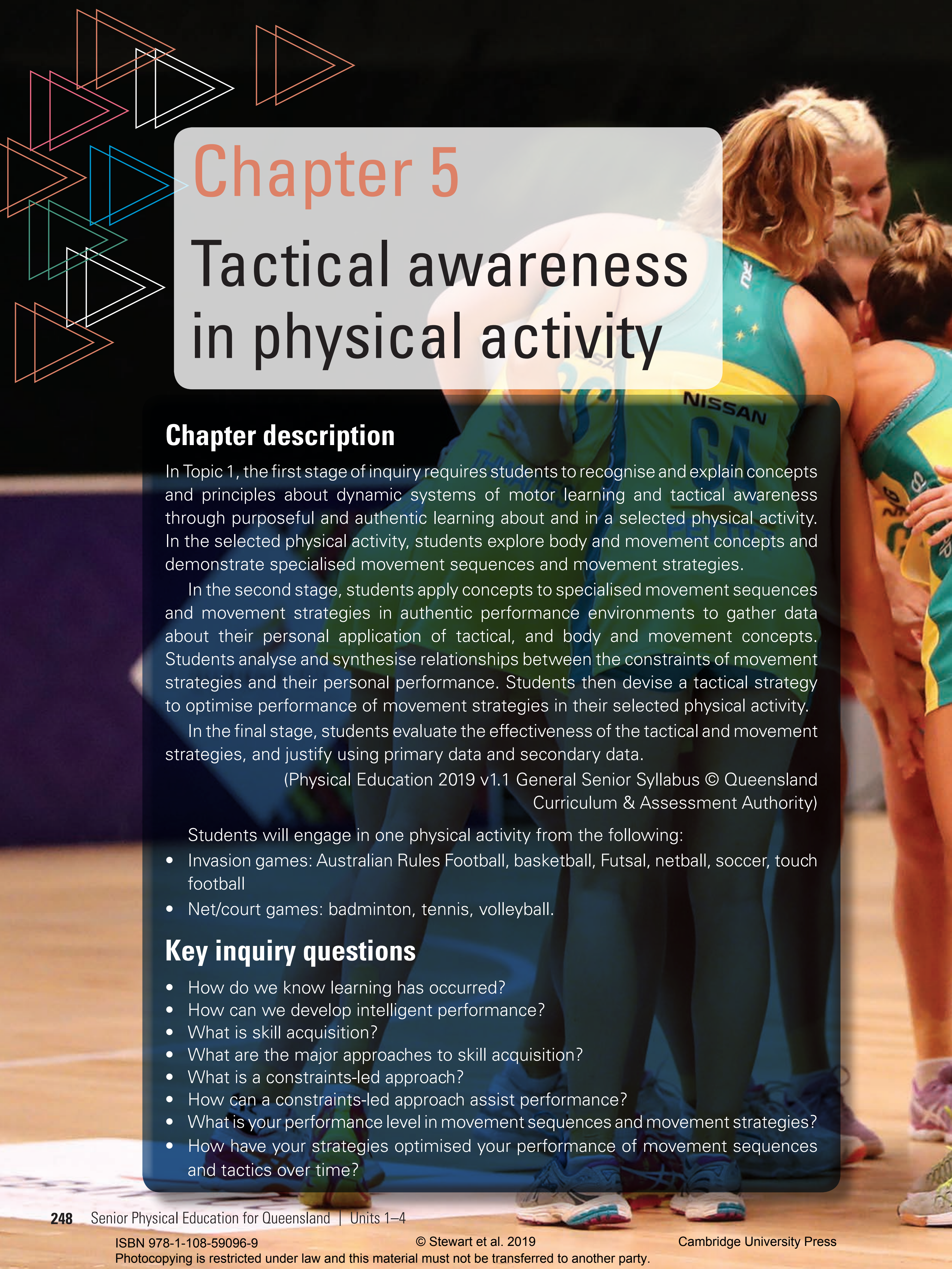

Chapter 5

Tactical awareness in physical activity

Chapter description

In Topic 1, the first stage of inquiry requires students to recognise and explain concepts and principles about dynamic systems of motor learning and tactical awareness through purposeful and authentic learning about and in a selected physical activity. In the selected physical activity, students explore body and movement concepts and demonstrate specialised movement sequences and movement strategies.

In the second stage, students apply concepts to specialised movement sequences and movement strategies in authentic performance environments to gather data about their personal application of tactical, and body and movement concepts. Students analyse and synthesise relationships between the constraints of movement strategies and their personal performance. Students then devise a tactical strategy to optimise performance of movement strategies in their selected physical activity.

In the final stage, students evaluate the effectiveness of the tactical and movement strategies, and justify using primary data and secondary data.

(Physical Education 2019 v1.1 General Senior Syllabus © Queensland Curriculum & Assessment Authority)

Students will engage in one physical activity from the following:

- Invasion games: Australian Rules Football, basketball, Futsal, netball, soccer, touch football
- Net/court games: badminton, tennis, volleyball.

Key inquiry questions

- How do we know learning has occurred?
- How can we develop intelligent performance?
- What is skill acquisition?
- What are the major approaches to skill acquisition?
- What is a constraints-led approach?
- How can a constraints-led approach assist performance?
- What is your performance level in movement sequences and movement strategies?
- How have your strategies optimised your performance of movement sequences and tactics over time?

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Key terminology

affordances
cognitive systems approach
constraints
deliberate practice
dynamic systems
ecological psychology
environmental constraints
intelligent performance
invasion games
motor learning
principles of play
tactical awareness
technical ability

Introduction

Being physically educated involves developing knowledge in the biophysical, sociocultural and psychological domains that underpin physical activity and using this knowledge to maximise enjoyment, engagement and physical performance for yourself and others. The physically educated become advocates for both the social and physical importance of being physically active.

This chapter explores tactical awareness as a key element within the biophysical sub-discipline of physical activity. It is through an understanding of tactical awareness that intelligent performers are created. Intelligent performers of physical activity are not 'passive participants'. While a passive participant allows game situations to unfold and then reacts to circumstances, an intelligent performer demonstrates game awareness and works to be proactive throughout their participation. They strive to 'read the play' in order to manipulate circumstances to their advantage, and have the skills and tactics to do this. These athletes can identify affordances, make effective decisions and manipulate technical and tactical aspects to maximise their own performance and that of their team.

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Inquiry cycle – stage 1: Engage and understand

5.1 Dynamic systems approach to motor learning

Motor learning has many definitions, stages and influences upon it. Learning can be considered to have occurred when the individual acquires skill, information or knowledge. This chapter will build upon the *dynamic systems approach* to motor learning established in Chapter 1, and focus specifically on tactical awareness. Before developing **tactical awareness**, it is relevant to revisit key aspects from Chapter 1. Remember that learning is non-linear in nature. The learner's ability to achieve a goal is not static, and may vary on the basis of many factors involving the individual, the task and the environment.

Newell's model of motor learning involves the stages of: assembly of a coordinative structure; gaining control of coordinative structure; and skilled optimisation. Importantly, according to modern systems theory, an individual shows learning when they know where in an environment to search for **affordances** that will allow them to achieve a goal. This underlying knowledge is important as individuals now aim to develop as *intelligent performers* through the manipulation of their **technical ability** and tactical ability.

motor learning the study of the processes involved in acquiring and refining skills; the field of study concerned with understanding changes in motor control

tactical awareness knowing what is happening around you and what options are available (affordances), then selecting (and appropriately adapting) a motor sequence that will be successful

affordances environmental characteristics that offer opportunity for action

technical ability the level to which a specialised movement sequence has been refined in order to produce consistently successful outcomes

> Movement systems do not have fixed coordination patterns which are somehow stored in their memories …. Instead, they exhibit coordination tendencies as parts come together long enough to form a functional movement pattern that can achieve a performance goal under specific environmental circumstances.
>
> *Davids, Button and Bennett (2008)*

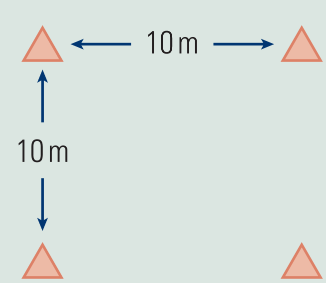
Activity 5.1

Engage-in

Inquiry question: How does tactical awareness contribute to being an intelligent performer?

RECOGNISE & EXPLAIN   DEMONSTRATE

Engage and understand



1 Participate in a game of 'Keep Away'.

Aim: keep the ball away from the defender

Three attackers vs. one defender

Equipment: 1 ball, 4 markers

Space: 10 m × 10 m square as a playing area

Rules: no contact, three-minute engagement.

Change rules: must make four passes; three-minute engagement

Change rules: no running with ball; three-minute engagement

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Apply and analyse

Apply: Use knowledge and understanding in response to a given situation or circumstance; carry out or use a procedure in a given or particular situation

2 Undertake a post-match reflection on the following.

a What strategies proved to be successful for you or your team?

b What other strategies could have been an option?

c What characteristics of 'Keep Away' make it an **invasion game**?

d Create a mind map highlighting the **principles of play** that are reflected in the 'Keep Away' game.

Evaluate and justify

3 Using examples from the 'Keep Away' game, evaluate how tactical awareness is a key component for **intelligent performance**.

invasion game a game where the aim is to attack an opponent's territory and score a goal or point

principles of play similar characteristics or tactical components in the game; include setting up attack, defending against attack, creating, defending and exploiting space, attacking opposition space and scoring

intelligent performance manipulation of rules, time, score, principles of play, affordances – technical and tactical, individual + team; limitations – technical and tactical, individual + team

Figure 5.1 Australia and Ireland compete against each other in an annual International Rules series.

Activity 5.2

Engage-in

Inquiry question: Does motor program practice in a closed environment develop skilled performances?

Option A – invasion games

Engage and understand

This activity can be applied across any invasion game with some simple adaptations, focusing on either kicking or passing.

Participate in Drill 1 and Drill 2.

Aim: To develop technical ability

Equipment: 2 balls, 8 markers

Space: Drill 1 – 10 m, Drill 2 – 10 m × 10 m grid

Rules: no contact, no running with the ball

(continued)

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1 **Drill 1:** Use the equipment to set up a receiving zone 10 m apart. In pairs, complete 60 stationary passes which are received inside the zone. Identify what was needed to complete this task successfully in comparison to a game situation. Consider, tracking the ball, tracking of team member, tracking of opponent, movement to space.

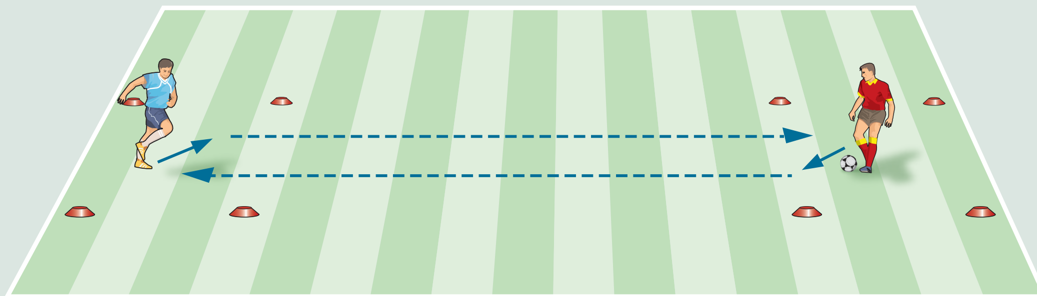

Figure 5.2 Drill 1 as a soccer activity

2 **Drill 2:** Use the equipment to set up a 10 m × 10 m grid. In fours, complete 60 passes to a moving player around the outside of the grid, by passing the ball anticlockwise. The receiver should move off their marker to receive the ball in front as they move towards the next marker, then immediately look to pass the ball to the next player who is also leading. Identify what was needed to complete this task successfully in comparison to a game situation. Consider, tracking the ball, tracking of team member, tracking of opponent, movement to space.

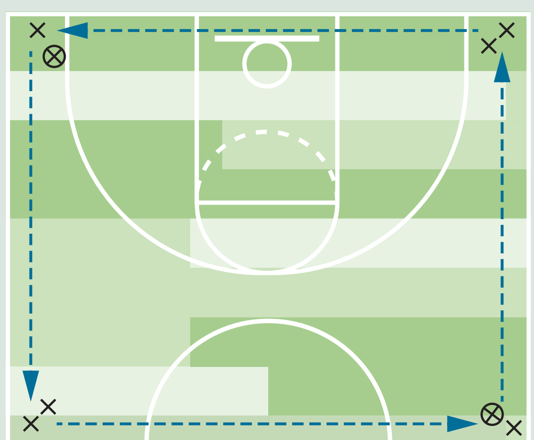

Figure 5.3 Drill 2 as a basketball activity. This could be a straight passing activity in a 10 m × 10 m grid, or dribble and pass using a half court.

Apply and analyse

Analyse: Examine or consider something in order to explain and interpret it, for the purpose of finding meaning or relationships and identifying patterns, similarities and differences.

3 Post drills reflect on the following:

a Was technical ability developed in each drill?

b How closely aligned were the tasks to a game environment?

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c Consider what other factors are involved when successfully completing these techniques in a game environment?

d How do these other factors affect the successful performance of the skill?

Option B – net and court games

Engage and understand

Participate in Drill 1 and Drill 2

Aim: Develop technical ability of setting in volleyball

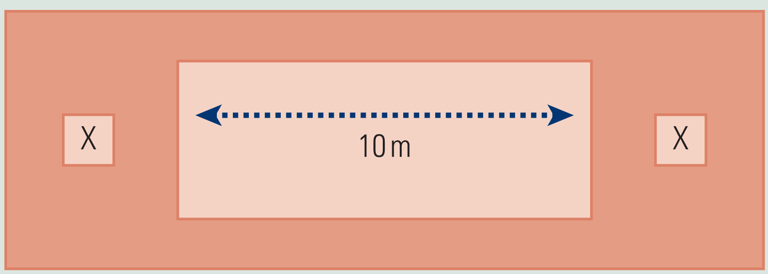
Equipment: 1 ball

Space: Drill 1 – 10 m, Drill 2 – 10 m × 10 m grid

Teacher explains three key points of passing.

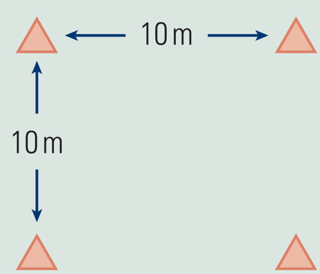
4 **Drill 1:** Complete 60 stationary set passes in pairs. If ball drops, start again. Identify what was needed to complete the task successfully – for example, tracking of ball, tracking of team member, tracking of opponent, movement into space.

Continue drill for 10 minutes.



5 **Drill 2:** Complete 60 set passes in pairs. Pass around the grid. Once you have passed the ball, go to where you passed it. If the ball drops, start again. Identify what was needed to complete the task successfully – for example, tracking of ball, tracking of team member, tracking of opponent, movement into space.

Continue drill for 10 minutes.



Apply and analyse

6 After the drills, reflect on the following:

> *Analyse: Examine or consider something in order to explain and interpret it, for the purpose of finding meaning or relationships and identifying patterns, similarities and differences.*

a Was technical ability developed in each drill?

b How closely aligned were the tasks to a game environment?

c Consider what other factors are involved when successfully completing these techniques in a game environment. How do these other factors affect the successful completion of the skill?

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Activity 5.2 highlights a more traditional approach to developing technical ability. However, it has previously been discussed that these skill–drill game type practice scenarios are not ideal for developing tactical awareness, and therefore are not likely to produce intelligent performance. For intelligence performance to develop, a learner must be exposed to more contemporary training activities.

Activity 5.3

Engage-in

Inquiry question: What is intelligent performance?

RECOGNISE & EXPLAIN

ANALYSE & SYNTHESISE

Engage and understand

Read the following excerpt:

What is intelligent performance?

Before we can discuss how to develop intelligent performance we first need to try to define intelligent game play. To exemplify some of the issues, we will look at what on face value would seem to be a straightforward exercise, a typical 2 vs. 1 in Rugby. A Rugby player who draws the defender and then passes the ball to his team mate when faced with a 2 on 1 attacking opportunity could be said to have made an intelligent choice – or perhaps not! This is because the **individual constraints**, **task constraints** and **environmental constraints** in any specific performance must be considered when judging the appropriateness of a decision. In our example, the player on the ball may not have the perceptual skills to (a) spot the isolated defender or (b) the technical skill to have the ability to pass the ball accurately or with the required speed to the player as the pass needs to be made with his weaker left hand. In this situation, the better option for the attacker might be to attempt to feint a pass and then beat the opponent using his superior side step. Similarly, the action capabilities of teammates and opponents will impact on the decision-making process of the player. For example, if the team mate is much slower than the defender, giving him the ball could result in the attack failing. The task constraints, i.e. the state of the game and the position on the pitch must be considered. Finally, the environmental conditions will influence the final decision. The wind may be so strong that a pass of more than a few metres would be blown off line and have little chance of ever reaching the team mate. In summary, what should be clear from this discussion is that movement solutions will vary as each individual strives to satisfy the unique constraints on him/her. Additionally, small changes to individual structural or functional constraints (such as increased strength), task rules or equipment, or environmental constraints can lead to dramatic changes in movement patterns adopted by learners to solve performance problems.

Source: Renshaw and Clancy (2008, pp. 2–3).

individual constraints the unique mental and physical abilities of the individual that affect their decision-making and movement patterns, and that can be displayed during performance

task constraints the rules, equipment and goal or purpose of an activity that limit the decision-making and movement patterns that can be displayed by an individual during performance

environmental constraints the social or situational factors that limit the decision-making and movement patterns that can be displayed by an individual during performance

1. Examine the information from the above source and construct a table with headings of Task, Learner and Environmental constraints.
2. Formulate examples of constraints that might be able to be categorised under each heading.

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Apply and analyse

Analyse: Examine or consider something in order to explain and interpret it, for the purpose of finding meaning or relationships and identifying patterns, similarities and differences.

3 Consider and explain how this information may affect the learning environment.

4 Identify what changes you would make to the tasks in Activity 5.2 (on pp. 251–3) to facilitate intelligent performance.

5 Examine the following learning environments and analyse whether intelligent performance would be developed:

- **a** practising forward defensive shots in cricket batting when facing a bowling machine
- **b** practising 100 jump shots from the top of the key way
- **c** playing 1 vs. 1 basketball in a half court
- **d** playing 4 vs. 4 touch in a park of approximately 20 m × 20 m.

Activity 5.3 has enabled reflection on the more traditional method of skill development and considered what intelligent performance is. The following activities present a more modern approach to developing skills.

Activity 5.4

Engage-in

Inquiry question: Is it possible to develop technical learning in open environments?

Option A – invasion games

Engage and understand

1 Participate in a small-sided game – 3 vs. 3 of End Ball

Aim: Score by passing the ball to own team member over the line.

Equipment: 1 ball, 4 markers

Space: 30 m × 15 m grid

Rules for Australian Rules Football, basketball, netball and touch – initial rules are:

- **a** Ball must be passed on the full.
- **b** If ball is knocked down by an opponent, you maintain possession.
- **c** If your team drops the ball, the opponents receive possession.
- **d** When you catch the ball, you must stand still but may pivot on the spot.
- **e** Defenders cannot contact the player in possession and must be 1 m away.

Rules for Futsal and soccer – initial rules are:

- **a** Ball must be kicked.
- **b** When in possession, players cannot dribble the ball; they trap the ball and stand still, but may pivot around the ball to pass.
- **c** A defender must be a minimum of 1 m away.
- **d** If a team member does not stop the ball, possession is lost.

(continued)

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2 Teacher explains three key points of passing.

Game 1: Play for 15 minutes.

Game 2: Change of team numbers to End Ball 5 vs. 5. Change the scoring system so points scored in the corner are worth more, play the game for 15 minutes.

Score zone worth 2 points	Score zone worth 1 point	Score zone worth 2 points

Game 3: End Ball 5 vs. 5 – For Australian Rules Football, basketball, netball and touch football.

Change of scoring system: different points system, dependent on type of pass used – for example, Australian Rules Football: using a kick to pass instead of a handball is worth three points; pass over 10 m worth three points, for Futsal and soccer – change of rules: when in possession, players cannot dribble the ball but are only allowed two touches (two contacts with the ball).

Play game for 15 minutes.

Apply and analyse

KEY COGNITION

Make decisions: Select from available options; weigh up positives and negatives of each option and consider all the alternatives to arrive at a position.

3 Post-game reflection on the following:

- **a** Identify what was needed to complete the task successfully.
- **b** Review critically how well you, your partner and your team 'cheated'/manipulated rules for an affordance/advantage.
- **c** Make a decision about your and your team's demonstration of intelligent performance in Activity 5.4.

Option B – net and court games

Engage and understand

4 **Game 1**: Participate in a small sided game – 5 vs. 5 Newcombe Ball

Aim: To have the ball hit the floor inside the court on the opposite side of the net

Equipment: 1 ball

Space: 1 volleyball court or similar

Rules:

- Each point begins with the ball being thrown from behind the baseline.
- Team catches the ball.
- Team is allowed to have three catches on their side of the net.
- Cannot move with the ball.

Teacher explains three key points of passing.

Play game for 15 minutes.

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5 **Game 2**: Participate in a small sided game – One-Bounce Volleyball

To have the ball hit the floor inside the court on the opposite side of the net

Equipment: 1 ball

Space: 1 volleyball court or similar

Rules:

- Each point begins with the ball being thrown from behind the baseline.
- The ball cannot be caught, and must be hit – dig, set or spike.
- Ball is allowed to bounce once between each shot.
- Team is allowed to have three shots on its side of the net.

Teacher explains three key points of passing.

Play game for 15 minutes.

Apply and analyse

Make decisions: Select from available options; weigh up positives and negatives of each option and consider all the alternatives to arrive at a position.

6 Post-game reflection on the following:

a Identify what was needed to complete the task successfully.

b Review critically how well you, your partner and your team 'cheated'/manipulated rules for an affordance/advantage.

c Make a decision about how you and your team demonstrated intelligent performance in Activity 5.4.

Note: remember the following, intelligent performance = manipulation of rules, time, score, principles of play, affordances – technical and tactical, individual + team, limitations – technical and tactical, individual + team.

Activity 5.5

Check-in

1 Summarise what learning is and how we know it has occurred.

2 Describe what a learning experience using a more cognitive approach to learning would look like.

3 Create a diagrammatical representation of intelligent performance, including a description of the factors that impact it.

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How can we develop intelligent performance?

> Intelligent performance can be developed by creative coaching that promotes emergent decision making through a process of attunement to key information available in the performance environment. This process can only take place if the practice environments are representative of the performance environment with all key information sources present. Coaches should create variability in the practice environment by manipulating individual, task and environmental constraints forcing performers to explore the practice environment and come up with new functional solutions.
>
> *Renshaw and Clancy (2016, pp. 4–5).*

From the information previously provided, it is important to note that by not prescribing solutions, individuals will find the optimal solution based on self, teammates and desired goal. Constraints enable the emergence of movement behaviours or affordances. Constraints are the variables that affect the successful completion of a task within an environment. Constraints can both enable and limit performance. This has implications for teachers/coaches, who may manipulate task constraints within learning scenarios so that emergent affordances can occur.

Environmental constraints are limitations on strategy options due to external factors that focus on achieving optimal solutions. Figure 5.5 illustrates the task of scoring in touch. Listed are some environmental constraints that may need to be considered to solve the problem.

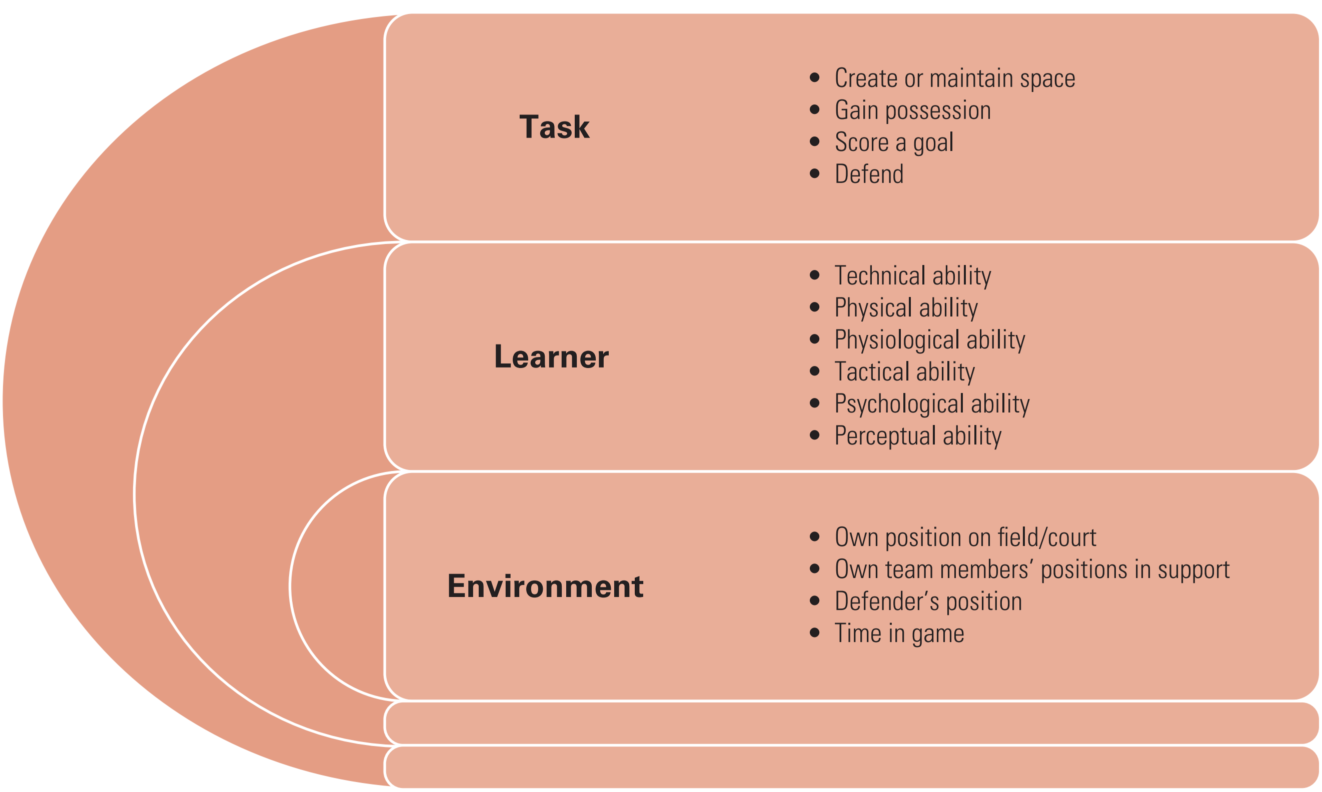

Figure 5.4 Finding an optimal solution

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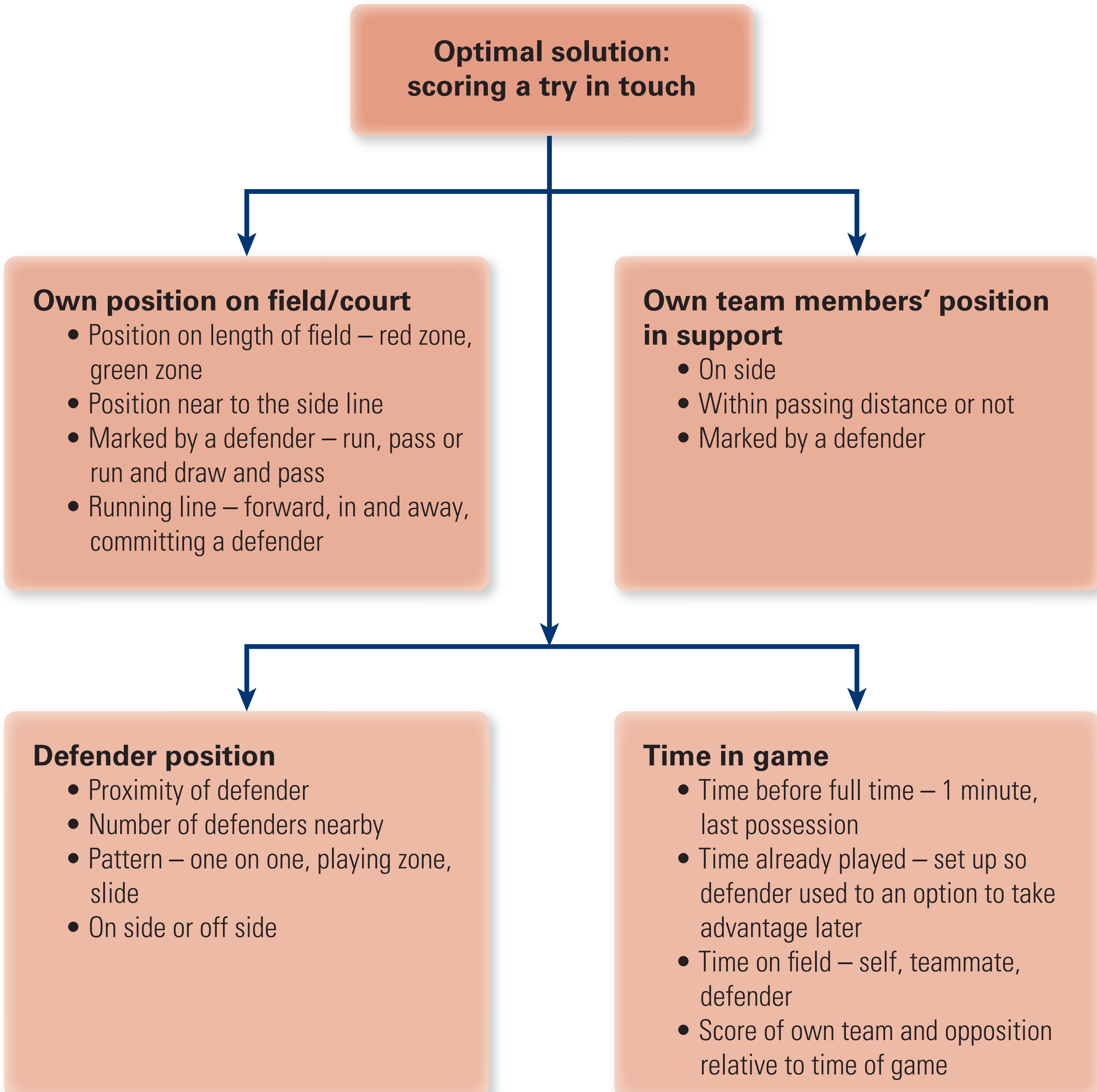

Figure 5.5 Environmental constraints to consider when attempting to score a try

> The process of skill acquisition is distinct from execution of the skill (motor control) in that learning is a gradual process that occurs over many performance attempts, resulting in behavior that is less vulnerable to transitory factors such as fatigue, audience effects, and anxiety.
>
> *Source: Davids, Button and Bennett (2008, p. 4).*

Learning scenarios or practice with variations, whereby students make decisions and receive immediate feedback on the success of tactical and technical choices, is preferred. It is inherent that errors will occur as part of the learning process. As Yoda states in *Star Wars: The Last Jedi*, 'The greatest teacher, failure is.'

Therefore, a strategy of multiple attempts with a number of variable solutions based on solving the specific problem at that moment is preferred – for example, in 3 vs. 3 touch, the defender's position has changed.

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Activity 5.6

Engage-in

Inquiry question: What is involved in developing technical ability in authentic environments?

Apply and analyse

1 Determine which tasks in Activities 5.2 (on pp. 251–3) and 5.4 (pp. 255–7) were linear in nature and which were non-linear.

- *Linear learning*: the cognitive concept that learning progresses with ongoing improvement from beginner to expert as experience is gained.
- *Non-linear learning*: the dynamic systems concept that motor learning will progress and regress as a performer trials different solutions in various contexts in order to find success.

2 Review the current version of the Physical Education syllabus and recall characteristics of either invasion or net and court games, as relevant to the physical activity you are currently studying.

3 Play a game of End Ball for 15 minutes. Every five minutes, implement a change – for example, complete using a touch ball, netball, ultimate disc.

4 Analyse and explain what you needed to do to ensure an accurate, effective catch and pass, and the factors that affected this – for example, tracking the ball in flight as it was passed to you. Graphically represent your knowledge by using a mind map with the central theme of successfully catching and passing the ball within the game environment.

5 Justify why it is more beneficial to ensure that training activities align with authentic game environments using examples for your own experiences in Activities 5.1 (on pp. 250–1) and 5.2.

6 Reflect on what is involved in developing technical ability in authentic environments.

Activity 5.7

Engage-in

Inquiry question: How do we develop tactical understanding and awareness?

Engage and understand

Watch the video on costraints learning vs. isolated practice, available at www.cambridge.edu.au/redirect/8041, and answer the following questions.

Summarise: Give a brief statement of a general theme or major point(s); present ideas and information in fewer words and in sequence.

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1 Summarise data from the following sections:
   - a Introduction
   - b Skill and training
   - c Procedures: Closed drills and open drills
   - d Skill demands
   - e Discussion.

Apply and analyse

2 Appraise the difference between closed and open drills and assess their value in developing tactical awareness.

Figure 5.6 Rachel Jarry of Australia shoots under pressure from Sasa Cado of Serbia

Activity 5.8

Engage-in

RECOGNISE & EXPLAIN | ANALYSE & SYNTHESISE | DEMONSTRATE

Inquiry question: How do you perform in authentic environments?

Engage and understand

1 Capture digital evidence of your performance in a variety of modified game and match situations. Consider 1 vs. 1, 2 vs. 2, 3 vs. 3 situations as appropriate for your physical activity of study. Ensure digital evidence is stored in at least two locations for review, comparison and contrast later in the unit in preparation for assessment.

Apply and analyse

KEY COGNITION

Critique: Review (e.g. a theory, practice, performance) in a detailed, analytical and critical way.

2 Critique the digital data and justify two technical and two tactical strengths and weaknesses of your play, citing specific examples from the footage.

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Figure 5.7 Professional athletes, such as volleyball players, develop coordination patterns that they can adapt to many conditions.

5.2 Two major approaches to investigating skill acquisition

What is skill acquisition?

Skill acquisition requires us to interact effectively with our environment, detect important information, and time our responses appropriately. It thus should result in coordination patterns that are adaptable to a range of varying performance characteristics. Adaptive behavior is important because conditions like the environment, task requirements, and our motivations can change every time we perform a motor skill.

Source: Davids, Bennett and Newell (2006).

Cognitive and experimental psychology … refers to the establishment of an internal state or representation of an act which is believed to be acquired as a result of learning and task experience … ecological perspective which suggests that the term skill acquisition may not refer to an entity but rather to the emergence of an adaptive, functional relationship between an organism and its environment … In this respect, the terms 'skill adaptation' or 'skill attunement' might be more suitable to describe this process.

Source: Araújo and Davids (2011, p. 1).

What are the major approaches to skill acquisition?

Two major approaches investigating motor learning are the cognitive systems approach and dynamic systems theory.

Cognitive systems approach to motor learning

The **cognitive systems approach** is a more traditional approach to motor learning, based on earlier motor learning theories presented through the 1960s. This approach may be seen as similar to a computer processing information, and generally includes two underlying

cognitive systems approach acquisition of information-processing abilities

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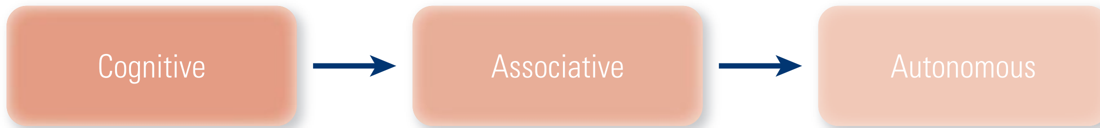

Figure 5.8 Fitts and Posner's stages of learning model

concepts. The first is that learning occurs as a result of feedback following a process of input of information to the brain from the environment (ascertaining what is occurring), processing of the information by the brain (deciding what movement is required) and an output (executing the movement). This concept of information processing relies on a top-down hierarchical control system with cognitive processes of the brain used to coordinate skilful movement patterns. The second concept is that learning from information processing changes over time as a learner progresses from beginner to expert. This concept is described through Fitts and Posner's stages of learning model, which highlights different learning characteristics as an individual transitions through the cognitive and associative stages to become autonomous. Chapter 1 provides a full explanation of the cognitive systems approach.

From this early work on motor learning, our understanding of motor development has changed, and in recent years the effectiveness of the cognitive systems approach has been questioned. New theories have developed to describe how people learn motor skills. It is now widely accepted that a contemporary dynamic systems approach to motor learning more effectively describes the motor learning process.

A dynamic systems approach to motor learning

The dynamic systems theory views an athlete as a complex system with many components impacting it. This concept requires the learner to adapt their motor responses in accordance with variations in the task, themselves and the environment to provide a successful solution to the problem or challenge the situation has presented. It also highlights that a successful solution to a situation may not be one specific skill; rather, success could be achieved through multiple alternatives, all of which may produce a successful outcome. Its basic underlying assumption about learners more accurately describes the thinking and actions of humans during physical performance, particularly in open and *dynamic performance* environments.

The notion of multiple solutions to the same situational problem also incorporates the concept that learning is **non-linear** – that, while learning and experimenting with skills, an individual may show progress, but then revert as technical proficiency is sought through refining techniques or when implementing different tactical strategies. Due to the non-linear nature of the dynamic systems approach, it is more closely aligned with Newell's stages of learning based on Bernstein's degrees of freedom.

non-linear not in a continuous straight line, which may involve peaks and lows of performance

The first stage of Newell's stages of learning model is assembling a coordination pattern, which involves the athlete aiming to establish a basic relationship among the key components of the task, environment and themself as the learner. This is characterised by a limited degree of freedom while assembling appropriate body actions to complete the task. The second stage is gaining control of coordination structure: this advantages a tighter fit between the assembled co-coordinative structure and the performance environment. The final stage is the skilled optimisation of control stage, where the athlete is more flexible and open to exploiting environmental information sources, thus enhancing efficiency and control. Athletes are able to exploit their own and team members' positions based on opponents and manipulate task execution based on their own strengths and weaknesses.

As learning is non-linear within the dynamic systems approach, learning activities tend to promote holistic learning, where skills are not separated for practice, but technical and tactical components are instead developed simultaneously through modified game-like scenarios. Dynamic interactions through activities can produce rich responses through self-organisation within complex systems. This system is

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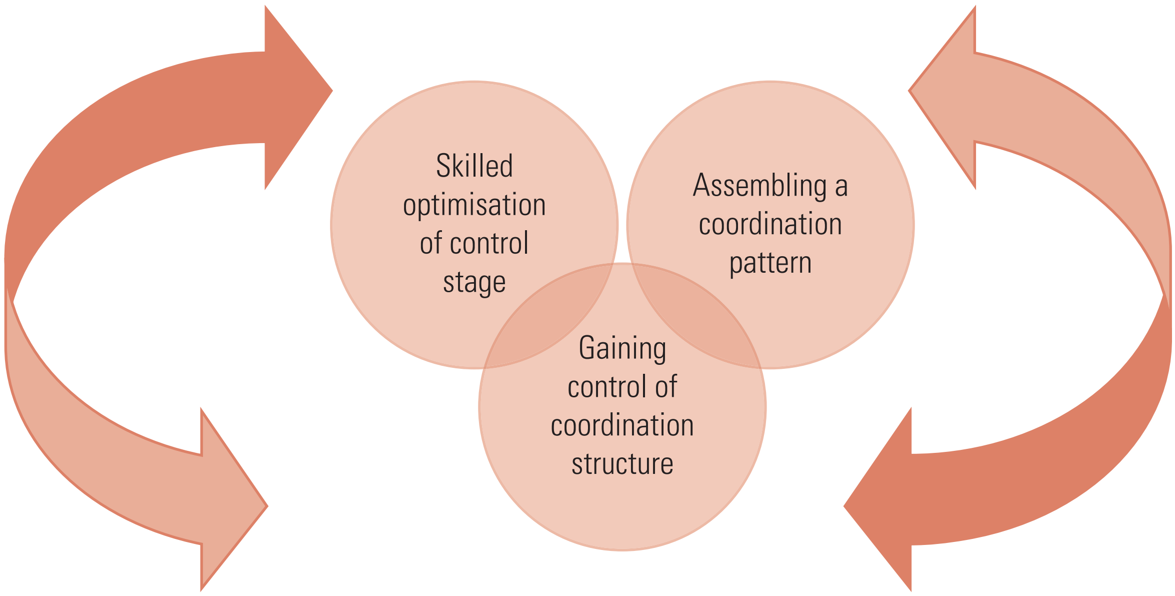

Figure 5.9 Complex system (dynamic performance environment)

non-linear in nature and embraces chaos, whereby the learner responds to constraints to form a stable motor pattern. Constraints enable the emergence of movement behaviours or affordances. Constraints are the many different variables that affect the successful completion of a task within an authentic game environment. For example, the weather conditions will affect the way a set shot in Australian Rules Football would need to be performed if there was a strong wind. Constraints can both enable performance (e.g. tall height of player in completing a jump for a basketball tip-off) and limit performance (e.g. a send-off in touch affecting the time and space available due to the 6 vs. 5 scenario). Constraints can be organised into those that involve the *learner*, the *task* or the *environment*. To maximise skill acquisition, training activities must be designed to reflect the constraints found in game situations so that skills and tactical implementations can be improved. It is now widely accepted that training activities that reflect constraints and a dynamic systems approach will produce greater learning gains than the application of a linear cognitive approach.

ecological psychology how the body's systems coordinate actions with the environment, objects and surfaces

A non-linear approach to learning and the design of training activities also aligns with **ecological psychology**, which is how the body's systems coordinate actions with the environment, objects and surfaces. Athletes perceive – for example, through vision – and coordinate actions with their environment. Performance is characterised as functional under different conditions through the manipulation of movement patterns after variable repeated practice.

Activity 5.9

Check-in

1. Go to www.cambridge.edu.au/redirect/8006 to watch a YouTube clip.
2. Identify the stage at which the labourer may be in relation to the two models of stages of learning.
3. Explain why you believe the labourer's actions fit your selected stage of learning.

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Activity 5.10

Engage-in

Inquiry question: How do the two different stages of learning and degrees of freedom impact learning?

Engage and understand

1 Identify information relating to systems theory by drafting the following table.

Traditional motor learning system	Contemporary skill acquisition theory
Name of theory	
Characteristics of system/theory	
Non-linear or linear	
Linked stage of skill acquisition and characteristics	
Outcomes	
Implications for learning	

(continued)

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2 Capture digital evidence of your performance.

3 Complete two of the following tasks, for each one use dominant side first followed by non-dominant side.

- **a** Australian Rules Football – 20 kick passes to partner for accuracy over 20 metres
- **b** basketball – 20 free throws
- **c** Futsal – 20 shots for goal over 15 metres
- **d** netball – 20 shots for goal from 6 metres
- **e** soccer – 20 shots for goal over 20 metres
- **f** tennis – 20 serves
- **g** volleyball – 20 overhead serves
- **h** badminton – 20 singles serves.

Apply and analyse

KEY COGNITION

Examine: Investigate, inspect or scrutinise carefully; inquire or search into; consider or discuss critically an argument or concept in a way that uncovers the assumptions and interrelationships of the issue.

4 Undertake a post-game reflection on the following:

- **a** Examine your level of performance for both dominant and non-dominant side.
- **b** Analyse what stage of learning you are at for dominant and non-dominant sides using both Fitts and Posner's, and Newell's models.
- **c** Examine variations in your performances between dominant and non-dominant sides, and consider and explain how this links to the two major approaches.

What constitutes a skilled performance?

Consider an elite performer in your sport. What constitutes a 'skilled performer'? Are they able to complete a skill with high proficiency? Are they able to apply and implement the skill at the right time, having selected the right option? Are they able to show adaptability of the execution of the skill so it solves the problem of performing to gain the optimum outcome? As seen, there is some confusion around the word 'skill'.

We should not refer to 'skills' as a plural: we just refer to developing skill (singular) – that is, skill acquisition. Why? In modern motor learning theories, motor skill involves the development of two key components: technical and tactical. Performance involves coupling both of these abilities for a successful solution in an authentic game environment. For example, in Activity 5.6 (on p. 260), reflection occurred on what was required to ensure an accurate, effective catch and pass, and the factors that affected this. This led to the concept of technical and tactical components, and the coupling of these:

- **Technical proficiency.** This is developing ('learning' and refining) motor programs/motor movement. Motor movements can be general for everyday life (like writing, walking, picking up things, etc.), but when applied to physical activity it involves the movements required to participate in specific sports/activities – the syllabus refers to these as 'specialised movement sequences' – for example, a pass in touch football. This is what teachers traditionally would regard as the different 'skills' of the game, but really they are just different movement sequences.
- **Tactical awareness.** This is knowing what is happening around you and what options are available (affordances), then selecting (and appropriately adapting) a motor sequence that will be successful – such as learning when to pass in touch.

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To ensure an accurate, effective catch and pass, both these elements of 'skill' development are essential.

Specific physical activities require different contribution levels from both these elements. For example, a 'skilled' javelin thrower develops high technical proficiency but, due to the nature of the activity, requires limited tactical awareness. However, the touch player must develop both technical proficiency and tactical awareness. In addition, due to the nature of this type of activity, technical proficiency is less concerned with developing a 'perfect technique' and more focused on a motor program that can be adapted and manipulated to the specific circumstance at the time. This explains why tactical awareness is so important to invasion or net-court games, where cognitive learning models don't hold up and dynamic learning models more effectively account for the learning process. It also demonstrates that modern dynamic learning approaches can be just as effective in performance-type sports like javelin, shot put or archery. There is just less tactical awareness required.

To assist in developing learning activities, a physical activity could be on placed on two continua that explore these features:

- **Does my sport require high or low technical proficiency?** Does it need a refined technique that can be repeated for accuracy, and that biomechanically suits my body composition to maximise power and speed, or does it need an adaptable technique that can be adjusted in response to affordances to achieve successful outcomes? Specialised motor sequences for any sport could be placed on a continuum from highly technical to highly adaptable.
- **Does my sport require high or low tactical awareness?** Is it performed in a dynamic performance environment with a huge number of variables to consider with many constraints and therefore affordances for success, or is it performed in a closed and predictable environment with limited constraints, and therefore limited decisions to make? Sports could be placed on a continuum based on the affordances available – consider Australian Rules Football at one end, with shot put towards the other.

Understanding the different contributions of these two elements of skill helps us to target training for skill acquisition and maximise motor skill development – a shot putter might use more of a traditional approach when completing a biomechanical analysis, looking for small refinements to seek improvement, while the touch player is coached using a more dynamic systems, constraints-led approach that enables both technical and tactical elements to improve simultaneously. The aim of training is to enable the individual to be attuned to their own affordances, the environment and the task itself. So the ability to create a skilled performance in both net and court games and invasion games relies on the completion of technical and tactical elements.

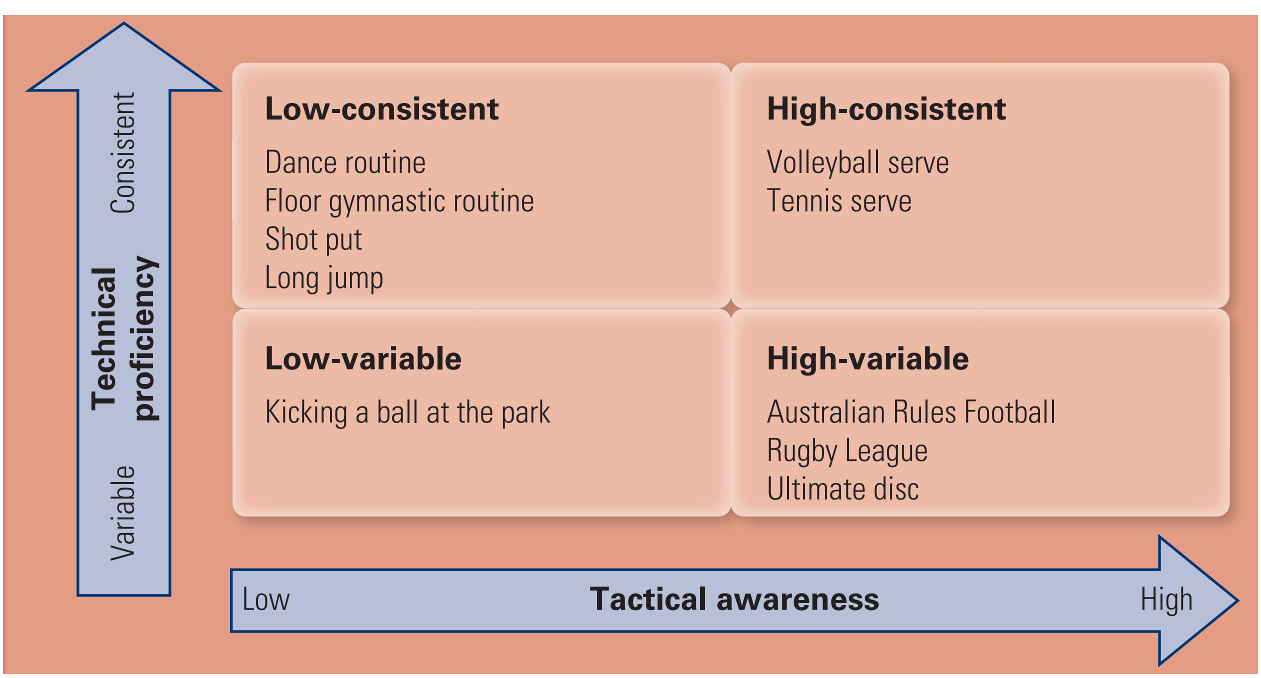

Figure 5.10 Due to the nature of the physical activity, different motor programs may require different levels of technical proficiency and tactical awareness to implement them successfully. This may be reflected in the learning and training activities developed.

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Activity 5.11

Engage-in

Inquiry question: How can we develop tactical understanding?

Engage and understand

1 Review your notes on the article in Activity 5.7 (on pp. 260–1).

2 Review your notes on the value of open and closed drills from Activity 5.7.

Apply and analyse

3 Reflecting on the review undertaken:

- **a** Design and implement two five-minute training activities (one closed and one open) that target the development of a specific tactic for your physical activity of study. Consider a principle of play – for example, creating space.
- **b** Appraise the value of open training environments and evaluate how these data may affect the development of learning tasks for your physical activity.

Figure 5.11 Brisbane Lions training session at University of Tasmania Stadium, 19 December 2017

Evaluate and justify

Evaluate: Make an appraisal by weighing up or assessing strengths, implications and limitations; make judgments about ideas, works, solutions or methods in relation to selected criteria; examine and determine the merit, value or significance of something, based on criteria.

4 Reflect on each training activity and use the data collected to evaluate its effectiveness for developing the specific tactic targeted.

5 Reflect on both training activities and determine which was more fun. Consider whether this would impact learning.

6 In 100 words, present and justify two important aspects that need to be considered when developing the training activities for tactical development that presented themselves in this activity.

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Activity 5.12

Check-in

1. Identify major characteristics of the dynamic systems approach to skill acquisition.
2. Recall the different stages and characteristics of Newell's stages of learning.
3. Label, describe and give examples of constraints from your performance in the physical activity being undertaken.
4. Use the hexagon from Activity 1.8 (on p. 16) in Chapter 1 to identify the major rate limiter for each category for your own performance.
5. Based on question 4 above, use Newell's of stages of learning to classify your own performance.

5.3 Constraints-led approach to learning

The constraints-led approach (CLA) is a framework for understanding and developing movement skills. Based upon dynamic systems theory and ecological psychology, this approach allows athletes, coaches, students and teachers to develop better training activities that enhance skill acquisition. Within the framework, learners identify interacting constraints among themselves, the task and the environment to develop a stable and functional movement pattern.

The CLA is underpinned by several key assumptions about skill acquisition, which should be reflected in an effective motor learning environment:

Figure 5.12 Players play on a muddy pitch in a match between Besiktas and Boluspor in Istanbul in 1981.

- Activities must be learner-centred.
- The design of practice tasks must be representative of an authentic environment.
- Learning tasks should simplify rather than deconstruct.
- Learning requires the learner to assemble a unique movement solution that will help satisfy task constraints in a particular situation.
- Effective learning activities manipulate constraints to promote particular affordances from the performance environment, allowing the learner to develop technical and tactical skills through self-organisation.
- Learning requires continual exploration by the learner in practice as repetition with variation.
- There is no ideal movement pattern to learn; the correct movement pattern is the one that is successful in the current situation.

What are constraints?

Constraints are boundaries that shape a learner's self-organising movement patterns, cognitions and decision-making processes (Renshaw et al., 2010). Three categories of constraints have been proposed.

Source: Renshaw and Holder (2010, p. 35).

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Learner constraints

- Height
- Limb length
- Fitness levels
- Technical skills
- Attentional control
- Intrinsic motivation

Environmental constraints

- Weather conditions
- Pitch conditions
- Quality practice facilities
- Structure of the backyard
- Locality
- Cultural constraints such as family, teammates
- The culture of a sporting club and access to high-quality coaching

Task constraints

- Goal of the task
- Rules of the game
- Equipment available
- The relative state of the game

Figure 5.13 Three constraint categories, adapted from Renshaw and Holder (2010, p. 35).

Activity 5.13

Engage-in

Inquiry question: What constraints exist within the constraints-led approach?

Apply and analyse

After reading and reviewing the information in Figure 5.13, do the following:

1. Draw a triangle with constraints listed as the central theme.
2. Label each of the apexes with a constraint category.
3. Draw a thought bubble around each apex of the triangle and within each bubble provide four examples of ways to manipulate the constraint it contains.

Figure 5.14 A-League match between Brisbane Roar and Melbourne Victory at Suncorp Stadium, 17 December 2017

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Activity 5.14

Engage-in

Inquiry question: How can we develop adaptable technical abilities for authentic environments?

Engage and understand

1 Read the following extract.

Technique change

Would you suggest to Tiger Woods that he change his golf swing to improve his game? At what stage should you begin to teach young swimmers a new stroke? Practitioners must continually address questions such as these regardless of the performer's current ability. In these kinds of situations, practitioners tend to rely on a preconceived image of an idealized technique to determine whether a change is required. Research has shown, however, that even in highly stable skills such as rifle shooting or golf putting, common optimal coordination patterns do not exist (Brisson & Alain, 1996; Ball, Best & Wrigley, 2003; Fairweather, Button, & Rae, 2002). This is because each time a skill is performed, it must be adapted to subtle differences in initial conditions (e.g. changes in body sway, physiological status, or psychological factors) and in the environment (e.g. a slight breeze, different temperatures, different surfaces). Given the multitude of constraints that can alter the behavioral manifestation of a movement skill, even elite performers need to display a significant amount of functional movement variability (Button, Macleod, Sanders & Coleman, 2003; Davids, Glazier, Araújo & Bartlett, 2003). This idea has strong implications for a learner model and suggests that the emphasis during learning should be on encouraging change and adaptation rather than achieving some hypothetical, idealized state.

Source: Davids et al. (2008, p. 98).

Apply and analyse

2 Examine the above information and explain an isolated idealised technique (specialised movement sequence) for your current physical activity.

Consider: Think deliberately or carefully about something, typically before making a decision; take something into account when making a judgment; view attentively or scrutinise; reflect on.

3 Consider the information gathered and distinguish what parts of your personalised technique may need to be different from the idealised technique due to personal constraints – refer to those identified in Figure 5.13.

4 Spend some time in the performance environment and collect some footage of your performance of the selected technique. Review your footage in comparison to the 'idealised' technique that you explored earlier.

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Activity 5.15

Active investigation

Inquiry question: How can we manipulate constraints in the learning environment to develop adaptable technical abilities with decision-making for authentic environments?

Option A – invasion games

Engage and understand

Capture digital evidence in the performance domain while completing a 5 vs. 5 End Ball Netball Passing Game: 20 m length × 10 m width.

1 **Game 1:** Rules –
   - **a** Ball must be passed on the full.
   - **b** If ball is knocked down by an opponent, you maintain possession.
   - **c** If your team drops the ball, the opponents receive possession.
   - **d** When you catch the ball, you must stand still but may pivot on the spot.
   - **e** Player has only one second in possession of the ball.

2 **Game 2:** Add constraint that teams are now 6 vs. 4 and when the player gains possession of the ball, they have 10 seconds with the ball and may move 1 m.

3 **Game 3:** Go back to Game 1, 5 vs. 5; however, increase the width of the field to 20 m (20 m length × 20 m).

4 **Game 4:** Change Game 3 by adding in the rule that a player may run 5 m with the ball.

Apply and analyse

5 Post-game:
   - **a** Ascertain what type of constraint was manipulated in Games 1, 2, 3 and 4.
   - **b** Compare and contrast what performances (or identify the affordances that emerged in each game) emerged from the original game and Games 2, 3 and 4.
   - **c** Review what effect the various constraints had on completing the goal of passing the ball and scoring.

Evaluate and justify

6 Evaluate whether each game was representative of invasion games. Why?

> *Critique: Review (e.g. a theory, practice, performance) in a detailed, analytical and critical way.*

7 In 300 words, critique whether the game would develop the technical ability of passing in an invasion game and determine why. (Use primary and secondary data.)

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8 In groups of four, review individual critiques and provide feedback on the effectiveness of the primary and secondary data used.

9 Analyse whether adaptable technical abilities can be developed for authentic environments.

Option B – net and court games

Engage and understand

Capture digital evidence in the performance domain while completing a 1 vs. 1 game of badminton.

10 Game 1: Rules –

- **a** Play in half of the court
- **b** 1 vs. 1
- **c** A point is only scored if the shuttle lands *between* the short service line and long service line for doubles.

11 Game 2: Change rules – a point is only scored if the shuttle lands *between* the short service line and the net or the long service line for doubles and the back, boundary line.

12 Game 3: Go back to Game 1; however, increase the width of the field to full singles game.

13 Game 4: Go back to Game 2; however, increase the width of the field to full singles game.

Apply and analyse

14 Post-game:

- **a** Ascertain what type of constraint was manipulated in Games 1, 2, 3 and 4.
- **b** Compare and contrast what performances emerged from the original game and Games 2, 3 and 4.
- **c** Review what effect the various constraints had on completing the goal of underarm and overarm clears and drop shots.

Evaluate and justify

15 Evaluate whether games completed were representative of net and court games. Why?

Critique: Review (e.g. a theory, practice, performance) in a detailed, analytical and critical way.

16 Use both primary and secondary data in a 300-word critique of the task's capacity uses to develop adaptable technical ability of underarm and overarm clears and drop shots.

17 In groups of four, review individual critiques and appraise effective use of primary and secondary data.

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Activity 5.16

Check-in

Complete the table below in relation to important implications for implementing a Constraints-led approach

Implication	Explanation in own words	Example
A learner-centred approach		
The design of practice tasks representative of authentic environment		
Task simplification rather than deconstruction		
The manipulation of constraints to match the learner and promote emergent affordances to challenges through self-organisation		
The continual exploration by the learner in practice as repetition with variation		
The concept of no ideal movement pattern		

Soon you will engage in physical activity to evaluate your own performance. Using an understanding of the constraints-led approach, you will devise learning tasks to enhance your own game play – that is, demonstrate tactical awareness through intelligent performance. The design of tasks should take the mentioned points on board.

Davids and colleagues (2008, p. 105) remind us of further considerations of the constraints-led approach:

- Careful consideration is needed concerning how key task and personal constraints interact to influence performance and skill acquisition for each learner.
- Time spent in practice is one among many important constraints on attainment of excellence. Practitioners should not over-emphasise quantity of time spent in practice because the power law of practice is just one of many different learning curves that describes how individual learners may change over time (Newell et al., 2001).
- Time spent in practice does not necessarily guarantee the acquisition of expertise. What athletes are challenged to do during practice is a more accurate index of skill acquisition than amount of time spent on the training field (Davids, 2000). The microstructure of practice needs to be monitored so that qualitative differences between practice sessions are understood.
- Sport scientists and practitioners need to work together to fully understand the nature of the personal, task, and environmental constraints acting on individual performers in different sports and physical activities.

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- Practitioners could facilitate rapid development and skill acquisition by careful identification and manipulation of the major constraints on each learner during practice and training. Planned manipulations may cause behaviour jumps or sudden transitions in skill level. This is akin to infants who skip motor milestones, exemplified by research observing the appearance or disappearance of stepping in infants. In this respect, behaviours may just be waiting in the wings to be brought out from each learner (Thelen & Smith, 1994).
- Individual differences need to be understood and valued more than ever. Variation could signal successful adaptation to unique constraints. For example, the history of sport is littered with successful athletes who have satisfied task constraints in unique ways. Learning could be viewed as a personal struggle to assemble a successful coordination solution to a given movement problem.
- The key unit of analysis from a constraints-led approach is the individual performer (Button, Davids & Schöllhorn, 2006). Variability in movement performance needs to be carefully interpreted. Sometimes high levels of variability help in adapting to the environment, and on other occasions low levels help increase performance stability.
- Many activities involve complex movements. Although genetic variations may or may not limit certain capacities for a person (e.g. power or physical endurance), other strengths can be exploited for performance excellence.

Source: Davids et al. (2008, p. 105).

Activity 5.17

Check-in

1. Identify the three constraint types that affect performance.
2. Use an example to help explain how each of the three types of constraints may act as affordances (positive and negative) within the physical activity undertaken.
3. Use an example to show how each constraint type may influence your performance.
4. Consider how you can manipulate a constraint within your physical activity to achieve affordances – for example, environment: increase width/size of field for greater opportunity for lateral movement of the ball.

Figure 5.15 France's Caroline Ladagnous carries the ball during the women's Rugby Sevens training session, 5 August 2016

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Activity 5.18

Engage-in

Inquiry question: Can a simple manipulation of constraints develop affordances within a sport to encourage specific technical and tactical development?

Option A – invasion games

Engage and understand

Participate in a game of Two Goal/Bucket Ball – 5 vs. 5.

1 **Game 1:** Aim is to score by passing the ball to catch the ball in a rubbish bin or to score inside a small goal area.

Rules for Australian Rules Football, basketball, netball and touch football – initial rules:

- Ball must be passed on the full.
- If ball is knocked down by an opponent, you maintain possession.
- If your team drops the ball, the opponents receive possession.
- Defenders cannot contact the player in possession and must be 1 m away.

Rules for Futsal and soccer – initial rules:

- Ball must be kicked.
- When in possession, players cannot dribble the ball; they can trap the ball and stand still, but may pivot around the ball to pass.
- A defender must be a minimum of 1 m away.
- If a team member does not stop the ball, possession is lost.

2 **Game 2:** One goal is worth two points and is a small area; another goal is worth one point and is a larger area.

3 **Game 3:** Increase the size of the two-point scoring zone.

Apply and analyse

4 Critique what effect the rule constraint had on the game – what affordances were developed?

5 Change teams so that the numbers are now 6 vs. 4 or 7 vs. 3. For the team with lower numbers, increase goal sizes.

6 Critique the impact on both teams from the change in numbers.

Evaluate and justify

Evaluate: Make an appraisal by weighing up or assessing strengths, implications and limitations; make judgments about the ideas, works, solutions or methods in relation to selected criteria; examine and determine the merit, value or significance of something, based on criteria.

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7 Evaluate whether the manipulation of constraints led to emergent affordances in the invasion games.

Option B – net and court games

Engage and understand

Participate in a game of volleyball – 5 vs. 5.

8 **Game 1:** Participate in a small-sided game – 5 vs. 5 Newcombe Ball

Rules:

- Ball is thrown from behind the base line to commence each point.
- Team catches the ball.
- Team is allowed to have three touches on its side of the net; the first two can be catches; the last shot must be a hit.
- Cannot move with the ball.

9 **Game 2:** Participate in a small sided game – One-Bounce Volleyball

Rules:

- Ball is thrown from behind the service line to commence each point.
- Ball is allowed to bounce once between each shot.
- Team is allowed to have three shots on its side of the net. Last shot must be a hit over the net.

10 **Game 3:** As for Game 2; however, any time a point is won from a spike, it scores four points.

Apply and analyse

11 Critique what effect the rule constraint had on the game – that is, what affordances were developed.

12 Change teams so that the numbers are now 6 vs. 4. For the team with lower numbers, a winning point from a spike is now worth six points.

13 Critique the impact on both teams of the change in numbers.

Evaluate and justify

KEY COGNITION

Evaluate: Make an appraisal by weighing up or assessing strengths, implications and limitations; make judgments about the ideas, works, solutions or methods in relation to selected criteria; examine and determine the merit, value or significance of something, based on criteria.

14 Evaluate whether the manipulation of constraints led to emergent affordances in the net and court game.

Figure 5.16 Mixed doubles match of the Vodafone Premier Badminton League, 23 December 2017

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Activity 5.19

Engage-in

Inquiry question: Can you manipulate tasks constraints to develop a desired affordance?

Engage and understand

1 Read the following extract.

> Manipulating task constraints is perhaps the most common way in which teachers and coaches have attempted to improve learners' performance from this theoretical viewpoint. Often, teachers introduce artificial rules in order to emphasise a specific aspect of performance (e.g. requiring teams to make 10 passes before scoring). However, from the point of view of nonlinear pedagogy, changes to game rules must be based on the key pillar of task representativeness in order to provide learners to attune to key affordances in order to develop appropriate information–movement couplings. A good example of a coach who uses this approach in rugby is Wayne Smith, the All Blacks coach. He manipulates task constraints in training games that require players to work out task solutions for themselves; 'You think of a way, e.g. if you want to work on your forwards picking the ball up and going through the middle of the defence, you create ways to spread the defence at training' (Kidman 2005, 196). In invasion games, task simplification by reducing the number of players in teams is a common strategy used by teachers in order to reduce the attentional demands on players. However, this approach has encountered some resistance from adults who want to see the children play the 'adult version' of games as soon as possible. The importance of playing small-sided games has recently been highlighted in the context of football by Fenoglio (2003). In a recent report on the use of 4 vs. 4 games at the Manchester United academy, Fenoglio (2003) showed that by playing 4 vs. 4 rather than 8 vs. 8 games, players made 135% more passes, had 260% more scoring attempts and scored 500% more goals. In addition, the number of 1 vs. 1 encounters between attackers and defenders increased by 225% while the number of dribbling tricks demonstrated by learners increased by 280%. The increased frequency of these important sub-phases of football during practice tasks clearly allows learners greater opportunities to practice basic skills and to gain more experience of tactical requirements in game contexts. The advantages of small-sided games for physical conditioning have also been demonstrated. A recent study by Impellizzeri et al. (2006) found that using small-sided games, compared to interval training for example, resulted in similar levels of improvement in aerobic fitness and match performance for junior soccer players.
>
> *Source: Renshaw et al. (2010).*

2 Under the headings of the three different categories of constraints, recall and identify the constraints mentioned in the article.

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Evaluate and justify

3 Consider the information on the previous page and evaluate the advantages of small-sided games as a learning environment. Use the table below to help guide the evaluation through a four-step process.

Evaluate = Appraise, judge, examine, determine

- *Step 1: Appraise.* Identify the criteria to be applied in this evaluation as shown in the left-hand column of the table below.
- *Step 2: Judge.* Assign a rating for each criteria to judge the advantages of small-sided games. 5 = very good, 4 = good, 3 = okay, 2 = poor, 1 = very poor.
- *Step 3: Examine.* Consider each criteria and give a weighting if appropriate. That is, is one criteria more important than another? For example, variation in practice may be considered twice as important as task simplification. Variation of practice would receive a weighting of 2, while task simplification would receive a weighting of 1. Write this in the weighting column.
- *Step 4: Determine.* Multiply the rating by the weighting in order to find the score for each criteria. Individual criteria with larger scores would provide a good argument that small-sided games do provide learning advantages. Add the scores from each criteria to determine an overall score. Again a high overall score would indicate, that in general, small-side games offer advantages for learning. Reflect on the scores from both columns and in the Evaluation column in the table use an appropriate adjective to describe the level of advantages small-side games offer a learner (i.e. are there 'few advantages', 'limited advantages', 'some advantages' or 'a great number of advantages').

Criteria	Rating	Weighting	Score	Overall score	Evaluation
A learner-centred approach					
The design of practice tasks representative of authentic environment					
Task simplification rather than deconstruction					
The manipulation of constraints to match the learner and promote emergent affordance to challenges through self-organisation					
The continual exploration by the learner in practice as repetition with variation					
The concept of no ideal movement pattern					

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Activity 5.20

Active investigation

Inquiry question: Can you manipulate task constraints to develop a desired affordance?

Engage and understand

1 In groups of seven, collaborate on the design of a 2 vs. 2 or 3 vs. 3 learning scenario within the game. The aim of the game should be to attune learners to themselves, their task or the environment by applying a constraint to promote an affordance in the game. For example, increase width of field to promote lateral movement.

2 Implement the 3 vs. 3 game and capture digital data.

Apply and analyse

3 Analyse data in relation to performance and identify opportunities and successful outcomes of the targeted affordance.

Evaluate and justify

Judge: Form an opinion or conclusion about; apply both procedural and deliberative operations to make a determination.

4 As a group of seven:

- **a** Appraise whether the introduction of the constraint enabled the learner to self-organise when solving the problem – that is, did they work out a successful action for the situation for themselves.
- **b** Judge whether the learning scenario was representative of the authentic environment.
- **c** Determine whether the implementation of the constraint developed the desired affordance.

Inquiry cycle – stages 2 & 3: Apply and analyse; Evaluate and justify

5.4 Evaluating specialised movement sequences

You will now further evaluate your performance of specialised movement sequences and movement strategies will now be explored. Scaffolding through active investigations will assist in developing strategies to enhance your own game play.

The Physical Education General Senior Syllabus (Queensland) uses 'Almond's work', cited in Mitchell, Oslin and Griffin (2006), which classifies physical activities into six categories:

1 aesthetic
2 invasion
3 net and court
4 performance
5 striking and fielding
6 target.

The classification of physical activities places sports with the same characteristics together. For example, target games are those that involve scoring by throwing, striking or hitting a ball or object at a specific goal or objective.

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Due to the nature of different physical activities, it can be seen that sports within a classification have similar characteristics or tactical components. These are key ingredients of success, and are known as the *principles of play* – for example, in a game of soccer, the team that holds possession of the ball for longer periods of the game is most likely to win.

Activity 5.21

Check-in

1 Draft a table using the six categories of physical activities listed on the previous page. List common characteristics of the sports category and give three examples of each.
2 Classify your current physical activity.
3 Identify and list the common characteristics of the category of sport in which your physical activity is classified.

The possession of the ball is labelled as maintaining possession. This is identical to an Australian Rules Football game, where the team that 'maintains possession' for the greater percentage of the game is most likely to win. An example of the importance of this principle of play is obvious when commentators analyse possession data at half-time. Therefore, within a sport, there are several principles of play, which are the general strategies that aid performance and increase the likelihood of success.

Principles of play are particularly important in activities that require a higher strategic element for success, and these are generally invasion, or court and net games. The major principles of play for these categories include:

- setting up attack
- defending against attack
- creating, defending and exploiting space
- attacking opposition space
- scoring.

The ability to recognise patterns within a game, and to implement and adapt the principles of play, is considered integral to performance mastery.

Activity 5.22

Engage-in

Inquiry question: How could you use principles of play to enhance your performance?

Engage and understand

1 Play your selected physical activity.
2 At the conclusion, draft a table using the principles of play.
3 Under each heading provide at least three examples of ways of demonstrating the specific principle of play for your selected activity – that is, what are three 'tactics' used to achieve each principle?

Apply and analyse

4 Identify the principle of play at which you were most effective and explain how and why.
5 Identify the principle of play at which you were least effective and explain how and why.

(continued)

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Evaluate and justify

6 Determine whether you could use principles of play to enhance your performance.

7 Reflect on Activity 5.21 on the previous page, and compare and contrast similarities and differences between your list and information from the current version of the Physical Education syllabus below.

Invasion game characteristics

The purpose of invasion activities is to score points by invading the opponent's territory, while limiting the points scored by the opposing team.

Points can be scored by the ball crossing the line or being thrown, shot or struck into a goal.

In offensive plays, movement may occur:

- off the ball, when players position themselves to receive passes, create space or threaten the goal or line
- on the ball, when players move with the ball and execute responses such as passing, controlling the ball, evading and scoring.

In defensive plays, movement may occur:

- off the ball, when players move to mark or guard their opponents, restrict space for opponents to run into, or intercept the ball
- on the ball, when players apply pressure to the ball carrier and execute responses such as clearing or blocking the ball or passage of play, or making body contact.

Net and court game characteristics

These physical activities involve a net or court.

The purpose is to send the ball into the opponent's court so that it cannot be played or returned within the court boundaries.

Specific rules are in place about the number of bounces allowed.

In offensive plays, shot placement and court awareness are crucial to winning points.

In defensive plays, players must defend space and position themselves to return the ball.

Source: Physical Education 2019 v1.1 General Senior Syllabus © Queensland Curriculum & Assessment Authority

5.5 Specialised movement sequences and principles of play

Developing decision-making and tactical awareness in sport

The development of expert players and decision-makers has been studied for many years. In *Outliers: The Story of Success*, Malcolm Gladwell arrived at the conclusion that it takes 10 000 hours of **deliberate practice** to achieve mastery of a motor skill.

deliberate practice a special type of practice that is purposeful and systematic

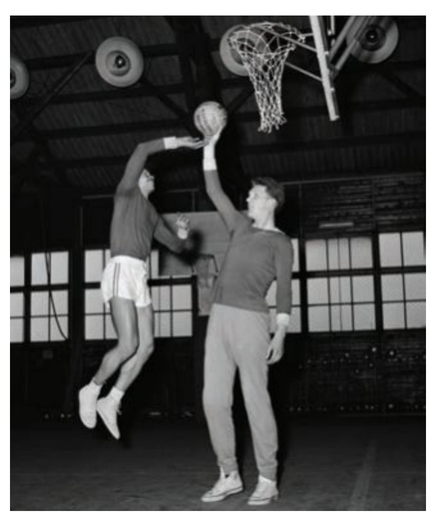

Figure 5.17 French national team members Roger Antoine and Jean-Claude Lefebvre

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Activity 5.23

Active investigation

Inquiry question: At what level is your performance in authentic environments?

Engage and understand

Option A – invasion games

1 Digitally capture performance in the following situations. Demonstrate specialised movement sequences through game play of 1 vs. 1, 2 vs. 2, 2 vs. 1, 3 vs. 2, 3 vs. 3, 5 vs. 5 and full game options.

2 Identify and experiment with the following:

- **a** *Attack/offensive options:* gaining possession, creating a + 1 situation = switch, wrap, dump, give and go, in and away, in and out ball, block, screen, pattern recognition of defence.
- **b** *Defence options:* person on person, zone, press, pattern recognition of attack.
- **c** *'On-the-ball' and 'off-the-ball' movements:* awareness – for example, movement execution, pass or shot selection.
- **d** *Space:* for example, movement pathways, use of space, when to run into space or when to pass.
- **e** *Quality of movement:* for example, force development, efficiency and outcome
- **f** *Relationships:* for example, interaction with opponent and team members, verbal and non-verbal communication.

3 Review the video captured in relation to the technical and tactical elements identified in the current version of the Physical Education syllabus (see below). Evaluate your current ability level for each by scoring yourself from 1 to 8 and collate how often each element was used and where you had success with each.

Technical aspects within all positions of your physical activity of study

- *Australian Rules Football* – leading, marking, bouncing, handballing, kicking, tackling, ball handling, tapping the ball, punching the ball, forward and backward movement based on ball movement.
- *Basketball* – dribbling, passing, running fast breaks after receiving an outlet pass, driving into the key to pass or shoot, outside shooting, free throws, stopping or steering opposition ball-handlers into a trap situation, rebounding, inside shooting, blocking shots, setting screens, boxing out, rebounding, transitioning between offence and defence, tip-offs.
- *Futsal* – passing, shooting, jockeying, tackling, receiving, protecting the ball from defender, throwing, forward and backward movement based on ball movement.
- *Netball* – one-on-one defence, defending shots for goal to limit scoring, rebounding, gaining possession, catching and passing, leading and driving into space, defending and attacking, catching, passing, baulks and fakes, step-in shot, step-back shot, lay-up.

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- *Soccer* – forward and backward movement based on ball movement, defensive and offensive play, passing, delaying and blocking shots, jockeying, tackling, throw-ins, dribbling, heading. Trapping Strikers – forward and backward movement based on ball movement, defensive and offensive play, passing, shooting, throw-ins, dribbling, heading, tackling, trapping.
- *Goalkeepers* – positioning in relation to goal and attackers, catching, diving, throwing, shot stopping, ball control, trapping, passing, tackling, goal kicks, punt/drop kicks.
- *Touch football* – forward and backward movement, sidestep and swerve, switching and wrapping, dump-and-split, slow then fast movement, dummy passing, defensive and offensive play, passing, effecting a touch, roll ball, scoop, tap, scoring, positioning on the edges.

Source: Physical Education 2019 v1.1 General Senior Syllabus © Queensland Curriculum & Assessment Authority

Option B – net and court games

4 Digitally capture performance in the situations listed below. Demonstrate specialised movement sequences through game play of 1 vs. 1, 2 vs. 2, 2 vs. 1, 3 vs. 2, 3 vs. 3, 5 vs. 5 and full game options.

5 Identify and experiment with:

a *Setting up attack:* force the opponent to the baseline or net – for example, a forehand high or long serve, or forehand or backhand short serve; control a rally and draw the opponent to a specific area on court – for example, drop shot, or to the corners of the court; move the opponent to the back court and create space in the front court – for example, variations of ground strokes, lob, defending against attack; draw the opponent from the baseline to the front court to allow time to return to ready position – for example, use of drop shot; hit the ball from the attacker's front court into the rear court of the opponent – for example, cross-court forehand or backhand passing shot; use front-court setter to implement attack; use different attack; serve or hit options – for example, back-court setter, triple front-court hitters, short serve, top spin or jump serve; force opposition to use a 'free ball' or non-attacking return; pattern recognition of defence.

b *Defending against attack:* move the opponent to the back court and create space in the front court – for example, a forehand clear, cross-court forehand or backhand; hit the shuttle/ball from the attacker's front court into the rear court of the opponent – for example, net lift.

c *Creating, defending and exploiting space:* move the opponent to the back court and create space in the front court – for example, cross-court forehand or backhand; hit the ball from the attacker's front court into the opponent's rear court after drawing them to the net – for example, lob; maintain court position through transition from attack to defence – for example, 'off the ball' and 'on the ball' movements; front-court setter and back-court setter strategies to implement attack.

d *Attacking opposition court and scoring:* win a rally, following an opponent's high shot to the net – for example, backhand or forehand net kill or overhead smash; drive the shuttle/ball into the opponent's court to score and win the rally, or win with the following

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shot at the net – for example, smash, cross-court volley; maintain court position through transition from attack to defence – for example, 'off the ball' and 'on the ball' movements; front-court setter and back-court setter strategies to implement attack.

e *'On-the-ball' and 'off-the-ball' movements:* awareness – for example, movement execution, pass or shot selection.

f *Space:* for example, movement pathways, use of space.

g *Quality of movement:* for example, force development, efficiency and outcome.

h *Relationships:* for example, interaction with opponent and team members, verbal and non-verbal communication.

6 Review the video captured in relation to the technical and tactical elements identified in the current version of the Physical Education syllabus (see below). Evaluate your current ability level for each by scoring yourself A to E and collate how often each element was often used and where you had success with each.

Technical aspects within all positions of your physical activity of study

- *Badminton*: front court – serve (forehand, backhand, high, short), net lift, drop shots, net kill, transition to defensive (side-to-side) formation; rear court – serve (forehand, backhand, high, short), clear, drop shots, smash, transition to defensive (side-to-side) formation; ready position – use at the centre of play, base position or in doubles defensive (side-to-side) formation; footwork – shuffle step; grip.
- *Tennis*: baseline – serve, smash, lob, approach shot, passing shots, forehand, backhand; net – smash, drop shot, lob, volley, forehand, backhand; ready position – use at the centre of play, net position and baseline position; footwork; grip.
- *Volleyball*: setter – set (forward, reverse, quick), block, tip, dig, serve (underarm, overarm, topspin or jump), awareness of position; hitter (outside hitter, opposite hitter or back-court hitter) – spike (cross-court, line), block, tip, dig, serve (underarm, overarm, topspin or jump), awareness of position; libero – dig, serve receive, set, awareness of position, substituting; ready position – use at setter, hitter approach and serve or hit receive; footwork.

Source: Physical Education 2019 v1.1 General Senior Syllabus © Queensland Curriculum & Assessment Authority

Activity 5.24

Engage-in

Inquiry question: How can you score your performance?

Engage and understand

1 Read the information relating to a Game Performance Assessment Instrument (GPAI).

(continued)

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Game Performance Assessment Instrument

Ability to make strategic and operational decisions is essential to effective game play. The flaw of anthropometric and physiological testing of team sport athletes has been the absence of better predictors of performance such as technical and tactical abilities (Hoare and Warr, 2000; Regnier, Selmela, and Russel, 1983). Mednis (2001), Fry (1997), and Wisemantel (1997). Fitness and skill testing is of limited value in assessing a player's potential to play particular sports. Attempts therefore to identify talent need to be multi-faceted with respect to all performance contributors.

The GPAI is a multi-dimensional system designed to measure athlete's tactical understanding and skill level within game environments (Oslin et al., 1998). The GPAI provides researchers with a means of observing and coding performance behaviours. For any game wishing to be analysed, important tactics and skills need to be selected from seven prescribed game components (Base, Adjust, Decisions Made, Skill Acquisition, Support, Cover, Guard/Mark). These will be observed throughout the game. These components are given further detail to make them specific to the sport being analysed. A pro forma for End Ball is shown in the table on the following page. Every time a player makes an appropriate or inappropriate decision it is tallied within the table. Players are individually assessed according to the criteria. On completion of the Game the following results can be derived.

Game performance will be the measure used for this test.

Game involvement = total appropriate responses + number of efficient skill executions + number of inefficient skill executions + number of inappropriate decisions made.

Decisions Made Index (DMI) = (number of appropriate decisions made) ÷ (number of inappropriate decisions made).

Skill Execution Index (SEI) = (number of efficient skill executions) ÷ (number of inefficient skill executions.

Support Index (SI) = (number of appropriate supporting movements) ÷ (number of inappropriate supporting movements).

Overall Performance = (DMI + SEI + SI) ÷ 3

Source: Oslin and Mitchell (1998, p. 27).

Sample data sheet for game performance assessment – invasion game: End Ball

Category – criteria for appropriate/efficient rating

- Game involvement – e.g. number of touches made
- Decisions made: attack – e.g. passing; defence – e.g. rush
- Technical – e.g. catch
- Support – e.g. runs to space.

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Game involvement		Decisions made index		Skill execution index		Support index	
		A	IA	E	IE	A	IA
Touches made	||	Attack-pass 𝍸 |	|||	Catch |||	||	Runs to space ||||	|||
		Defence					
Totals							

Key: A = appropriate, IA = inappropriate, E = efficient, IE = inefficient

2 Compete in a game of End Ball. Capture digital evidence.

3 In pairs, draft up a GPAI for End Ball.

4 View video evidence and, with your partner, capture primary data in the table.

Apply and analyse

5 In pairs, reflect on the GPAI table you designed. What technical and tactical aspects would you add in that would make it more comprehensive?

6 Analyse the data and examine what the individual and overall performance figures suggest regarding your performance.

7 Construct a GPAI based on your selected physical activity using the following headings.

- Awareness – for example, movement execution, pass or shot selection
- Space – for example, movement pathways, use of space, when to run into space or when to pass
- Quality of movement – for example, force development, efficiency and outcome
- Relationships – for example, interaction with opponents and team members.

Activity 5.25

Active investigation

Inquiry question: At what level is your performance in authentic environments?

Apply and analyse

Undertake this Active investigation over a series of lessons where you alternate between collecting video evidence (primary data) through performance and analysing the footage as described on the following page.

(continued)

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1 Using the digital captured data, assign your movement sequences to the GPAI as either A = appropriate, IA = inappropriate, E = efficient, IE = inefficient for each of the categories.
- awareness – for example, movement execution, pass or shot selection
- space – for example, movement pathways, use of space, when to run into space or when to pass
- quality of movement – for example, force development, efficiency and outcome
- relationships – for example, interaction with opponent and team members.

2 Finalise a game performance score:

Games Performance = (Awareness + Space + Quality of Movement + Relationships) ÷ 4.

Evaluate and justify

3 Analyse the primary data collect and identify strengths and weaknesses in your performance.

Justify: Give reasons or evidence to support an answer, response or conclusion; show or prove how an argument, statement or conclusion is right or reasonable.

4 Where poor performance is identified, justify the cause – that is:

a You didn't recognise the affordances available.

b You recognised an affordance but selected the wrong skill or tactic for the situation; or recognised the affordance and selected the appropriate response, but an issue in application caused an error – technique issue.

c You recognised the affordance and selected the appropriate response, but an issue in application caused an error – tactical implementation issue.

5 Justify which stage of learning (Fitts and Posner's, and/or Newell) you demonstrated in decision-making and tactical awareness by synthesising data from your GPAI in relation to the following movement strategies:

a reading play

b recognising information and responding

c reacting to implement movement

d recovering with appropriate movements – for example, 'on the ball' and 'off the ball' recovery movements.

6 Make decisions about which movement strategies would be most suitable to focus on in order to optimise your performance.

7 Select one of the movement strategies identified and recommend how constraints in a small-sided game could be manipulated for emergent affordances to occur in your performance.

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Figure 5.18 Territory Storm vs. Canberra Giants ANL Round 4, 11 March 2017

Unfortunately, many physical education teachers and coaches have interpreted Gladwell's research as meaning that expert players and decision-makers develop as a result of many hours of massed-drill practice of sport-specific routines. More contemporary understandings, however, cast doubt on how beneficial this approach to learning is to the development of intelligent performers. This is due to the work of researchers such as Baker, Cote and Abernathy (2003) and Farrow and Raab (2017).

Bruce Abernathy's work revealed not only that pattern recognition was higher in expert performers, but that it was general in nature and was also transferable between sports. This might be demonstrated by players who are able to perform at an elite level across a number of activities. Other highly relevant data collected by studying expert sport performers indicated that the 10 000 hours of deliberate practice theory was flawed, and that far less sport-specific practice was required. In fact, participation in a range of sports within the same category may be far more beneficial in relation to development of expert decision-making. The work of Farrow and Raab in 2017 also found that technical and tactical components should be developed in combination for a learner, and must be introduced early in the learning process to be most effective.

Judith Rink (1996) also highlights the need for manipulation of the learning environment to develop decision-making skills and tactical awareness by ensuring that the learning environment is at an appropriate level and that practice tasks are representative of authentic environments:

> Transfer of practice to the game environment depends on the extent to which practice or training resembles the game. If the athletes do not practice in game-like scenarios, they will not play the game well, yet, if practice is too game-like, it may be too difficult to integrate and perform the emphasized skills. The resolution of this implication is that practice needs to occur at a level that incorporates as much of the game as the players can successfully manage.
>
> *Source: Rink (1996, p. 502).*

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Unfortunately, few Physical Education lessons or coaching sessions resemble this information. Many teachers and coaches merely replicate the way they were taught using a more traditional approach. However, the slow acceptance of a game-centred approach (teaching games for understanding, play practice and games sense) has been building both inside classrooms and in coach development courses.

The use and understanding of the non-linear constraints-led approach with dynamic systems theory and ecological psychology supporting the pedagogical approach may see more learner-centred development emerge in the future. As students, teachers and coaches reflect upon and recognise that decision-making behaviours emerge from interactions between the task/goal and the player and the environment, the resulting learning/coaching scenarios may be better suited to develop individuals and teams. This may lead to less massed drill practice and more open-ended student-centred approaches.

However, some historical limiting factors will still affect this. In Renshaw and Moy's 2017 article 'A Constraint-Led Approach to Coaching & Teaching Games: Can Going Back to the Future Solve the "They Need the Basics Before They Can Play a Game" Argument?', several factors are mentioned, including:

- Low uptake by teachers and high use of teacher prescribed drills.
- Harvey, Cushion, and Massa-Gonzalez (2010) found that TGfU challenged coaches' values, beliefs and dispositions.
- Games Centred Approach lessons are reliant on the teacher delivering the model effectively. Renshaw and Moy argue that lessons which have all of the features of a GCA delivered well can produce high quality-learning outcomes, whereas, those with poor implementation produce shallow ones.
- Relatively short induction periods not permitting the development of sufficient pedagogical content knowledge to provide novice teachers with the conceptual understanding of GCAs and how to implement them in practice (e.g. Wright, McNeill and Fry 2009).
- Justification for doing 'drills' was their importance in teaching students specific technical skills before playing the game (Moy, Renshaw and Davids, 2014).
- how can they play a game if they don't have good technique' argument?

Source: Renshaw and Moy (2017).

This article refutes a number of these arguments by stating:

- Traditional teacher-centred methods of teaching and coaching assume a gradual, linear process of learning, with teaching methods often characterized by blocked practice drills with augmented teacher instruction and feedback designed to help students develop sound technique or idealized motor patterns. Curtner-Smith et al. (2001) presented compelling evidence that PE teachers spend most of their time (up to 78%) engaging in such teaching strategies. Somewhat ironically, such strategies can limit the amount of time that learners are actually engaged in physical practice.
- However, the value of drills in enabling the emergence of functional techniques is questionable. For example, how does dribbling around cones, where the focus of attention is at the feet, enable a young player to travel with the ball in the game where there is a need to scan the environment to guide actions that take into account moving defenders? How can receiving a pass with no pressure from an opponent develop the ability to control the ball close to the body or perhaps more importantly away from the pressure of an oncoming defender?

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- A key limitation of traditional pedagogical styles then is that they tend to prevent individual learners from exploring and discovering their own functional movement solutions to a games problem, a more appropriate characterisation of learning in play (Davids et al., 2013).
- The decomposition of tasks in traditional games teaching also brings into question the 'transferability' of movement patterns developed in drills to games. A number of studies across a range of games and sports have shown that these unrepresentative practice tasks do not facilitate the emergence of movement patterns that exhibit fidelity with those seen in performance environments (e.g. Pinder et al., 2012; Dicks, Button & Davids, 2010).

Source: Renshaw and Moy (2017).

Indeed, further research highlights the need to ensure that decision-making processes are implemented at the start of learning so that relearning is not required. As stated by Australian Institute of Sport acquisition specialist Richard Shuttleworth:

> Traditional training methods usually prepare athletes for certainty about their actions instead of preparing them for uncertainty. However, given that team sport is unpredictable by nature, uncertainty should be embraced by coaches in training and used to enhance the learning and performance of athletes. The best decision-makers in sport adapt their decisions and actions to a changing environment, and perform in unstable or uncertain situations. Coaches need to emphasise adaptability and variability in training, rather than the traditional approach that focuses mainly on repetition and stability of athlete decisions and actions.
>
> *Source: Shuttleworth (2013, p. 25).*

Activity 5.26

Check-in

1. What was Gladwell's recommended time to gain mastery of skill acquisition?
2. From which activities was the information gathered?
3. Explain what modern research says about the time needed for mastery in the sporting domain.
4. Identify and explain what the limiting factors have been for practitioners using a non-linear constraints-led approach.
5. Identify and explain what arguments in modern research have refuted the use of the traditional approach in developing decision-making skills.

Figure 5.19 Maria Sharapova of Russia competes with Cagla Buyukakcay (not seen) of Turkey

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Activity 5.27

Active investigation

Inquiry question: How can you use digital data to optimise tactical and movement strategies in developing intelligent performance?

Engage and understand

1 Go to www.cambridge.edu.au/redirect/8004 to watch a YouTube clip about digital evidence in relation to Johnathan Thurston's performance.

2 Identify how the use of video analysis may be used to identify strengths and weaknesses.

3 Explain the affordances identified by Andrew Johns in relation to Johnathan Thurston's performance.

4 Over a number of lessons, capture footage of your performance in your physical activity of study (this could have been captured during previous lesson or activities).

Apply and analyse

5 Over a number of lessons, use video editing software to isolate sections of footage of your performance in which you demonstrate movement strategies (Activity 5.23 on pp. 283–5).

6 Over a number of lessons, use video editing software to isolate sections of footage of your performance in which you demonstrate specialised movement sequences (Activity 5.23).

7 Use the captured primary data and apply the following characteristics to your performance to give yourself a score out of 8.

The student work has the following characteristics:	Marks
• Accomplished and proficient demonstration of the specialised movement sequences and two movement strategies from two different principles of play in authentic performance environments. • Accomplished and proficient application of the body and movement concepts, including quality of movement and one other, to the specialised movement sequences and two movement strategies from two different principles of play in authentic performance environments.	7–8
• Effective demonstration of the specialised movement sequences and two movement strategies from two different principles of play in authentic performance environments. • Effective application of the body and movement concepts, including quality of movement and one other, to the specialised movement sequences and two movement strategies from two different principles of play in authentic performance environments.	5–6

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The student work has the following characteristics:	Marks
• Competent demonstration of isolated specialised movement sequences and a movement strategy in authentic performance environments • Competent application of the body and movement concepts, including quality of movement and one other, to some specialised movement sequences and a movement strategy in authentic performance environments.	3–4
• Variable or inaccurate demonstration of isolated movement sequences and a movement strategy in authentic performance environments. • Variable or inaccurate application of a body and movement concept to movement sequences and a movement strategy in authentic performance environments.	1–2
• Does not satisfy any of the descriptors above.	0

8 Create a voice-over on your digital capture, which critiques your performance using the data from tasks 5 and 6.

Self-organisation within the game environment – that is, the ability of a learner to work out a successful outcome to the problem currently being posed in the game (i.e. the current situation) – is a critical element of intelligent performance.

This is crucial, as during a game the coach can't tell the athlete what to do at a specific moment in time, and what might work for one competitor could be different from what might work for other players or the coach. Players must work out for themselves what to do (self-organisation). This skill must be developed as a learner if they are to demonstrate intelligent performance. Therefore, training must replicate this, with learning scenarios planned that provide multiple opportunities for players to solve problems for themselves (learner-centred).

Activity 5.28

Active investigation

Inquiry question:
How can analysis and implementation of strategies improve individual/team performance?

Engage and understand

1 Read the excerpt on the following page.

(continued)

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Traditional decision-making training

One main issue with traditional methods to training decision-making is that they involve repeating decisions and actions in practice against static or predictable opponents, usually until they seem errorless, but with little emphasis on what problem they help solve.

Another issue is the balance in coaching between providing 'stability' or structure (game plans, zones, etc., that act to constrain an athlete's decision-making), and 'instability' or variation (creativity needed for generating uncertainty in opponents) has moved more towards structure. This has led to higher levels of predictability in training and performance, reduced creativity in decision-making and, even more importantly, an inability to adapt to sudden changes.

As a result, athletes are evolving from being good decision-makers who can read the game, adapt and play what they see into pre-programmed robots who are sequenced and patterned, performing specific roles with a rather limited skill set. In some cases, athletes are not able to make decisions based on basic principles of the game (that is, possession, progression, compression, delay, etc.) as they did in their backyards and during unstructured practice.

Source: Richard Shuttleworth, 'Decision-Making in Team Sports' (2013, p. 25).

2 From the article, locate the issues that Shuttleworth identifies with traditional decision-making training.

3 Identify two constraints, both positive and negative, from your specialised movement sequences, based on the evaluation of your performance in Activity 5.23 (on pp. 283–5).

4 Identify two constraints, both positive and negative, from your movement strategies in relation to the principles of play (setting up attack, defending against attack, creating, defending and exploiting space, attacking opposition space, scoring). Ensure that your selections cover separate principles of play.

Apply and analyse

5 Review the principles listed below in relation to constructing small-sided games that are learner-centred, and use the non-linear constraints-led approach.

Key elements

Individual learner is essential.

- Consider the abilities of every individual taking part in the session.
- Students' ability will be across Newell's stages of learning: coordination, control or skill.

Constraints shape emergent affordances.

- Individual, environmental and task constraints shape performance.

Perceptions and actions must be linked.

- Movements must be developed with key perceptual information being present – for example, batting in cricket, bowler's hand action.
- Techniques and tactics must be developed together and should occur early in learning.

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Representative practice design

- Practices must reflect the authentic game environment – defence, net, etc.
- Practice needs to occur at a level that incorporates as much of the game as the players can successfully manage.

Variability

- Creating variability in the learning environment develops skilful and adaptable performers.
- Variability can create instability to improve performance.

Self-organisation

- The individual should be given repetitive variable practice to solve the problems.

Co-adaptability

- Players need to learn to react to the movement of teammates.
- The actions of individuals and opponents are linked.

Rate limiters determine decision-making ability

- The key to designing effective practice environments is to identify the key factors that are limiting performance at this moment in time.

Team patterns develop via a process of self-organisation

- Teams (and individuals) develop strategies that become stable.

Actions are decisions

- Give individuals choices – let them make decisions.

Instructions should be limiting

- Specific instructions can limit the emergence of the best solutions.

Feedback

- Feedback should focus on developing awareness.
- May be in several formats – internal, external, knowledge of results, knowledge of performance.
- May be verbal – information or question or visual.

6 Design two small-sided games for your identified movement sequences for games of 1 vs. 1, 2 vs. 2, 3 vs. 3 and/or 5 vs. 5.

7 Design two small-sided games for your identified movement strategies for games of 1 vs. 1, 2 vs. 2, 3 vs. 3 and/or 5 vs. 5.

8 Complete the table to critique whether designed games meet the key elements for improvement in your performance.

Key element	Evident	Not evident	Explanation of why and how
Individual learner's needs are essential			
Constraints shape emergent affordances			

(continued)

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Key element	Evident	Not evident	Explanation of why and how
Perceptions and actions are linked			
Representative practice design			
Variability			
Self-organisation			
Co-adaptability			
Rate limiters determine decision-making ability			
Team patterns develop via a process of self-organisation			
Actions are decisions			
Instructions should not be limiting			
Feedback			

9 In small groups, implement and demonstrate specialised movement sequences and movement strategy games.

10 Capture digital data of your performance in the small-sided games and authentic performance environments. Remember to store primary data in at least two locations.

11 Analyse data in relation to performance, and identify opportunities and successful outcomes of affordances.

Evaluate and justify

Reflect: Think about deeply and carefully.

12 Judge whether the learning scenario was representative of an authentic environment for your physical activity of study.

13 Appraise whether the introduction of the constraint enabled you to self-organise in solving the problem.

14 Reflect and explain any changes that occurred to your performance in relation to principles of play through the application of constraints.

15 Justify the level of success your constraint-based game had in developing the desired affordances and improving your performance.

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Activity 5.29

Engage-in

Inquiry question: Have you optimised tactical and movement strategies in developing intelligent performance?

Engage and understand

1 Implement the two tactical strategies for optimising performance for two different principles of play by applying two body and movement concepts.

2 Collect digital data on your performance in implementing strategies.

Apply and analyse

3 Analyse the primary data on implementing strategies in relation to successful outcomes.

Evaluate and justify

4 Evaluate the effectiveness of:

- **a** personal performances of the specialised movement sequences and two movement strategies from two different principles of play by applying two body and movement concepts, including quality of movement and one other, to appraise the outcome, implications and limitations
- **b** the tactical strategy by appraising the outcome, implications and limitations of the task, learner and environmental constraints and applied principles of decision-making
- **c** the modification and maintenance of the tactical strategy and movement strategies to optimise performance, using evidence from primary and secondary data.

Figure 5.20 Evaluating strategy

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Chapter summary

- Tactical awareness assists in optimising individual or team performance, and needs to be developed alongside technical skills.
- Learning has occurred when the athlete acquires skill, information or knowledge.
- Intelligent performance can be developed by:
  - manipulation of task, learner and environmental constraints to develop emergent affordances
  - action coupling of constraints.
- There are two major approaches to skill acquisition: the cognitive systems approach and the dynamic systems approach.
- Cognitive systems approach:
  - traditional
  - Fitts and Posner's stages of learning
  - linear learning: skill, drill, game.
- Dynamic systems approach:
  - modern approach
  - Newell's stages of learning
  - Non-linear learning – problem-solving.
- The constraints-led approach is a framework for understanding and developing movement skills. It involves identification of interacting constrains to develop a stable and functional movement pattern.
- The constraints-led approach assists performance because it:
  - is learner-centred
  - includes representative practice
  - involves simplification
  - offers unique solutions
  - promotes affordance
  - contains variation in practice
  - has no ideal movement pattern.
- Students used the analysis of gathered data about their own performance to devise strategies to optimise performance.
- Students evaluated the effectiveness of the tactical and movement strategies, and justified maintenance of strategies or modifications.

Chapter review

Multiple-choice questions

1 Learning is considered to have occurred when:

A skills have been acquired.

B information has been acquired.

C knowledge has been acquired.

D any of the above.

2 Learning is:

A linear in nature.

B able to automatically progress from one stage to the next.

C when an individual is attuned to information only from the environment.

D when a coordinated movement pattern occurs in a non-linear progression.

3 Intelligent performance is a concept:

A in which the athlete can manipulate rules, time, score and technical and tactical individual and team affordances to their advantage.

B involving individual learning in a closed environment and progression through several drills to enhance decision-making.

C linked to improving technical skills.

D revolving around only cognitive processes of the brain.

4 The cognitive systems approach is a more traditional approach that involves:

A information dissemination.

B input of information to the brain, processing information followed by execution of movement.

C stages of learning closely aligned to Newell's stages of learning.

D understanding of Bernstein's degrees of movement.

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5 The dynamic systems approach is a more modern approach involving:

A continual active updating of information.

B alignment with Fitts and Posner's stages of learning model.

C self-organisation in a complex system.

D the construction of tasks only for elite performers.

6 A learning approach that focuses on the learner attuning to the task, the learner and the environment is:

A the skill, drill, game approach.

B the closed environments approach.

C not realistic in games play.

D the constraints-led approach.

7 Constraints:

A are boundaries that shape a learner's self-organisation.

B are based on the learner, the task/goal and/or the environment.

C can lead to positive and negative emergent behaviour.

D all of the above.

8 When developing small-sided games so that the learner can develop affordances, the focus on manipulating constraints should:

A be teacher/coach-centred.

B be representative of the authentic environment.

C involve deconstruction of tasks.

D involve closed repetitive tasks.

9 The use of a Game Performance Assessment Instrument (GPAI) allows for:

A summation of forces to be reviewed.

B only tactical aspects to be evaluated.

C an evaluation of many aspects of performance.

D decision-making errors to be dismissed.

10 The principles of play involved in invasion games are:

A only useful when you are the coach of a team.

B setting up attack, defending against attack, creating, defending and exploiting space, attacking opposition space and scoring.

C defending the goal third, restarts of play, attacking opposition space, scoring and umpiring.

D useful for biomechanical considerations regarding limitations of performance.

Short-answer questions

1 Explain the differences between Fitts and Posner's, and Newell's stages of learning models.

2 Why might the use of skill, drill, game learning tasks not be beneficial for invasion games?

3 List and explain five implications of implementing the constraints-led approach.

4 Identify the three different types of constraints and provide an example of each.

5 Evaluate how affordances may be promoted through the manipulation of constraints in small-sided games.

Extended-response questions

1 Design a small-sided game that promotes two affordances from one principle of play. Present your game and, in 600 words, justify how the constraints implemented will cause the target affordances to emerge.

2 Develop a training activity using a dynamic systems approach to learning that is designed to target a specific tactic for a principle of play. Implement the training activity and evaluate its effectiveness. In 400 words, describe the activity and justify its effectiveness.

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Chapter 6

Ethics and integrity in physical activity

Chapter description

In Topic 2, the first stage of inquiry requires students to recognise and explain the concepts and principles about ethics and integrity in physical activity. In a range of physical activities, students explore the factors that influence fair play, ethical behaviour and integrity to gather data about engagement.

In the second stage, they use the ethical decision-making framework to analyse data and synthesise relationships between the factors that influence engagement in physical activity to identify an ethical dilemma. Students then devise an ethics strategy in response to the dilemma to optimise engagement in physical activity.

In the final stage, students evaluate the effectiveness of the ethics strategy to optimise integrity and engagement, and justify using primary data and secondary data.

(Physical Education 2019 v1.1 General Senior Syllabus © Queensland Curriculum & Assessment Authority)

Key inquiry questions

- What are ethics?
- What is integrity?
- How are ethics and integrity developed and displayed through physical activity?
- What is the importance of ethics and integrity to Australian physical activity?
- How do the principles of fair play enhance engagement in and enjoyment of physical activity?
- What ethical issues impact on the integrity and standing of physical activity in Australia?
- What ethical strategies help to maintain the integrity of physical activity and its participants?
- How can an ethical decision-making framework help limit ethical issues and increase integrity?

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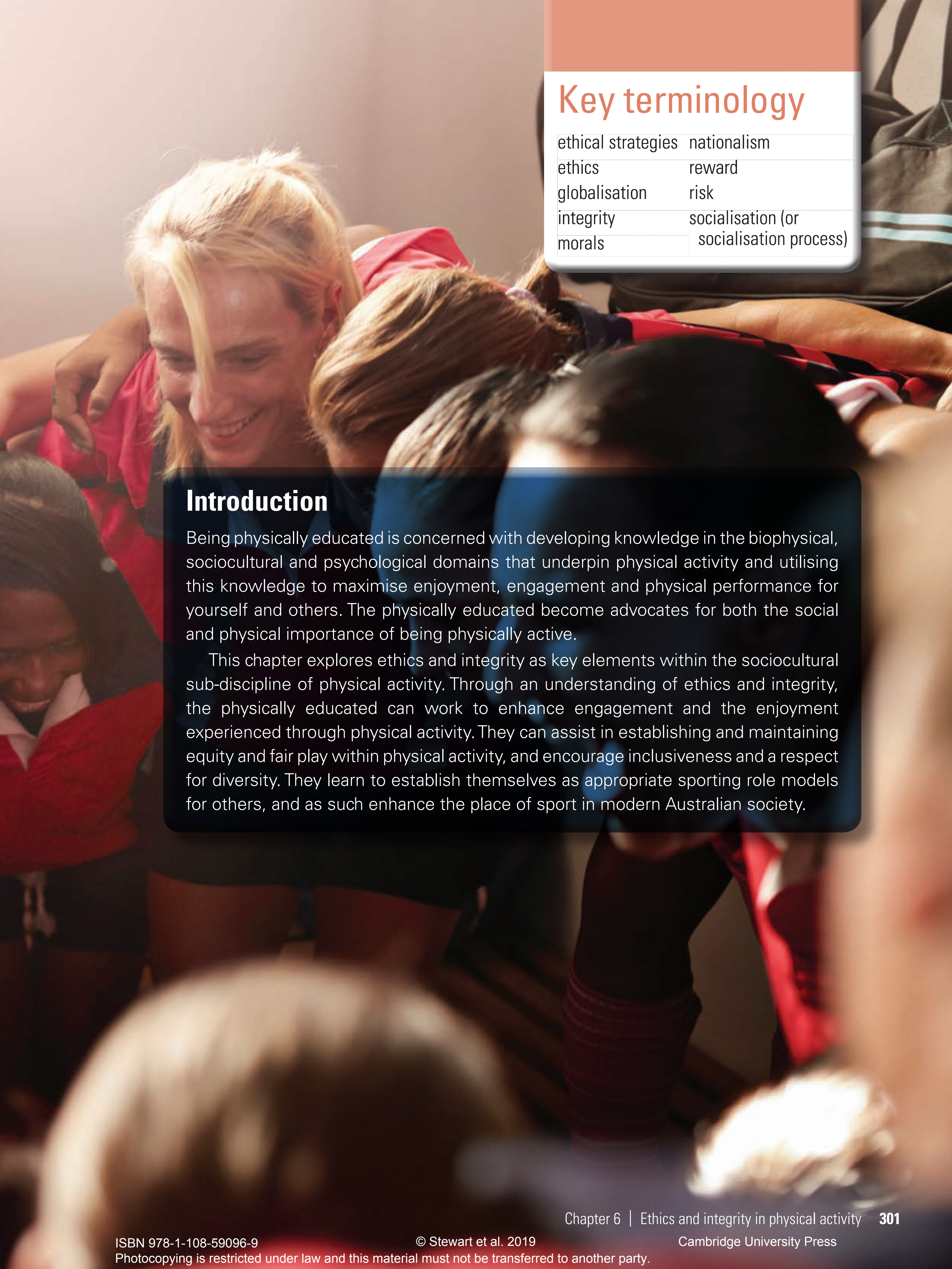

Key terminology

ethical strategies	nationalism
ethics	reward
globalisation	risk
integrity	socialisation (or socialisation process)
morals	

Introduction

Being physically educated is concerned with developing knowledge in the biophysical, sociocultural and psychological domains that underpin physical activity and utilising this knowledge to maximise enjoyment, engagement and physical performance for yourself and others. The physically educated become advocates for both the social and physical importance of being physically active.

This chapter explores ethics and integrity as key elements within the sociocultural sub-discipline of physical activity. Through an understanding of ethics and integrity, the physically educated can work to enhance engagement and the enjoyment experienced through physical activity. They can assist in establishing and maintaining equity and fair play within physical activity, and encourage inclusiveness and a respect for diversity. They learn to establish themselves as appropriate sporting role models for others, and as such enhance the place of sport in modern Australian society.

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Inquiry cycle – stage 1: Engage and understand

6.1 Ethics and integrity

What are ethics?

Humans have spent a considerable amount of time pondering the meaning of life. Ancient philosophers Plato and Socrates are famous for statements such as, 'The unexamined life is not worth living'. In a modern context, this is understood to mean that people should be introspective, reflect on their actions and find meaning in life for themselves. Philosophers may expand this central question to include, 'How should I live?', 'How should I act?' and 'What should I do?' In part, these questions can be answered through the exploration and application of **ethics**.

ethics a system of moral principles and values by which actions and proposals may be judged good or bad, or right or wrong

Activity 6.1

Engage-in

Inquiry question: How do ethics play a role in physical activity?

Engage and understand

1 Select a team sport to be the focus of a lesson's activity.
2 Set up uneven teams where one will have an obvious advantage over the other. If numbers allow, have players sitting on the sideline as reserves who are infrequently used.
3 Engage in the activity for a 20-minute half.
4 At half time, discuss that this is a team sport, and as such, teams win or lose as a group. As a result, any physical marks for this unit will be awarded to the whole team (everyone on the team will receive the same physical assessment result). As a consequence, the current teams will be used throughout the term so that some people are not overly advantaged, and therefore it is 'fair'.
5 Engage in the activity for the second half.

Apply and analyse

Analyse: Examine or consider something in order to explain and interpret it, for the purpose of finding meaning or relationships and identifying patterns, similarities and differences.

6 At the end of the match, reflect on the following with regard to team composition and 'group assessment':
   a How did it affect engagement?
   b How did it affect confidence and motivation?
   c How did it affect enjoyment?
   d Who would be advantaged and disadvantaged by this system?
   e Is there a more equitable way to organise teams? What might be a better strategy?

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Evaluate and justify

7 In a short statement, write how this activity sits with your own notion of what is right and wrong in sport and in education.

8 Discuss, as a class, your understanding of the term 'ethical' and whether this activity has displayed an ethical approach to physical activity.

9 Reflect on how unethical situations in physical activity may affect engagement, confidence, motivation and enjoyment of physical activity.

Ethics are a system of moral principles and values by which actions and proposals may be judged good or bad, or right or wrong. Ethics are closely linked to **morals**, and they may be used interchangeably by a philosopher or sociologist, with no clear distinction between the two. However, in areas such as governance, law, medicine, business and sport, it is important to recognise a difference between ethics and morals.

Ethics are determined by a group and establish the norms for what is right and wrong, good or bad. These 'guidelines' can be unwritten, and are reflected in the actions of the group and enforced by group members when these guidelines are broken. Consider a parent telling their child not to cheat when the family is playing cards. More typically, however, ethics refer to a set code that is proposed, monitored and enforced by a group, profession or community. Think of the ethics set by the medical, business or sporting community. Here, ethics may refer to a well-defined set of standards or guidelines that outline the behavioural norms for members of that group.

Morals, on the other hand, are an individual's personal code for what is right or wrong, good or bad. Through socialisation, individuals develop their own personal values, beliefs and attitudes in this area. When the ethics of a group and the morals of an individual align, then it is easy for an individual to display appropriate actions. For example, if a players' code of conduct for netball states, 'Follow all instructions from officials', and the player believes that 'the umpire's decision is final', then playing by the rules is an easy affair. However, if the player believes the umpire can make mistakes and winning is a priority, they may argue decisions. When there is a conflict between the **ethical standards** and an individual's morals, behaviours deemed inappropriate by the group can result.

morals an individual's sense of right or wrong developed through their own unique socialisation process

ethical standards a set of principles or guidelines that outline expected conduct reflecting underlying morals, such as trust, equality and kindness

integrity the application of generally accepted values and norms in daily practice

What is integrity?

With every action, behaviour and word spoken, people make an ethical decision about whether or not to follow the expectations established by those around them. It is through their actions that people display **integrity**, which is the application of generally accepted values and norms in daily practice. People with high integrity are those who consistently display ethical behaviours through their actions.

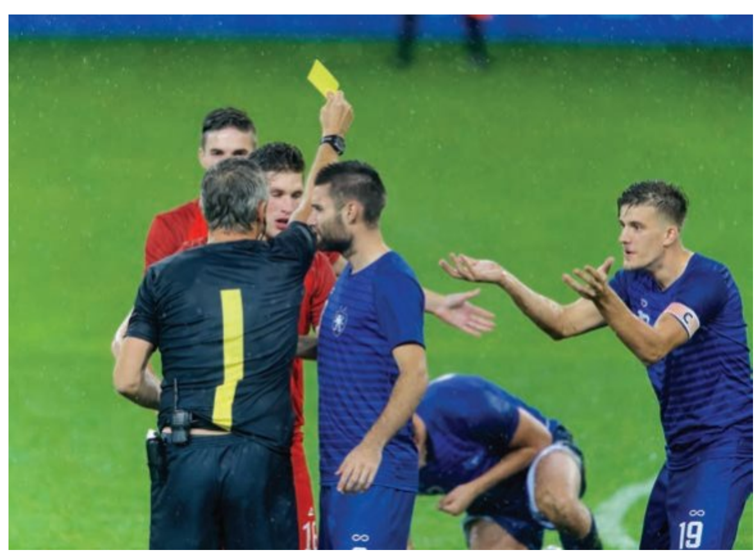

Figure 6.1 Where there is a conflict between the ethical standards set by the group and an individual's morals, inappropriate behaviours may result.

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Activity 6.2

Check-in

1 Use one sporting and one non-sporting example to explain the difference between ethics and morals.
2 Explain why ethics could be easy to change, whereas morals are much more difficult to influence.

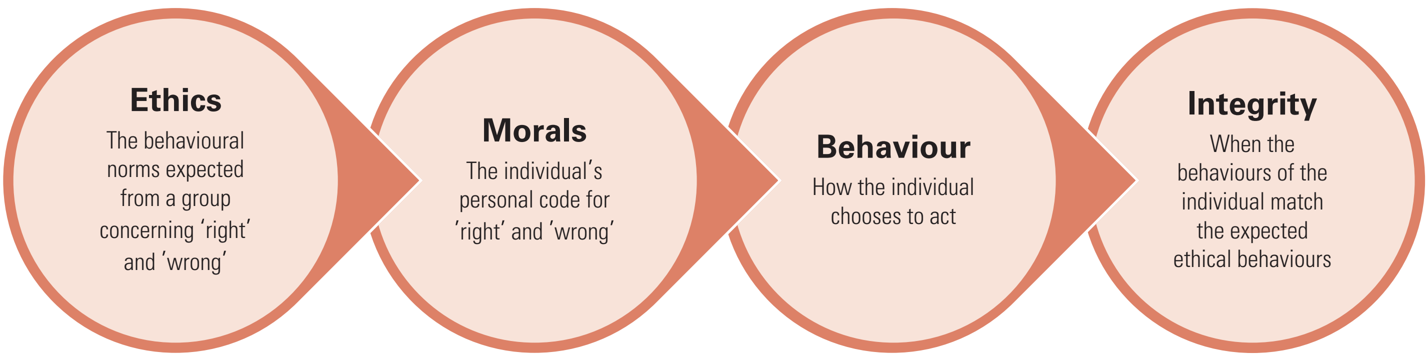

Figure 6.2 A person's morals are a key link between the ethical behaviours that are expected by those around them and the behaviour that is actually displayed.

Activity 6.3

Check-in

1 Integrity is displayed in a person's actions and reflects their morals. Through a think–pair–share, devise a list of the top five characteristics a sportsperson must display in order to be considered to have integrity.
2 Integrity can also be applied to a specific sport, club or competition. The integrity of these institutes is vital for maintaining community confidence. Identify five characteristics these institutes would need to display in order to maintain integrity.
3 Select a player from any physical activity – famous or local – who is recognised for their integrity or lack of it. Research their behaviours and be prepared in your next lesson to present your athlete and support your position on their integrity with two examples of their behaviours.

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Activity 6.4

Engage-in

RECOGNISE & EXPLAIN | DEMONSTRATE | ANALYSE & SYNTHESISE | EVALUATE | JUSTIFY

Inquiry question: How does a lack of integrity affect enjoyment of and engagement in physical activity?

Engage and understand

1 Undertake a physical activity for a lesson. For this activity, it is best to use a team game where all can participate throughout the lesson.

2 During the match, allow unethical behaviours to be displayed (where this does not compromise safety). For example:

- **a** Referees or umpires may police the rules 'loosely', favour a particular player or team or make obvious poor decisions.
- **b** Players may be encouraged to exploit or ignore rules to their advantage or to act in 'un-sportsperson-like' ways (within reason).

Apply and analyse

KEY COGNITION

Analyse: Examine or consider something in order to explain and interpret it, for the purpose of finding meaning or relationships and identifying patterns, similarities and differences.

3 Debrief the experience by:

- **a** identifying examples of unethical behaviours displayed by the referee or umpire
- **b** identifying examples of unethical behaviours displayed by the players.

4 Rate the following on a scale of 1–5:

- **a** enjoyment level
- **b** engagement of all participants
- **c** spirit in which the game was played.

5 Note how difficult it was personally to act in unethical ways – easy or hard.

Evaluate and justify

6 Reflect and respond: did a lack of integrity affect the general enjoyment and participation of players during this lesson?

7 How would a similar lack of integrity affect enjoyment, participation and the reputation of the sport if it were a regular feature in weekly club competitions?

KEY MESSAGE

Ethics allow behaviours to be judged as right or wrong.

KEY MESSAGE

An individual's behaviours reflect their own morals, which may or may not align with the expected ethical behaviours.

KEY MESSAGE

Integrity is demonstrated when behaviours align with the ethical behaviours expected by others.

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Activity 6.5

Engage-in

Inquiry question: Do ethical guidelines increase the positive experience of physical activity engagement?

Engage and understand

1 Review the findings from Activity 6.3 (on p. 304).

2 As a class, devise a set of guidelines for the same physical activity that outlines standards for sportsperson-like behaviour. Try to set very high expectations – for example:

- Hand the ball to your opponent at a changeover.
- Use supportive language to teammates, opponents and officials.
- You may even include an expected standard for play – for example, you must say one complementary thing each set with the ball or point, or apologise to an opposing player if accidental contact is made, or shake hands with an opponent when they score.

Apply and analyse

3 Implement these guidelines in a match.

4 Debrief the experience by rating the following on a scale of 1–5:

a enjoyment level

b engagement of all participants

c spirit in which the game was played.

5 Was it difficult to follow the guidelines?

6 Were un-sportsperson-like behaviours still displayed? If so, what were they?

Evaluate and justify

Evaluate: Make an appraisal by weighing up or assessing strengths, implications and limitations; make judgments about the ideas, works, solutions or methods in relation to selected criteria; examine and determine the merit, value or significance of something, based on criteria.

7 Evaluate how effective the guidelines were in creating a positive playing experience.

8 What guidelines could be adjusted or added to further enhance the playing experience?

9 Does playing with integrity provide a more positive playing experience for players?

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Figure 6.3 Ethical behaviours are an important factor in childhood activity, as they are vital for maintaining a sense of fun.

Activity 6.6

Engage-in

Inquiry question: How do ethical behaviours influence engagement and enjoyment of physical activity?

Engage and understand

1. As a class, brainstorm a list of activities that you played in junior primary school that were really enjoyable – for example, Cat and Mouse; Duck, Duck, Goose; Hide and Seek; or Tiggy.
2. Discuss why they were enjoyable.
3. For a lesson, relive your childhood by playing these games.

Apply and analyse

4. Towards the end of the lesson, stop and discuss the following:
   a. What was the enjoyment level experienced?
   b. What was the engagement level of the class?
   c. Were any unethical behaviours demonstrated?

(continued)

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d Do these activities still provide the same sense of 'fun' as when you were younger?

e What characteristics do these activities have that may promote ethics and integrity – for example, fair, honest, a lack of scoring, no set 'winner'?

Evaluate and justify

Appraise: Evaluate the worth, significance or status of something; judge or consider a text or piece of work

5 In a short paragraph, outline how important ethical behaviours are for establishing enjoyment and fun for participants in childhood games.

6.2 Integrity in physical activity

Culturally, physical activity and sport in Australia constitute a significant microcosm of society, and play an important part in the socialisation process of Australians. Physical activity is an important socialising agent in terms of establishing social and moral values such as teamwork, respect for others and rules, fair play, equity and honesty. It is through positive engagement that participants learn the physical and mental health benefits of being physically active, and experience the enjoyment that regular participation can offer.

There is not only cultural value in maintaining the integrity of physical activity, but for sporting organisations in a competitive marketplace, there is also a significant economic value. Ethical violations decrease the integrity of their product (a player, a club, a sport or sport in general). A decrease in integrity through displaying unethical behaviours makes it more difficult to market a sport, attract sponsorship and increase participation. It is through integrity that the cultural significance and economic worth of physical activity are maintained.

Figure 6.4 Extract from *The Essence of Australian Sport: What We Stand For*

The extract in Figure 6.4 was taken from *The Essence of Australian Sport: What We Stand For*, produced by the Australian Sports Commission in 2012. It is a reflection of the important role integrity plays in maintaining the ethical standards of Australia sport.

Despite the positives of physical activity, ethical violations detract from the important role of sport in society. To maintain the cultural and financial worth of a physical activity, significant time, money and intellect are invested at all levels of society to develop laws, rules and frameworks to uphold sporting integrity. These strategies are built on a solid foundation of ethics and protect against corruption and inequity. They address the conduct of all people involved in physical activity – players, parents, coaches, officials and administrators.

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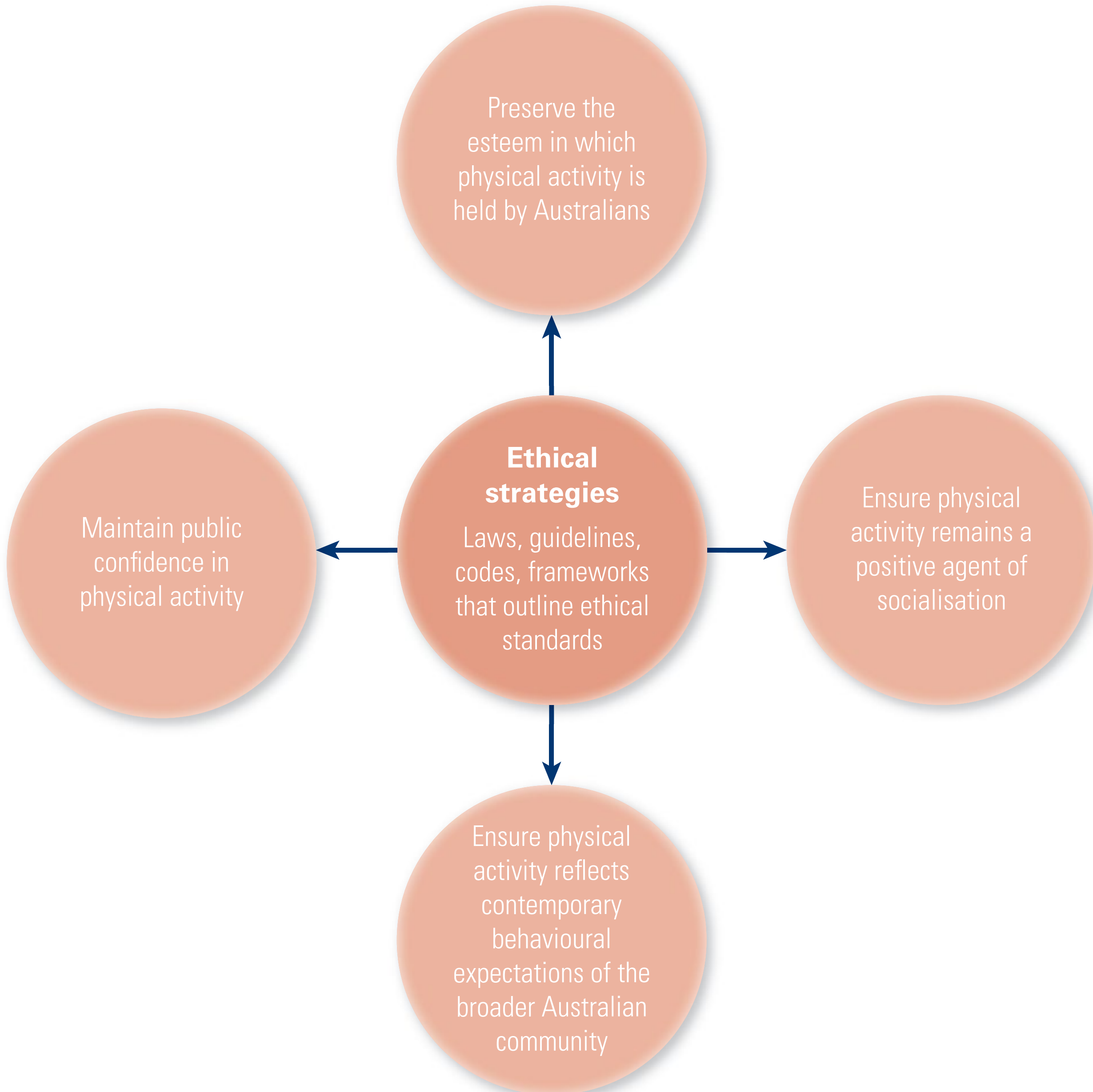

Figure 6.5 Ethical strategies work in many ways to maintain and enhance the cultural and economic value of physical activity.

Activity 6.7

Check-in

1. As a group, brainstorm a list of 'Australian' beliefs that are reflected in physical activity – for example, 'getting a fair go' or 'battling through to the end'.
2. Select one belief identified and provide an example of how it is demonstrated in general society, and one example specific to physical activity.
3. Outline some unethical behaviours that could be displayed in sport which might undermine this belief for spectators.

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> **KEY MESSAGE** Maintaining integrity in sport through ethical strategies is key to ensuring its high value in Australian society.

> **KEY MESSAGE** Ethical strategies include guidelines, policies, frameworks and codes that outline behavioural standards.

> **KEY MESSAGE** Ethical violations reflect poor integrity and lower the cultural and economic value of physical activity.

While ethical strategies work to uphold sporting integrity, there are still many unethical behaviours displayed by those in and around the physical activity and sporting industries. Table 6.1 lists some of the main ethical and integrity issues currently facing Australian sport.

High-level sport	Grass-roots sport
• Insufficient resourcing of management by sports governing bodies • The use of illicit and performance-enhancing drugs • Overseas-based criminal threats • Domestic criminal associations • Infiltration of sports through legitimate businesses, contractors and consultants • Match-fixing • Exploitation of inside information • Wagering vulnerabilities • Financial vulnerabilities • Specific high-risk individuals. **Source:** Taken from *Integrity in Sport*, Clearinghouse for Sport Australia, 2018.	• Juniors participating against more physically developed opponents • Sledging • Athletes being pushed too hard by coaches or parents • Negative coaching behaviours and practices • Juniors participating against more skilled opponents • Negative administrative behaviours and practices • Issues that most negatively impact on sport • Going beyond the spirit of the game • Verbal abuse • Negative coaching behaviours and practices • Athletes being pushed too hard by coaches/parents • Negative administrative behaviours and practices • Negative officiating behaviours and practices **Source:** Taken from Australian Sport Commission, Summary of the 2010 Ethical and Integrity Issues in Australian Sport survey.

Table 6.1 Main ethical and integrity issues currently facing Australian sport

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6.3 Ethics and values to promote community confidence in physical activity

In its purest form, physical activity provides a fair contest, free from corruption, equitable and inclusive. It provides a context to display honour, persistence and dedication. In addition, sport provides a stage for winners to celebrate with humility and losers to be gracious in defeat. As such, physical activity reflects characteristics valued highly in Australian society. Sport is therefore seen as a source of national pride; it provides a sense of community and develops **nationalism** among the Australian population. Our national identity has a significant sporting aspect, which can be traced back to Australia's emergence as an independent nation on the world stage. In modern Australia, physical activity also has significant worth from both an economic and a health standpoint. As a commodity, physical activity is a billion-dollar industry that relies on its reputation to maintain both its worth and its social standing.

nationalism devotion and loyalty to your own country and the desire for national advancement

Many factors contribute to the monetary and societal value Australians place on physical activity. When unethical behaviours are demonstrated in any of these areas, the result is a decline in the value of physical activity. Acting with integrity within the field of physical activity retains confidence and grows value.

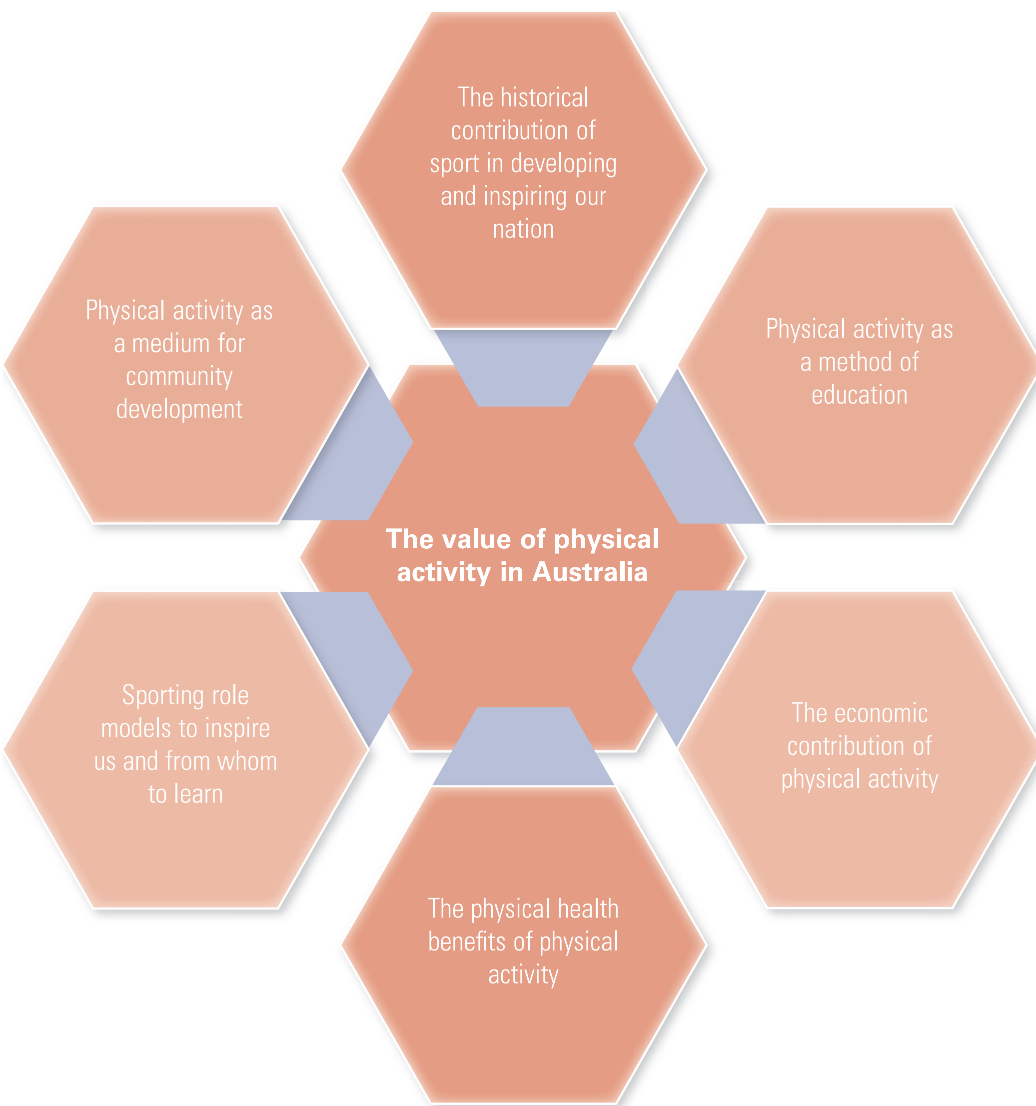

Figure 6.6 Many factors contribute to the monetary and societal value Australians place on physical activity.

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When ethical behaviours and integrity are shown, community confidence in physical activity is maintained and so too is its value. People are comforted by the fact that sport is continuing to reflect the beliefs and attitudes they 'hold dear'. Conversely, poor behaviours and corruption in physical activity can erode community confidence. Each time unethical behaviours are displayed at any level of participation, it will have a devaluing effect on sport. With ongoing ethical violations comes a lack of community trust. Confidence in sport begins to waver and people start to question whether physical activity (or a specific sport) still reflects appropriate social values. Consumers tend to shy away from 'cheap and nasty', and this is the perception when members of the sporting community act in unethical ways.

Ethical guidelines and standards are one way to combat poor behaviours and maintain community confidence in physical activity. Articulating ethical behaviours through policies, programs and codes demonstrates integrity and encourages the broader community to retain confidence in our sporting system.

Figure 6.7 Consider the impact of behaviours such as Johnathan Thurston picking up his own kicking tee, cleaning the change rooms while injured or giving his headgear away to fans.

While not all individuals may uphold these standards, there is a process in place to deal with those who tarnish the image of sport through their behaviours. At a time when there are many troublesome events globally, positive sporting behaviours can provide confidence and faith in human nature.

Activity 6.8

Check-in

1 Read the following scenario.

During an interschool sporting match, a fight breaks out between two players, which is instigated by a player from your school. Four other players from both sides join in the fight.

2 In groups, investigate the ethical frameworks your school has in place to address this situation (school behaviour management plan, sport code of conduct, others). What specific guidelines have been broken?

3 How would this incident affect the integrity of:

- **a** the instigating player
- **b** sport within your school
- **c** your school?

4 How would this incident be viewed by the following community members from your school:

- **a** student body
- **b** teachers and administration
- **c** parents and friends of the school.

5 Justify whether you believe the possible consequences for the players involved would be sufficient for the harm done to integrity.

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Activity 6.9

Check-in

1. Find a recent example of a player who has demonstrated high integrity in their chosen field. Outline why their actions showed integrity and infer how this may have boosted confidence in physical activity for those who are aware of the person's actions.
2. Find a recent example of a person/team being unethical in their chosen field. Outline why their actions lacked integrity and infer how this may have been detrimental to confidence in physical activity for those who are aware of the person's actions.

Sporting performance unaffected by illegitimate enhancements or external interests

The notion of **fairness** is held in high esteem by Australians across all areas of society. This attitude has a significant historical context, whether it be from our convict history, the time of the gold rush, our post-World War II multicultural workforce or the 10 pound Poms; Australia has always been a land of opportunity where, with a strong work ethic, anyone can succeed. Colloquially, Australians have always prided themselves on giving anyone a 'fair go', and many Australians would view this value as one of our most important.

'Fairness' is therefore a central feature of Australian physical activity. People can accept that there are winners and losers in a game, provided the contest has been a fair battle from the outset. As either a competitor or spectator, many are affronted when a contest is seen to be unfair, and this can lead to deep outrage from the community. As a result, in our culture cheating is perceived as taking the easy road to success at the expense of those who have committed to doing the hard work needed to succeed.

fairness where competitors have a relatively equal chance of success as all involved are undertaking the activity in accordance with the rules, ethics or logic

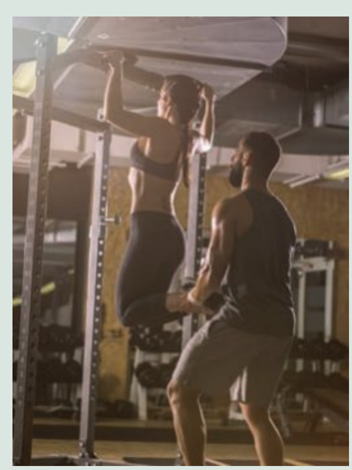
Activity 6.10

Engage-in

Inquiry question: How does illegitimate competition affect the outcome of matches?

Engage and understand

1. Ensure you have a reward for the winner of a flexed arm hang competition (one male, one female). See a flexed arm hang test procedure on the following page.



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Flexed arm hang			
This test measures upper body strength. Procedure: Healthy fitness zone	Age	Male (seconds)	Female (seconds)
1 Grasp pull-up bar with palms facing away from body. A spotter may assist in helping raise chin above the bar. 2 Time starts when performer is in position with chin above the bar. 3 Time stops when the chin hits the bar, drops below the bar or the head tilts back. The body may not swing during the test. 4 Performer may have one attempt only and their score is the number of seconds they last.	14	≥15	≥8
	15	≥15	≥8
	16	≥15	≥8
	17	≥15	≥8
	>17	≥15	≥8

2 Before recognising the winner, announce that the competition is subject to age-based criteria, so times will be adjusted as follows:

Month born	**July**	**August**	**September**	**October**	**November**	**December**
Time added	+0s	+1s	+2s	+3s	+4s	+5s
Month born	**January**	**February**	**March**	**April**	**May**	**June**
Time added	+6s	+7s	+8s	+9s	+10s	+11s

3 Announce the male and female winners based on age-adjusted times.

Apply and analyse

4 Was the outcome of the competition affected by the rules of the competition?

Analyse: examine or consider something in order to explain and interpret it, for the purpose of finding meaning or relationships and identifying patterns, similarities and differences.

5 Was this an ethical way to administer a competition to determine the greatest upper body strength?

6 How did participants feel about the winners? The competition?

Evaluate and justify

7 Using this experience as evidence, outline how illegitimate competition affects the integrity of sport.

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Activity 6.11

Engage-in

Inquiry question: How does illegitimate competition affect the engagement, enjoyment and the value of physical activity?

Engage and understand

1 Students will engage in a 100 m sprint race based on gender for the title of fastest male and female in the class. If possible, arrange a reward for the winner of each division.

2 Before commencing each race, have each student randomly select a number between 1 and 15. The number they select represents their starting position for the race – that is, the student who is allocated the number 6 may take 6 steps forward from the 100 m start and this becomes their individual starting position. Each student does this until all students have different starting positions for the race.

3 Conduct the race.

Apply and analyse

4 Analyse the effect the different starting positions had on the competitors and the outcome of the race. Consider the following:

- **a** Was the race a true indication of the fastest person in the class?
- **b** Was the race fair?
- **c** Was the winner deserving of the reward?
- **d** Which participants still put in maximum effort? Which did not?
- **e** How did competitors in the race feel about the competition, knowing the circumstances under which it was run?

Evaluate and justify

Justify: Give reasons or evidence to support an answer, response or conclusion; show or prove how an argument, statement or conclusion is right or reasonable.

5 Justify how this competition affected the engagement, enjoyment and value of 100 m sprint racing for competitors.

Note: The concept in this activity can be used three to four times in a variety of different physical activities. Consider events such as discus, javelin or shot put, where distance could be added or taken away; or archery, basketball, tennis, golf or badminton, where points could be given or taken away randomly, or based on criteria (e.g. height, arm span or hair colour). For example, in an archery competition after a round of shooting, students randomly select from the numbers 1–10 and then from a + or – ; the selected number is then either added or subtracted from their shooting score.

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As cheating is diametrically opposed to the values of many Australians, when sporting performances are affected by this unethical behaviour, confidence in physical activity is reduced. As participants or spectators, most Australians would agree that they just want the competition to be fair and honest – that all involved are displaying integrity.

There are many factors surrounding fairness and honesty that affect the legitimacy of sporting results. These negatively affect the integrity of sporting performances, and undermine the value placed on physical activity by Australians.

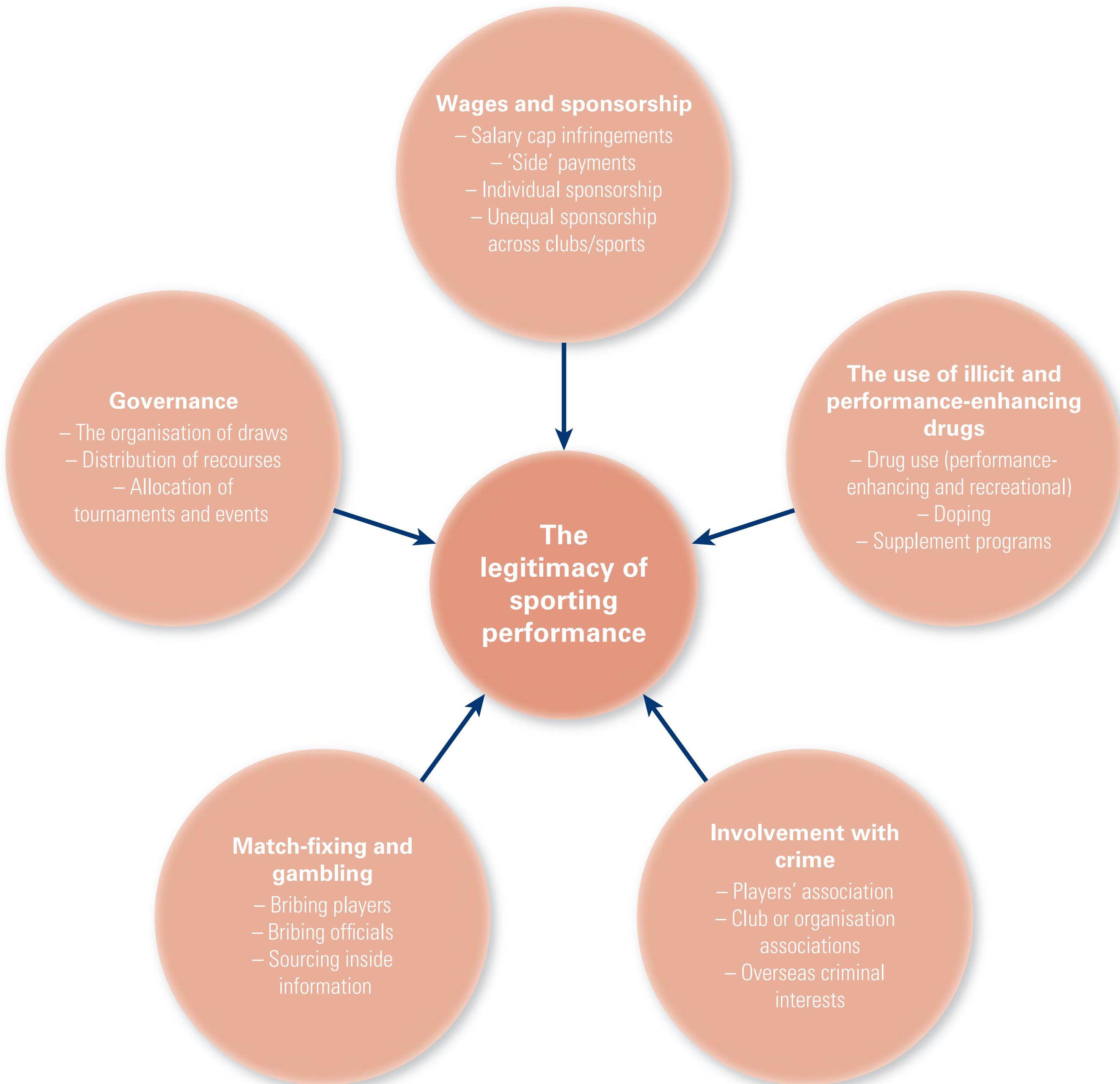

Figure 6.8 Some of the many factors surrounding fairness and honesty that affect the legitimacy of sporting results

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Figure 6.9 Gaël Monfils' behaviour during the 2017 US Open tennis tournament semi-final caused people to question whether his tactics were fair.

Activity 6.12

Engage-in

Inquiry question: How does illegitimate competition affect the notion of fairness?

Engage and understand

1. Divide students into teams to compete in a class round-robin basketball competition lasting one lesson.
2. Engage in matches for a lesson and collect primary data that would indicate a player or team's performance – for example, scores, for and against record.
3. Keeping the teams the same, conduct the same activity in the next lesson. However, before each match have a player from each team play scissors, paper, rock; the losing team must play the whole game (or a set time at the start of the match) with one hand behind their back.

(continued)

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4 Engage in the matches again, collecting the same type of primary data on player performance. At the completion of the match/competition, celebrate the winning team; if possible, award a prize as an incentive.

Apply and analyse

5 Debrief the activity.
   a Was the second competition a legitimate competition?
   b Which players gave their full effort throughout the second competition?
   c Which players' efforts were affected by the 'unfair' conditions?
   d What data or evidence did you collect from both competitions that would support your answers?

Evaluate and justify

Synthesise: Combine different parts or elements (e.g. information, ideas, components) into a whole, in order to create new understanding

6 In a 100-word statement, explain how this activity relates to the taking of performance-enhancing drugs and the notion of 'fair competition'.

Activity 6.13

Engage-in

Inquiry question: How does illegitimate competition affect the integrity of physical activity?

RECOGNISE & EXPLAIN | ANALYSE & SYNTHESISE | EVALUATE | JUSTIFY

Engage and understand

1 Divide students into two teams to compete in a class match – this activity will work best if the teams are pre-selected by the teacher. Organise a reward for the winning team and announce this to the class.

2 Before the start of the match, offer two players on one of the teams a greater reward if they perform 'below their best' to throw the match. Debrief them not to be obvious; if they can be identified at the end of the game, they will not get their reward.

3 Engage in the match.

Apply and analyse

4 At the completion of the match, celebrate the winners, then inform students that two players were asked to try to 'throw the match'.

5 Debrief the activity Stage 1.
   a Can students identify the two players?

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b Once identified, discuss what actions the two players took to try to 'throw the match'.

c Were they successful in influencing the outcome?

6 Debrief the activity Stage 2.

a How do players feel about the match now knowing other players were working against them?

b How did the two players feel about their role in the match?

Evaluate and justify

Justify: Give reasons or evidence to support an answer, response or conclusion; show or prove how an argument, statement or conclusion is right or reasonable.

7 Using examples from this learning experience, justify how the integrity of sporting competition is diminished when athletes intentionally under-perform.

Activity 6.14

Engage-in

Inquiry question: How does gambling affect the integrity of sport and players?

Engage and understand

1 Conduct a class discussion on recent examples of gambling incidents in sport. Consider using an article or internet resource as a stimulus for this conversation. Explore the aspects of who and why, as well as how it affected the integrity of the players involved and the sport in general.

2 Decide on a physical activity for this activity – a team sport like touch football, Australian Rules Football, Futsal or something similar works best, but this activity can easily be adapted for use in a competition in sports like, golf, tennis and badminton.

3 Conduct a class 'sweep' by placing the names of all class members into a 'hat' and having each class member pull out a name. Repeat this process a number of times; each time, students are drawing for a different reason. For example:

a first point scorer

b first person to have an impact in attack (e.g. first line break in touch football)

c first to make a specific error (e.g. a dropped ball)

d first to make a different specific error (e.g. miss a touch in touch football).

Students will need to record the players they have drawn for each of the categories included in the activity.

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4 If possible, arrange a prize as an incentive for the student who wins each category of the 'sweep'.

Apply and analyse

5 Undertake the physical activity, taking note of the players who perform the actions that were the focus of the sweep and the student who drew that player.

6 At the end of the match, reward the students who won the various sweeps with their prizes.

7 Debrief the activity by discussing the following:

a Did the sweep affect the effort of players?

b Did the sweep influence the decisions and skills implemented during the game?

c Did any students try to influence the outcome, either through their own on-field actions or by influencing the actions of others?

d Was the integrity of any students compromised by the sweep?

e Did the match itself have integrity?

Evaluate and justify

Justify: Give reasons or evidence to support an answer, response or conclusion; show or prove how an argument, statement or conclusion is right or reasonable

8 In 200 words, and using the primary and secondary data gathered during this activity, justify why ethical guidelines must address player gambling if the integrity of sport is to be maintained.

Enhancing the perception, reputation and standing of physical activity in Australian society

It is essential that if physical activity is to remain a valued microcosm of Australian culture, all those involved need to behave ethically and with integrity. This means athletes, administrators, officials, supporters and all other stakeholders in and around physical activity must undertake their involvement in a positive and constructive manner. The primary tools for enhancing integrity and positive engagement in physical activity are the ethical guidelines, policies and codes established to enhance the perception, reputation and standing of physical activity in Australia.

Physical activity and associated industries now have a significant number of policies, guidelines and frameworks covering all aspects of governance and participation levels to assist them in enhancing the perception, reputation and standing of physical activity in Australian society. Many of these are required by various levels of government within Australia, or the governing bodies for the specific physical activity. Over-arching policies exist, such as the federal government's National Sport and Active Recreation Policy Framework and the National Sports Plan.

6.4 Fair play in physical activity

The vital role played by physical activity in the betterment of society has been established throughout this chapter and also in Chapter 4. The health and social influence of physical activity are at their greatest when all people associated display the values of fair play. It is through the values of fair play that physical activity becomes a positive socialising agent for individuals, guiding them to act in ethical ways. Following the values of fair play allows people to act with integrity and, for Australians, uphold the expected behaviours of our society.

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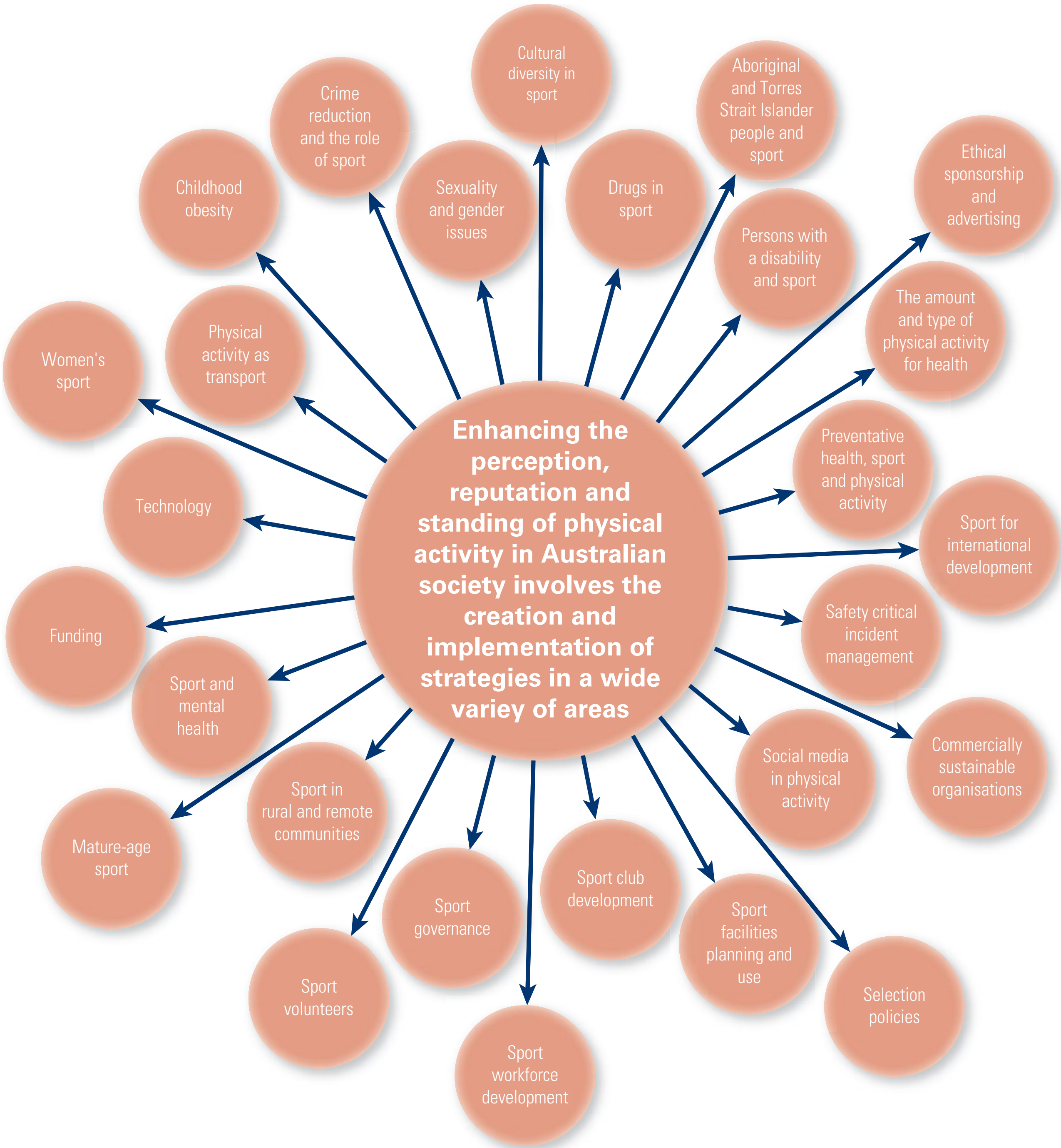

Figure 6.10 Policies, guidelines and frameworks for physical activity and associated industries

KEY MESSAGE Ethical strategies include policies, guidelines, codes and frameworks, which set the standards for all those involved in physical activity.

KEY MESSAGE Ethical strategies are the primary tools used to enhance ethical standards and integrity in physical activity.

KEY MESSAGE Through ethical strategies, the perception, reputation and standing of physical activity in Australian society are enhanced.

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Fair play is a complex concept that comprises and embodies a number of fundamental values that are not only integral to sport but relevant to everyday life. The International Fair Play Committee states that:

> Fair play is not a theory. Fair play is an attitude that manifests itself in behaviour. Whenever we act in the spirit of fair play we contribute to building a peaceful and better world.
>
> Without fairness and trustworthiness the established order of our society is at risk. If we do not play by the rules, we ruin the spirit of the game and it is impossible to play with destroyers of the game.
>
> Fair play, which is an essential and central part of successful involvement, promotion and development in both sport and life, can teach people tolerance and respect for others. It allows them to integrate into society and create a sense of teamwork. Fair play in sport is capable of giving hope, pride and identity, and it is able to unite where nationalities, politics, religions and cultures often divide.
>
> Cooperation in the spirit of fair play delivers even greater results than pure gamesmanship in all walks of life. It plays a key role, the role of a catalyst in today's society as a means of improving quality of life and human well-being.

Source: Adapted from the International Fair Play Values.

Figure 6.11 The fundamental values of fair play

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To act with integrity, all those associated with physical activity should comply with these ethical standards, which reflect the international expectations for sport participation.

The International Fair Play Committee works to educate all athletes, from children to adults, and from beginners to the elite. Below is a charter for youth participation in physical activity designed by the International Fair Play Committee.

Fair Play Youth Charter

- Fair play is the only way.
- I shall devote my utmost of my physical, intellectual and moral abilities to both training and competition.
- I shall observe the written and the unwritten rules of my sport.
- I shall treat my opponents in the same manner in which I would like to be treated.
- During the competition, my aim is to defeat my opponents, not to hurt or humiliate them.
- I shall respectfully acknowledge the decisions of the judges.
- I shall bear both victory and defeat with dignity.
- My greatest gratitude is towards my parents, teachers and trainers – without whom I would not be here.
- I am ready to help someone in need even if I put my own victory at risk by doing so.
- I represent my homeland with great humility and humbleness.
- I would like to be a role model for the youth in my country and my sport.

Activity 6.15

Engage-in

Inquiry question: To what degree do I demonstrate the values of fair play during physical activity participation?

Engage and understand

1. Develop a method of recording observations to collect primary data on how often the following fair play values are demonstrated, and how they are displayed during participation in physical activity: respect, friendship, team spirit, integrity, solidarity, tolerance, excellence, care, joy.
2. Engage in a variety of different competitive and non-competitive physical activities over two lessons and record observations using the method developed.

Apply and analyse

Analyse: Examine or consider something in order to explain and interpret it, for the purpose of finding meaning or relationships and identifying patterns, similarities and differences.

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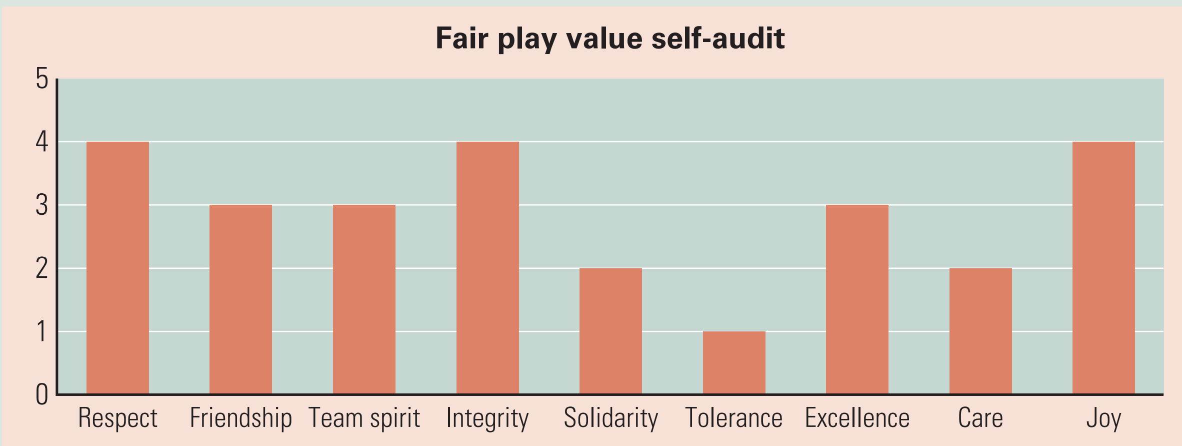
3 From the primary data you have collected, rate each fair play value on a scale of 1–5, with 1 being not demonstrated and 5 being demonstrated frequently. When making this judgment, it is important to consider when the value was demonstrated, displayed or observed – that is, you may feel you were acting with team spirit the whole time; however, did you actually display any actions to demonstrate this, such as congratulating a teammate when they scored?

4 Show your rating in a bar graph, with the values on the *x*-axis and the 1–5 rating on the *y*-axis. For example:



Evaluate and justify

5 Select one lowly rated value and discuss with others how this value could be displayed during class matches. Formulate a plan for action by listing three different behaviours you will undertake in the next match to demonstrate this fair play value.

6 Implement your plan in the next outside lesson.

7 Reflect: did you demonstrate the fair play value more often and to a greater degree? Did you demonstrate other fair play values more frequently as a result? When focusing on the positive values of physical activity during play, was there a subsequent increase in enjoyment or effort?

Activity 6.16

Check-in

1 Explain why fair play is an important value in Australian culture.

2 Describe the link between fair play and enjoyment for participants.

3 Explain how a system of ethical values, such as the fair play values, influences the integrity of individuals and teams.

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6.5 The role of peers, family, coaches, school and community in developing personal values and ethical behaviours

Figure 6.12 Socialising agents set, demonstrate and enforce ethical behaviours for the individual.

The process of *socialisation* describes the way an individual acquires knowledge, language, social skills and values from their surroundings. It is through engaging with various agents of socialisation that individuals learn acceptable social norms. The process of socialisation is comprehensively explained in Chapter 4, where peers, family, coaches, schools and the broader community are all established as essential agents for establishing appropriate values, attitudes and behaviours.

1 They set the ethical standards

Through the values and behaviours displayed, these groups demonstrate what is acceptable within the physical activity context. These values and behaviours then form the basis for the development of ethical standards. Ethical standards may be created through the formulation of specific policy documents to be followed, or may be communicated informally to individuals from the group. Ethical standards are designed to ensure that individuals act with integrity and understand how to create a positive physical activity experience for all.

2 They demonstrate the ethical standards

Once ethical standards are established, it is the role of peers, family, coaches, schools and the broader community to uphold these standards. It is through observation that individuals establish their own values and behaviours as part of the socialisation process. Therefore, each member of these groups must act as a role model, enacting the ethical standards to demonstrate them to the individual. Without effective role modelling from the larger group, individuals may not display ethical behaviours, as they are not deemed to be important, or they may learn alternative undesirable behaviours if these are being displayed.

3 They enforce the ethical standards

When individuals display unethical behaviours or actions. that lack integrity, it is the responsibility of these groups to provide consequences. When poor behaviours are left unchecked, it is far more likely that they will recur. Where formal ethical guidelines exist, consequences may be also outlined for infringements of these standards. However, in the case of family or peers, infractions of the unwritten ethical standards may result in a wide variety of consequences governed by parenting style or peer group composition.

Figure 6.13 Socialising agents play three key roles in developing ethical behaviours and values surrounding physical activity for the individual.

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Activity 6.17

Check-in

1 Complete Table 6.2 by adding relevant information to the rows for each agent of socialisation.

Agent of socialisation	An example of an ethical standard established from this agent that relates to physical activity	An example of how others display this standard	A possible consequence for breaking this standard
Informal, unwritten ethical standards			
Family	Always put in maximum effort	Siblings always train with high intensity	Spoken to by parent to find cause of low effort and reminder to always try your hardest
Peers			
Formal, written ethical standards			
Coaches	Treat players, officials and all others with respect	Listening when the coach is giving instructions	Loss of playing time or starting position on the team
Schools			
Community			

Table 6.2 Agents of socialisation develop values, attitudes and behaviours for an individual through a vast array of formal and informal ethical standards.

2 Think of an example of an ethical standard that you observe across all agents of socialisation listed in the table. In 100 words, use various examples from your upbringing to describe how the process of socialisation has taught you this ethical standard.

6.6 Globalisation and media coverage as stimuli for ethical values and behaviours

Globalisation is the process by which the societies, cultures and communities of the world are becoming increasingly interconnected. Historically, different societies were limited in their interactions with others due to geographical location and a lack of technology. However, advancements in transport and communications (such as the internet) now ensure that all people globally can interact with others across the planet. This modern phenomenon has greatly enhanced economic trade, cultural exchange and the sharing of ideas.

Globalisation has affected physical activity in many ways. There are economic benefits as a worldwide marketplace for sport is now a reality. Some activities, like football (soccer), tennis, motor racing and golf, are popular on the world stage and enjoy lucrative financial benefits as a result. Sports like badminton continue to grow in popularity in specific regions like Asia, and help to

globalisation
the process by which the world is becoming increasingly interconnected

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develop a cultural exchange for those areas. While badminton participation remains comparatively low in Australia, its popularity has grown – partly due to globalisation and an increased connectedness to our Asian neighbours.

Other activities that have ventured beyond their own national boundaries have developed both financial rewards and cultural change. Consider the impact of the NBA (America's elite basketball competition) on the world and Australians. Improved technology sees games broadcast in over 200 countries and translated into over 45 different languages. Thanks to the internet, anyone is able to access games and social media allow a global community of fans to follow their favourite player or team. While basketball in Australia has traditionally been valued poorly, through globalisation American basketball is now more popular than our own domestic competition, and it is more common to see Australians wearing franchised supporter clothing of NBA teams than Australian NBL teams. As a result of global marketing, the best basketball players in the world desire to be part of the NBA's money and fame.

While globalisation has facilitated interest in and access to a wider variety of physical activities, it has also increased the ethical issues associated with physical activity. Typically, unethical behaviours are the result of three key areas associated with globalisation:

- increased economic benefit
- increased fame and status for organisations, clubs and players
- increased national status on the world stage.

Due to globalisation, there are now much greater rewards in these areas, and therefore greater incentives for those involved with physical activity to act in unethical ways. There are also increased incentives for those outside the sporting field to show an interest for financial gain. This can be beneficial in terms of international sponsors bringing billion dollar companies into the sporting arena, or detrimental with regard to organised crime and betting syndicates. While the risks involved are high, the benefits can be very lucrative, and therefore unethical behaviours can be tempting for those with lower personal moral standards.

KEY MESSAGE

Globalisation has stimulated cultural exchange and economic growth within all areas of society, including physical activity.

KEY MESSAGE

Globalisation has provided positive benefits to physical activity.

KEY MESSAGE

Globalisation has increased the rewards involved in sport, and as a result there is more incentive to act unethically.

Activity 6.18

Check-in

1 As a class, brainstorm a list of unethical incidences that have occurred on the world stage over the last 15 years. Note the incident, the sport and any specific players involved.

2 Spend 30 minutes engaging in some secondary research using the internet to source other examples. Discuss search words that may assist in refining searches for the topics you seek. As new examples are found, add them to the list you have already created.

3 Examine the incidences, and identify three sports that have questionable integrity resulting from these occurrences.

4 Using specific examples as evidence, outline a physical activity that has low worldwide integrity.

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Activity 6.19

Check-in

1. Assess the overall impact of globalisation on physical activity by creating a list of positives and negatives.
2. Divide the class in half and engage in an informal debate on the following subject: 'Globalisation has been detrimental to the integrity of sport'. Allow time for sides to prepare their basic arguments and simply progress point and counter-point in a structured class argument. Alternatively, construct a 300-word persuasive essay either for or against the above contention.

6.7 The influence of media coverage on ethical values and behaviours

In response to the cultural significance placed on sport in Australia, the media have always had a vested interest in reporting sporting achievements. From recording Don Bradman's cricketing accomplishments from England in 1930 to the television broadcast of the 1956 Melbourne Olympics to modern State of Origin telecasts and broadcasts of the Olympic and Commonwealth Games, the Australian media have always been advocates for physical activity. Due to ongoing technological advancements, the media are now engaging with Australians in all aspects of life. On a typical day, many Australians engage more with the media – including online – than with family and friends. Consequently, the media have developed into a key agent of socialisation with a significant influence over the values of individuals. The images and messages that the media send to viewers are therefore vital to the way individuals embrace physical activity.

Within contemporary Australian society, the media both reflect and set standards when it comes to ethical behaviours. In the end, media organisations are businesses, and the most successful media outlets are those that attract the largest audience share. Engaging an audience involves the media providing a product that relates to a large proportion of the population. Therefore, the media have financial incentives to publicise topics in ways that reflect the values and expectations of the majority of people. The media will reflect the dominant culture in order to retain their audience. Consider an athlete caught taking performance-enhancing drugs after winning an international event. The media would report on this in a negative way, branding the athlete a cheat and a national disgrace. Here the media are simply reflecting social expectations about fair play, and reinforcing society's expectations on ethical standards. There would be very little incentive for the media to show the athlete as a victim of the highly stressful and competitive world of elite sport, as this would not reflect the ethical standards society has with regard to cheating.

Due to media saturation in our society, the media can also work to set ethical standards, particularly where there is division in public opinion concerning what is ethical. Consider a player terminating their contract with one club at the end of the season to take up a position at another for great financial gain. Media headlines may ask questions about the player's ability to play out the season or their commitment to their current club. In this sense, the media may be establishing an expectation that players should value loyalty over greater financial security. If this issue is in the media often enough, then public opinion may be influenced, as it 'appears' to be popular opinion. As a result, the governing body of the sport might feel pressure to review the guidelines around player transfers to retain the integrity of their competition.

Whether the media are reflecting or setting ethical expectations, there is no doubt that they serve as our 'social conscience'. This means that the media, through their headlines, stories and images, work to remind

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society of our values and ethical standards. The media tell us what should be offensive, what should be tolerated and what behaviours should be celebrated. They highlight popular social opinion, and therefore can influence the ethical standards and guidelines that are created in response to society's expectations.

Activity 6.20

Check-in

1 At a youth sport level, the media seem to report regularly on the issue of competition guidelines regarding divisions. Discuss whether sports like Rugby League and Rugby Union have competitions based on age, ability or size.
2 Undertake some research into how the media have covered this issue. From what you find, which method do the media seem to favour? Cite specific articles as evidence to justify your belief about the media's preference.

The media's role in creating sporting role models

Media saturation in the daily lives of many Australians means the performances and behaviours of players – both national and international – are readily accessible. News stories through traditional media forms, as well as the internet and social media, ensure elite players are under constant scrutiny. On-field performances are critiqued, with behaviours and reactions judged. Off-the-field lifestyles, relationships and social interactions are all a source of fodder for traditional and social media. It is due to the constant media attention given to athletes that they have become important role models in society. While at times athletes may be unwilling role models, there is no doubt that in the modern sporting era, they are held accountable to the game, the club, the team and themselves.

Figure 6.14 Positive role models in the media are essential to maintain integrity in sport and the value of physical activity for the Australian people.

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Athletes who display integrity and promote themselves positively are able to gain financial benefits, such as sponsorship. Clubs that have established a good reputation can also market themselves as being strong, clean, reliable, trustworthy and high-performing, and this increases their value to fans and makes them a sound investment for sponsors. There are certainly performers at all levels of sport who spend their whole career acting ethically, showing integrity and acting as outstanding role models for other members of society. However, players who continually demonstrate unethical behaviours and low integrity are seen as poor role models. They have very little ethical capital, and as a result poor ethical behaviours are not forgiven easily by the public and these athletes are labelled 'bad for the sport'.

Activity 6.21

Check-in

1 Through research, identify three players or clubs that have displayed unethical behaviours, resulting in a loss of sponsorship. For each, note the player/club, the sponsor and the behaviour that was displayed.

2 Select a player in any sport who you believe has integrity. Make a list of the behaviours they have displayed throughout their career (both on and off the field), which have built this 'ethical capital'.

Activity 6.22

Engage-in

Inquiry question: How can I be a good role model for younger athletes?

Engage and understand

1 Organise for your class to join with a younger Physical Education class for two lessons as they undertake their normal outdoor activity. You will not be there to coach, but to be a part of the learning just like the other younger students. A class between Year 3 and Year 8 would be ideal.

2 Before you engage in these lessons, brainstorm behaviours that would make you a good role model to these students. Consider behaviours under the following headings:

   a as an athlete

   b as a learner

   c as a person.

3 Under each heading, plan two behaviours that you will try your utmost to demonstrate throughout your two lessons with the other class.

Apply and analyse

4 Engage your plan while joining the selected class; you might not only demonstrate your selected behaviour, but also encourage others. For example, if your behaviour as a learner is to listen to instructions, you might ask others talking to be quiet so you can listen.

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5 Make notes on how successful your strategies were, and how being a good role model to others made you feel.

Evaluate and justify

Appraise: Evaluate the worth, significance or status of something; judge or consider a text or piece of work.

6 From this experience, and knowledge of your own actions, appraise your worth as a role model for younger students at your school.

6.8 Creating policies to mandate ethical behaviours

Society must continue to value physical activity, as it makes a significant contribution not only to the health of Australian citizens, but also the social and moral development of the Australian people. With physical activity being a multibillion-dollar industry it is essential that people feel they are getting value for money when it comes to such a significant investment. To ensure the reputation of physical activity within Australian culture, it is vital that the community retains its confidence in sport. With every positive interaction with physical activity, community confidence grows and so does its value to the Australian people. However, with every negative experience or detrimental news story, public confidence is eroded and the value of physical activity declines.

The most effective way to increase positive experiences with physical activity, and to decrease the exposure to negative ones, is through being specific about what is acceptable and expected in the physical activity domain. This is achieved through the creation of **ethical strategies**. An ethical strategy is a method or plan of action devised to bring about ethical behaviours and encourage individuals to act with integrity. Typically, a strategy involves the creation, implementation and regulation of ethical standards, guidelines, frameworks or codes.

ethical strategy a method or plan of action devised to bring about ethical behaviours and encourage individuals to act with integrity; typically involves the creation of ethical standards, guidelines, frameworks or codes

Ethical strategies are effective because they are explicit when setting expectations, can be mandated to individuals within a group and in many cases are easily policed. As these documents are based on social expectations, they reflect public opinion in setting norms, and are therefore widely supported.

An important aspect of any ethical strategy is that it is regularly scrutinised for its effectiveness. In other words, is the strategy achieving the desired outcome? Is there an increase in the number of individuals displaying the 'correct' ethical behaviours and a decrease in those being unethical?

Strategies also need to be reviewed periodically to ensure they still reflect social values. The expected ethical behaviours of a community change over time, and policies and guidelines need to reflect these changes. Consider the tolerance given to on-field fights during Rugby League or Australian Rules Football matches during the 1970s, compared with those of the modern era. Current player codes now reflect a society that is less accepting of violence and physical assault. However, ethical strategies are easily changed through a review of wording, or by adding or removing specific sections. With the release of updated policies and guidelines, participants are again able to understand the new expectations set.

Organisations and institutes of all types and at all levels take on the responsibility of creating ethical strategies for the good of their physical activity. In some cases, these strategies are mandated by a higher authority to ensure the 'good running' of the

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school or club. Some of the institutes creating ethical policies related to physical activity include:

- government bodies (federal, state and local)
- government departments (e.g. Australian Sports Commission, Education Queensland, the Queensland Studies Authority)
- international sporting organisations (e.g. FIFA, the International Olympic Committee)
- sporting authorities
- sporting clubs
- schools.

These organisations produce ethical strategies in a wide range of areas relating to physical activity. A comprehensive list of these areas was displayed in Figure 6.10 (on p. 321). However, the policies and guidelines that directly affect physical activity at a school level or in local clubs revolve around:

- behavioural standards for players, coaches, officials, parents, spectators and teachers
- diversity, equity and inclusiveness
- safety and risk management
- funding and sponsorship
- sport participation, development and education
- resource development and maintenance
- governance (how the institute is organised, run and makes decisions).

One key resource for all Australians involved in physical activity – particularly at a youth club level – is the Play by the Rules initiative. This website-based initiative provides a wealth of information for further investigation during this unit of work and may provide assistance when undertaking assessment tasks.

Play by the Rules provides information, resources, tools and free online training to increase the capacity and capability of administrators, coaches, officials, players, parents and spectators to assist them in preventing and dealing with discrimination, harassment, child safety, inclusion and integrity issues in sport.

First developed by the South Australian Government in 2001, Play by the Rules has developed into a unique collaboration between the Australian Sports Commission, Australian Human Rights Commission, and various departments from all states and territories. The investment in this strategy alone demonstrates the importance of ethical and equitable participation in physical activity for the Australian people.

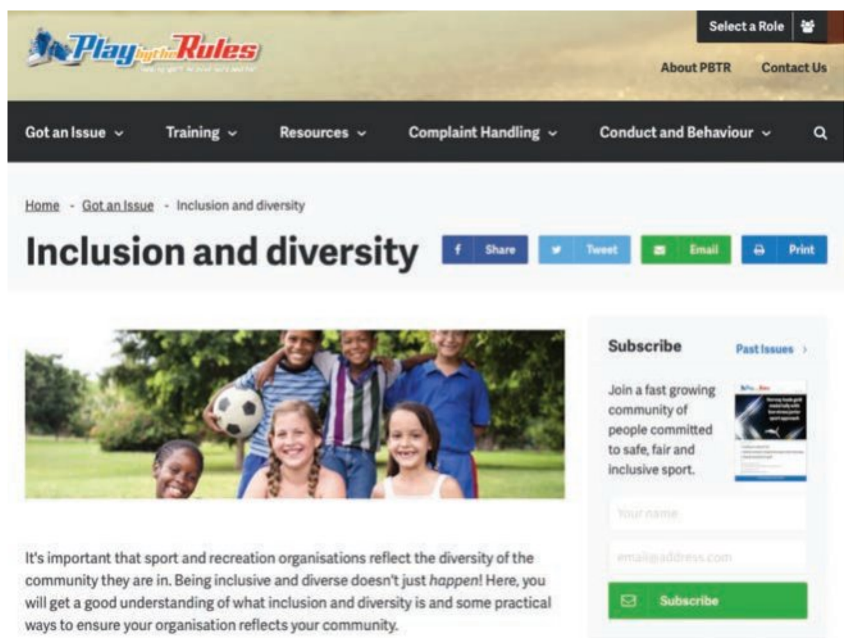

Figure 6.15 The Play by the Rules initiative

KEY MESSAGE

Ethical strategies specifically outline the expected behaviours of all stakeholders in physical activity.

KEY MESSAGE

When followed, ethical strategies ensure that integrity is maintained.

KEY MESSAGE

Ethical strategies must continue to meet community expectations if they are to be effective.

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Activity 6.23

Check-in

1 Describe how ethical strategies can positively influence integrity.
2 Locate policy documents that address behaviour and risk-management guidelines for each of the following groups:
   - **a** your physical education class
   - **b** your school
   - **c** a community sporting club.
3 Use the documents gathered to complete the table below.

	What policies or guidelines exist that mandate behaviour or safety requirements?	Who produced these documents?	Were the policies a mandated requirement from a higher authority? If so, whom?	Which values of fair play are clearly targeted by the policies?	Which values of fair play are not specifically addressed in the policies?
				Respect, friendship, team spirit, integrity, solidarity, tolerance, excellence, care, joy	
Class					
School					
Local community sporting club					

4 From analysing the documents gathered, identify two fair play values that are clearly supported through the ethical strategies.
5 From analysing the documents gathered, identify one fair play value that is currently under-represented, and write a guideline that is designed to set an expectation for this ethical behaviour across all areas.

6.9 What are ethical dilemmas?

Ethical dilemmas are situations that extend across different areas of morality. A number of options must therefore be considered to resolve the situation; in many cases, none of the solutions are totally ethically acceptable or preferable. Ethical dilemmas exist in all areas of daily life. An easy example might be sharing your homework with a friend who has not completed it. Do you provide your work to copy, knowing the other person has not put in the effort and would not be learning from the experience? Or do you support a friend by assisting them in their time of need? Which solution is more beneficial for your friend and you?

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Another example, which relates more to physical activity, may be a local council that must decide between funding for two community projects. One group is petitioning for $10 000 to upgrade the local athletics track used by 2000 community members, while another group requires the $10 000 to start a new archery club as there are currently no facilities for a projected 200 people. What is the council's decision and why? The solution to an ethical dilemma may not satisfy all affected, or solve the issue for everyone; however, an effective solution to an ethical dilemma is one that is equitable and justifiable, and in the case of physical activity, one that reflects the values of fair play.

As ethical dilemmas occur in all aspects of life, this can be a very broad subject to discuss and analyse. However, in order to refine the scope of investigation, the Physical Education General Senior Syllabus (Queensland) defines ethical dilemmas in physical activity as:

> situations manipulated in physical activity, based on inclusion, codes of conduct, financial processes, performance enhancement, impacts of globalisation of physical activity; impact of technologies on physical activity
>
> In Physical Education, ethical dilemmas are determined by the interactions between your values, principles and your purpose for engagement in the physical activity.
>
> *Source: Physical Education 2019 v1.1 General Senior Syllabus © Queensland Curriculum & Assessment Authority*

Figure 6.16 Ethical dilemmas in Physical Education can be grouped into four priority areas of study that affect equity or access within physical activity.

Activity 6.24

Check-in

1 Have each student in your class write about an ethical dilemma that is experienced in your Physical Education class when undertaking physical lessons. Consider each of the following four areas:

   a gender inclusion (or exclusion) in physical activity

   b the impact of ability levels on engagement and participation in physical activity

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c. the equitable distribution of technology and equipment enhancements for physical activity
d. the influence of corruption over fair play in physical activity.

2. Quickly review each person's suggested ethical dilemma and decide on one from each category.
3. Divide the class into four groups and allocate one of the selected dilemmas to each group.
4. As a group, consider the issue and make a recommendation to improve or eliminate the dilemma in future lessons.

Gender inclusion (or exclusion) in physical activity

For many physical activities that traditionally are stereotyped as gender-neutral, there are competitions that are male, female and mixed. This allows personal preference for an individual to engage with the activity in a way that is comfortable for them. Examples include touch football, volleyball, tennis, badminton and Oztag. Other physical activities, such as Australian Rules Football, Rugby League, Rugby Union, cricket and netball, often encounter ethical dilemmas with mixed divisions. This is due to the physically of the activity, where a sense of fairness and the possibility of injury are weighed against being inclusive. These activities must also work against cultural stereotypes, which see them as male or female activities. Gender guidelines are challenged when a female wants to engage in a male environment or vice versa. Due to the biological differences between the sexes – such as speed, muscular strength and power – activities such as swimming, triathlon, and track and field events continue to be run with separate male and female divisions to retain a sense of fairness and equality.

Ethical dilemmas surrounding gender inclusion can often result when catering for individual needs or due to of a lack of other participants. Some people prefer to engage only with the same gender in physical activity – it provides a sense of fairness in an environment that enables confidence and may be free of judgment. Consider the market for women-only gyms or fitness training sessions. Others prefer the challenge or the social aspect of a mixed environment. In some situations, gender inclusion issues result due to a simple lack of participants: there may not be enough players to establish a male or female competition, and therefore the participant is forced to either play with the opposite sex or not play at all. All sports work to be inclusive of both genders; however, on a case-by-case basis, each individual situation may provide a different ethical dilemma.

Activity 6.25

Engage-in

RECOGNISE & EXPLAIN | ANALYSE & SYNTHESISE | EVALUATE | JUSTIFY

Inquiry question: How do ethical guidelines based on gender create an ethical dilemma in individual physical activities?

Engage and understand

Note: For single-sex classes, or for an alternative, this activity may be undertaken using bibs to allocate male and female gender roles. When you reach the Evaluate and justify section,

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you may draw on other anecdotal primary data which you have experienced outside of the current Physical Education environment.

1 In an individual sport, create a one-lesson mixed competition. Consider archery, golf, lawn bowls, badminton, tennis, or a track and field event.
2 Create a simple method to collect the following data for all participants post-competition: engagement, enjoyment, confidence.
3 Use the following scale for each.

Very low	Low	Normal	High	Very high
1	2	3	4	5

4 Use a simple tally table to collate the data for the class. Take note of the responses for each gender.

	Very low		Low		Normal		High		Very high	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Engagement										
Enjoyment										
Confidence										

5 Run the competition and collect data.
6 In another lesson, run two separate competitions in the same activity – one male and one female.
7 Run the competition and collect the same data set.

Apply and analyse

Analyse: Examine or consider something in order to explain and interpret it, for the purpose of finding meaning or relationships and identifying patterns, similarities and differences.

8 Review the data sets as a class, looking for trends – for example, did females generally engage more in the mixed competition?
9 Seek additional information:
   a that may be impacting the data – for example, where there was very low engagement, was this a result of the competition or simply a lack of interest or ability in the selected activity?
   b that may assist in understanding – for example, which students preferred the mixed competition and which preferred the segregated environment? Why was this the case?

Evaluate and justify

10 Using the primary data collected to justify your response, outline some of the ethical issues faced when individual physical activities create competitions based on gender.

Note: This activity could be run across two or three different physical activities to collect a variety of data.

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Activity 6.26

Engage-in

Inquiry question: How do ethical guidelines that are inclusive of genders create an ethical dilemma in team activities?

Engage and understand

Note: For single-sex classes, or for an alternative, this activity may be undertaken using bibs to allocate male and female gender roles. When you reach the Evaluate and justify section, you may draw on other anecdotal primary data which you have experienced outside of the current Physical Education environment.

1. Select a team physical activity and play a structured mixed match for a set time (e.g. 25 minutes). Ensure there is an equal number of males and females on the field for each team at any point; this is important for data collection. Modify where teams usually consist of an odd number (e.g. basketball). Activities might include basketball, Futsal, touch, soccer, Oztag or any other suitable invasion game.
2. During the match, use a simple tally sheet to record the number of times someone from each gender touches the ball. If possible, consider recording the touches for each individual player and then collating gender data later.
3. Engage in the match.
4. Many mixed-team sports (or Physical Education classes) battle with the integration of male and female players. While female players are represented on the field, they may not be fully 'included' in the play. They may find themselves at the extremities of the field, or cut out of the action. Investigate rules or practices that team sports use to better integrate males and females on the field – for example, maximum–minimum representation on the field at all times, different scoring systems for males and females or females must touch the ball before scoring.
5. For the physical activity selected here, implement rules that are more inclusive of female players. For example: double points if a female scores; a female must touch the ball in every play; before a point is scored, a female player must touch the ball.
6. Implement the game under the same team structure as earlier and record female and male involvement using the same data-collection method.

Apply and analyse

7. Review the data sets as a class, looking for trends. For example:

> *Analyse: Examine or consider something in order to explain and interpret it, for the purpose of finding meaning or relationships and identifying patterns, similarities and differences.*

   a. Did females generally engage more when the rules required them to do so?
   b. What percentage increase or decrease was there in male and female involvement?
   c. Did females score more when rules were implemented?

8. Seek additional anecdotal evidence – for example:
   a. Did players adjust their strategies to be more inclusive of females?
   b. Did females feel more involved in the match?

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c Did females feel like this engagement strategy was helpful or condescending?
d How did males feel when they were required to be inclusive?
e Which match did males and females enjoy more?

Evaluate and justify

9 Using primary data to justify your argument, write a 200-word persuasive response either for or against the following statement: 'All Physical Education classes involved in mixed activities should permanently mandate rules that promote gender engagement.'

Activity 6.27

Check-in

1 Gender inclusion in (or exclusion from) physical activity is one area of study where ethical dilemmas occur. In a think–pair–share activity, think of some ethical dilemmas that may occur under this heading for each category below:

Local-level sport	
Elite-level sport	
Youth sport	
In team activities	
In individual activities	

2 The Play by the Rules website offers some great advice for people faced with a wide variety of ethical dilemmas. Access the site and work your way through the 'Girls Playing in Boys Teams' interactive scenario to learn more about this specific issue.

The impact of ability levels on engagement and participation in physical activity

Activity 6.28

Engage-in

Inquiry question: How can ability levels be used in an inclusive way?

RECOGNISE & EXPLAIN ANALYSE & SYNTHESISE EVALUATE JUSTIFY

Engage and understand

1 Select an individual physical activity – for example, archery, badminton, tennis, triathlon, or a track or field event.

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2 Investigate the handicap system employed in golf. How does it work? How does it create equity for players of different ability levels during competition?
3 Engage in some game play for the individual physical activity selected to assess ability level.
4 As a class, develop a handicap system for the selected physical activity and allocate handicaps to each student based on previous performances.

Apply and analyse

5 Apply your handicap system in a tournament environment to find a class champion in the selected activity.
6 Post competition, collect class data on engagement, enjoyment and confidence using a similar method to that described in Activity 6.25 (on pp. 335–6).
7 Analyse the data and establish what trends were found.

Evaluate and justify

8 In a short statement, evaluate whether a handicap system in individual physical activities is an effective strategy to increase inclusiveness for participants.

Activity 6.29

Engage-in

Inquiry question: Do ability groupings encourage participation in team physical activity?

Engage and understand

1 Select a team sport.
2 Collect primary data by engaging in a series of matches with teams for each match selected based on different criteria:
   a random teams – mixed ability
   b high ability vs. high ability and low ability vs. low ability
   c age based – born first half of year vs. born second half of year
   d student selected – friendship groups
   e teacher selected – 'even' teams.
3 Following each match, collect class data on engagement, enjoyment and confidence using a similar method to that described in Activity 6.25 (on pp. 335–6).

Apply and analyse

4 Review the data to ascertain the 'best system' of allocating teams for each data set.

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Evaluate and justify

Appraise: Evaluate the worth, significance or status of something; judge or consider a text or piece of work.

5 Decide which system for team make-up was most effective overall and justify your selection.
6 Outline the relationship found between ability level grouping and participation for your Physical Education class.

Activity 6.30

Check-in

1 The impact of ability levels on engagement and participation in physical activity is one area of study where ethical dilemmas occur. In a think–pair–share activity, think of some ethical dilemmas that may occur under this heading for each category below:

Local-level sport	
Elite-level sport	
Youth sport	
In team activities	
In individual activities	

2 Select one of the ethical dilemmas that interests you, undertake some research and identify any policy documents or guidelines that might be available in your selected situation.

Figure 6.17 What ethical dilemmas may occur in elite-level sport such as international Rugby Sevens at the Commonwealth Games?

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The equitable distribution of technology and equipment enhancements for physical activity

Activity 6.31

Engage-in

Inquiry question: To what level can an equitable distribution of resources and technology affect the fair play values of 'fair competition' and 'equality'?

Engage and understand

1 Select an individual sport from tennis, badminton, golf or archery.

2 Engage in five competitive matches of this activity (for golf, this may mean playing match play rules over three holes). Try to play against people of similar ability. Record the score in each match.

3 Now play the same opponents again; however, before each match perform scissors, paper, rock, with the loser to use the following equipment:

- **a** badminton: plastic racquet or one with broken strings
- **b** tennis: mini-sized racket, wooden racket or one with broken strings
- **c** golf: fewer clubs or older style clubs
- **d** archery: arrows with torn fletching or tape around the shaft.

For accurate data, try to approach the match with the same determination to win – don't give up just because of the equipment being used. Record scores for each match again.

Apply and analyse

4 Analyse your scores, looking to see how much the change in equipment changed the results.

5 As a class, discuss anecdotal evidence – were you encouraged by the situation or demotivated by poor equipment? Were you challenged or did you want to give up?

Evaluate and justify

6 As a class, discuss how a lack of equipment and resources can affect the fair play values of fair competition and equality.

Consider: Think deliberately or carefully about something, typically before making a decision; take something into account when making a judgment; view attentively or scrutinise; reflect on.

7 Consider how this experience relates to athletes from wealthy and poor nations preparing for the Olympic Games.

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Activity 6.32

Engage-in

Inquiry question: To what level can an equitable distribution of resources and technology affect the fair play values of 'fair competition' and 'equality'?

Engage and understand

1 Select two relatively evenly matched teams and engage in an invasion team activity for 20 minutes. Note the score.

2 If possible, fit one team with heart rate monitors for another 20-minute match. Members of this team are not allowed to have their heart rates above 140 bpm at any stage.

3 Alternatively, if heart rate monitors are not available, assign one team to participate only at 80 per cent intensity. Your teacher may referee/umpire, and if they decide a player is engaging beyond 80 per cent, then an automatic handover, point or free throw/pass might be awarded to the opposing team.

Apply and analyse

4 Reflect on the overall scores and see how this alteration affected the performance and outcome.

Evaluate and justify

Consider: Think deliberately or carefully about something, typically before making a decision; take something into account when making a judgment; view attentively or scrutinise; reflect on.

5 Consider how this activity reflects the inequality experienced when some teams do not have access to appropriate training programs, training equipment or suitably skilled coaching staff. How does this affect the fair play values of fair competition and equality?

Activity 6.33

Check-in

1 The equitable distribution of technology and equipment enhancements in physical activity is one area of study where ethical dilemmas occur. In a think–pair–share activity, think of some ethical dilemmas that may occur under this heading for each category below:

Local-level sport	
Elite-level sport	
Youth sport	
In team activities	
In individual activities	

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2 Select one of the ethical dilemmas that interests you, undertake some research and identify any policy documents or guidelines that might be available in your selected situation.

The influence of corruption over fair play in physical activity

Activity 6.34

Engage-in

Inquiry question: How can corruption affect the integrity of competition?

EVALUATE

Engage and understand

1 Select an individual sport, such as badminton, tennis, archery, or a track and field event, and identify the top four students to be part of a competition. Identify how this competition will run within the next lesson and publish a draw if required.

2 You will need some Monopoly money for this activity. The winner is to receive $1000 for winning the competition. Break the remainder of the class into four groups, *secretly* allocate each group a player in the competition and give them $10 000.

3 Each group is to use its allocated money to influence the result of the competition and get its player to win. The groups may need some class time to discuss how this might be achieved. The competition players' goal is to receive as much money as possible for their participation, but they cannot openly throw matches.

Apply and analyse

4 Conduct the competition in the next lesson, so groups have a chance to approach players secretly. Analyse the effect of corruption on the tournament in two stages.

5 Discuss the following:

  a Which player ended up with the most money (including the $1000 prize for winning and any bribes received)?

  b Which groups had what players?

  c What did groups do to influence the players involved? What was offered and what was taken?

  d Did players change their performance or try their best?

  e How were matches influenced – what actions did players take to affect the results?

6 Reflect on the following:

  a Was there integrity in this competition?

  b What unethical behaviours were demonstrated?

  c What fair play values were undermined?

  d Was the integrity of players maintained? Why or why not?

(continued)

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Evaluate and justify

Evaluate: Make an appraisal by weighing up or assessing strengths, implications and limitations; make judgments about the ideas, works, solutions or methods in relation to selected criteria; examine and determine the merit, value or significance of something, based on criteria.

7 Use the barometer below to evaluate the degree to which each fair play value was affected by the corruption of this tournament.

Value	1 Very little	2	3	4	5 Significant
Fair competition					
Respect					
Friendship					
Team spirit					
Equality					
Integrity					
Joy					
Care					
Excellence					
Tolerance					
Solidarity					
Sport without doping					

Activity 6.35

Engage-in

Inquiry question: Can one player influence a team result?

Engage and understand

1 Perform a team activity and secretly allocate one player from each team to influence the outcome. Do not alert other players that this is happening.

2 Engage in the match.

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Apply and analyse

3 Debrief the activity by informing all there was a 'mole' on each team, and have students try to identify the player.

4 Discuss the actions displayed by each mole in trying to influence the outcome of the match.

Evaluate and justify

5 Evaluate whether one player can have a significant impact on the outcome of a team game.

Consider: Think deliberately or carefully about something, typically before making a decision; take something into account when making a judgment; view attentively or scrutinise; reflect on.

6 In an appropriate format, outline the risks and rewards for an elite player who might be faced with this situation.

Activity 6.36

Check-in

1 The influence of corruption over fair play in physical activity is one area of study where ethical dilemmas occur. In a think–pair–share activity, think of some ethical dilemmas that may occur under this heading for each category below:

Local-level sport	
Elite-level sport	

2 Explain why ethical gambling institutes have a vested interest in ensuring fair competition and equality.

6.10 Ethical decision-making

When exploring the notion of ethical decision-making, two scenarios are worth exploring. The first is an individual who is considering engaging in unethical behaviour – that is, someone who may knowingly break ethical standards. The second consists of those who must make ethical decisions about strategies to enhance equity, access or fair play for the participants in physical activity.

Individuals at all levels of physical activity face ongoing decisions about what behaviours to display. Do individuals act in accordance with the set ethical guidelines? Do they act with integrity? Do they behave in a way that is deemed appropriate by the sporting community? Or do they choose behaviours that are unethical? The decision about how to act in these circumstance is greatly influenced by the individual's moral values in relation to **risk** and **reward**.

risk the probability of a negative outcome occurring

reward the benefit that can be gained from a situation

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Some individuals have high ethical standards and high moral values, and for these people no level of reward can sway them towards unethical behaviours. However, for others, rewards such as winning, success, financial gain or fame are big temptations that may influence behaviours. The external pressures and expectations from family, peers, clubs, sponsors or society can also contribute to the decision to behave unethically. This is why it is important for ethical strategies to set clear consequences for breaches; these serve as deterrents to 'breaking the code'.

When the rewards gained through unethical actions appear to outweigh the risks, then it is more likely that unethical behaviours will occur. Unethical actions are significantly more likely when the individual's decision-making is guided by lower moral values concerning fair play, cheating and integrity. Participants facing an ethical dilemma regarding fair play and cheating may ask themselves, 'What can I get away with?' versus, 'What actions can I live with?' The resulting action will be a reflection of their personal integrity and values.

A second type of ethical decision is one that is required to create or review ethical strategies, or regarding the implementation of these strategies. Here, institutes such as clubs, governing authorities and schools, as well as government, must make ethical decisions to enhance the equity, access or fair play for participants in physical activity.

As these decisions affect a wide range of participants, it is important that the decision-making process is clear and transparent, as these organisations will be held accountable for their choices. When devising ethical strategies, such as policies, guidelines or codes, many institutes must demonstrate that they have followed the procedures and guidelines of higher governing bodies that have mandated a course of action. They must also demonstrate to the community that the strategies they devise are equitable. While any strategies will generally advantage some while disadvantaging others, it is an important aspect of accountability that a strategy can be justified to the community. This is why undertaking a formal, documented decision-making process is essential.

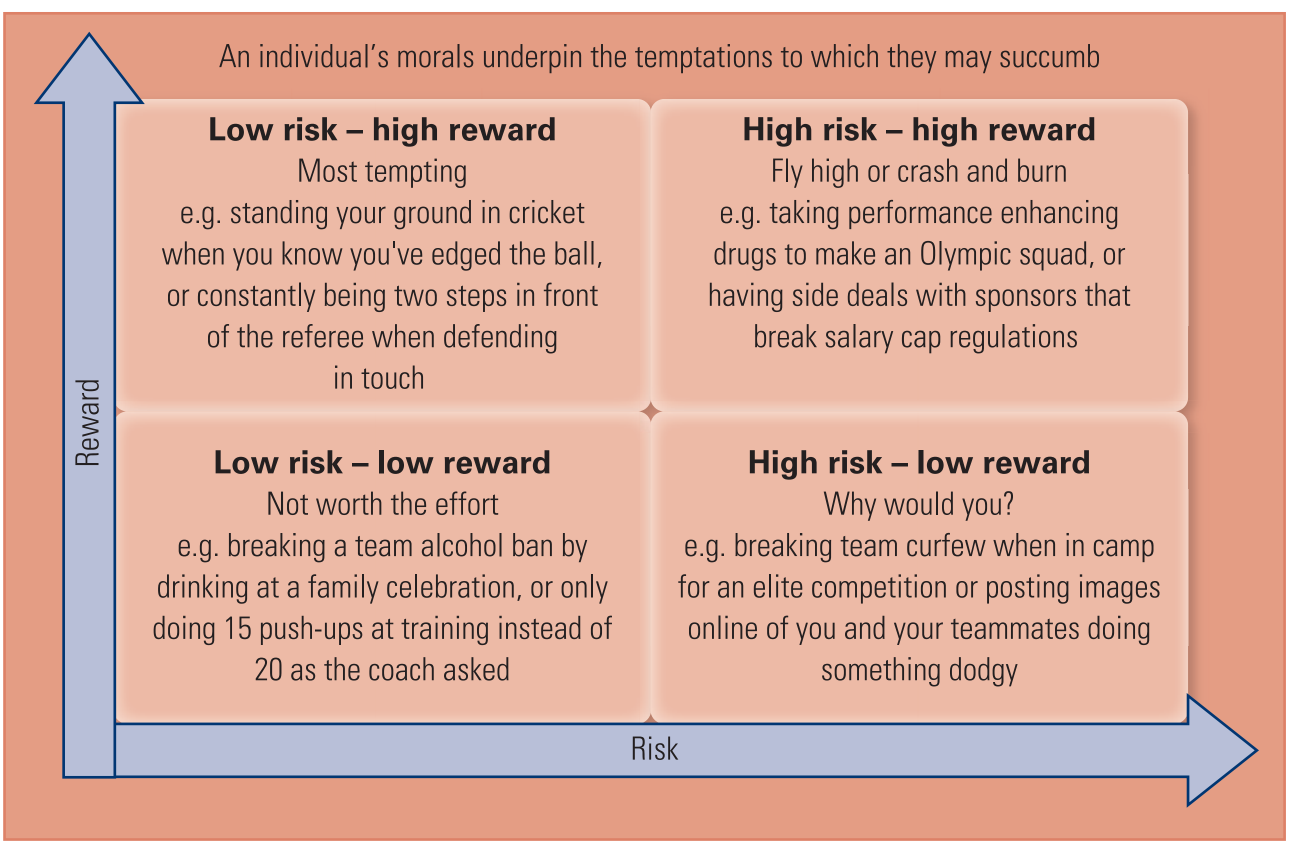

Figure 6.18 An ethical dilemma: risk and reward

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One example of this ethical decision-making process is how a club develops a code of behaviour for its players, officials, parents and spectators. The club itself needs to follow the guidelines set by the government regarding issues like equity, discrimination and inclusive practices. The club may also need to adhere to guidelines or templates handed down from the governing authority for its specific sport. The club may look to examples already established by other clubs, as well as canvassing its own members during the creation process to ensure the code of behaviour reflects the values of members. While the resulting code may not please all individual club members, the ethical decision-making process undertaken should ensure that all see the value of adhering to the guidelines established.

Once ethical strategies are developed, they must be implemented effectively if they are to be successful. Again, having an ethical decision-making framework to document how a decision is reached is essential to ensure that those affected feel the decision was reached after consideration of all possibilities. Ethical decisions need to reflect community expectations to:

- be free of bias
- be transparent
- be equitable and just
- explore all possibilities before making a final decision
- give consideration to possible consequences
- reflect community expectations.

Ethical decision-making while implementing a strategy can be demonstrated when enacting funding guidelines. Here a cricket club may have to make a decision about how to spend an amount of money. Does the club spend $2000 to repair the irrigation system for its fields, or does it spend the money on purchasing additional protective equipment for its junior teams? The ethical dilemma may be a result of conflicting priorities – the improved cricket fields would benefit all members, whereas the protective equipment only benefits some, but is a matter of child safety. Whatever the outcome, the cricket club will need to ensure its members understand how an equitable and ethical decision was reached.

Decisions that are deemed ethical are those that reflect equitable practices. However, it is important to note that 'equity' can take on many meanings when it is part of any decision-making process. For example:

- Equity as *equality* – will the decision benefit every individual equally (or the largest possible amount)?
- Equity as *need* – will the decision address an issue where some are disadvantaged?
- Equity as *inclusivity* – will the decision increase participation or engagement?
- Equity as *demand* – will the decision meet the requirements of those most frequently involved?
- Equity as *market equity* – will the decision produce a financial benefit?
- Equity as *efficiency* – will the decision be good value for money?

Each of these different 'interpretations' of equity must be considered during a decision-making process in order to solve an ethical dilemma. However, these differing definitions of equity frequently contradict each other, and each may lead to a different ethical solution – hence ethical dilemmas are seldom easy to solve.

An ethical decision-making framework

An ethical decision-making framework provides structure to the decision-making process. It demonstrates transparency and ensures decisions are informed and justifiable. When implemented correctly, a decision-making framework produces outcomes that are equitable.

KEY MESSAGE
Ethical dilemmas occur both when tempted by unethical behaviours and when engaging with ethical strategies.

KEY MESSAGE
Organisations must demonstrate accountability and transparency regarding the decisions they make.

KEY MESSAGE
Undertaking a formal decision-making process demonstrates accountability and transparency.

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The ethical decision-making framework presented in the Physical Education General Senior Syllabus (Queensland), and adapted in Figure 6.19, is just one model that demonstrates how ethical decisions can be made. There are many other similar processes that can be implemented to produce ethical results. Many institutes and organisations have their own established processes and guidelines in place to demonstrate how ethical decisions are made. The Play by the Rules website also provides advice on ethical decision-making that provides assistance for the remainder of this unit.

The ethical decision-making framework: A five-step process

STAGE 1

Identify the ethical dilemma

Clearly articulate the problem or situation and identify the tension that exists between the organisation's or player's values

- Find information about:
  - – the relevant facts of the problem or situation
  - – individuals and groups who have an important stake in the outcome.

STAGE 2

Identify possible solutions and/or behaviours

- Are there examples of similar dilemmas previously being addressed?
- Where previous examples exist, how successful were the strategies implemented?
- Are there examples of similar dilemmas previously being addressed *(i.e. extent to which behaviour changed or the dilemma solved, amount of people reached or helped, was the outcome a permanent change or band aid solution, was it cost effective)*?
- How effectively will the identified solutions transfer to your context? *Consider: How much will it need to be adapted? Will any adaptions affect the success of the strategy?*
- Are there any other possible solutions that have not previously been attempted? Consider:
  - – totally new thinking; or
  - – correcting the flaws in other strategies – where did they go wrong?
- Formulate a list of potential strategies.

STAGE 3

Evaluate alternatives

- Use criteria to evaluate potential strategies, which might include:
  - – level of good produced *(which strategy will produce the most good and do the least harm)*
  - – respect for rights *(which strategy will best respect the rights of all who have a stake)*
  - – level of equality produced *(which strategy will treat people equally or proportionately)*
  - – how many people will benefit *(which strategy will best serve the community as a whole)*
  - – level of behavioural change *(which strategy will lead players to act with integrity, or reflect the values of fair play)*
- Select a strategy based on evaluation.

STAGE 4

Provide a course of action

- Refine the selected strategy.
  This may include how the strategy can best be delivered to the intended player/s, target group or organisation.
- Implement the strategy.

STAGE 5

Reflect on the effectiveness of the strategy

- Determine the effectiveness of the strategy by:
  - – gauging the degree to which the strategy has affected the dilemma (*to what degree has the problem been solved*) – what has changed, what has not?
  - – gauging the longevity and sustainability of the changes displayed.
- Has there been a permanent change or will it revert?
- How long can the strategy continue – does it need to continue
  - – identifying any unforeseen consequences (both positive or negative) on all stakeholders?
- Determine whether the strategy should continue.
- Determine whether modifications to the strategy are required.

Figure 6.19 Ethical dilemmas in Queensland Senior Physical Education can be grouped in four priority areas of study that affect equity or access within physical activity. An ethical decision-making framework can be employed to address issues in all these priority areas.

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Activity 6.37

Engage-in

Inquiry question: How can I increase engagement in our current physical activity among junior students?

Engage and understand

1 Individually or in small teams, develop a strategy to increase engagement for lower year levels in a physical activity that is assessed in your Senior Physical Education subject. The goal is to increase access for younger students so they will be better equipped when they reach Senior Physical Education.

2 Your strategy must be ethical, increase engagement and be realistic.

Apply and analyse

3 Use the Play by the Rules Ethical Decision-Making Framework to guide the development of your engagement strategy and document each stage as you progress right to the point of implementation. In researching potential strategies during stage 2 of the process, you might consider accessing the Program and Product Development section of the Clearinghouse for Sport website.

Evaluate and justify

Appraise: Evaluate the worth, significance or status of something; judge or consider a text or piece of work.

4 Once you have devised your strategy, pair with another group or individual and take it in turns to explain your strategy and the ethical decision-making process you went through.

5 Provide a 100-word appraisal to your partner/group outlining the strengths and weaknesses of the strategy they proposed.

Inquiry cycle – stages 2 & 3: Apply and analyse; Evaluate and justify

In this section, you will be required to use the knowledge and understandings established about ethics and integrity during the earlier part of the chapter investigate, propose and implement ethical strategies in your class, school or community context. These strategies will focus specifically on ethical dilemmas related to either equity or engagement for individuals or groups within these contexts.

6.11 Ethical dilemmas related to equity and engagement in physical activity

Ethical dilemmas occur as a result of many unique factors specific to the individuals and groups involved. Consequently, the ethical strategies developed to

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overcome these dilemmas must be tailored to the circumstances of the specific context. What works in one situation to improve equity and engagement may not always be as successful in a different context. As you investigate ethical dilemmas through this chapter, it may be relevant to refer to Tables 6.3 and 6.4 as a reference to assist in guiding your research, strategies and evaluations.

Equity refers to giving value to, and celebrating, personal, social and cultural differences in society. Therefore, in a physical activity context, ethical dilemmas associated with equity typically concern the removal of barriers that hinder access for individuals or groups. When investigating these ethical dilemmas, you must consider the demographics of those who currently have access to physical activity and those who are being marginalised or excluded.

Key demographics to investigate include:

- gender
- age
- ability level (including abled and disabled participants)
- socioeconomic status
- culture, race or religion.

Key questions to consider when contemplating equity strategies:

- Which demographic groups currently access the physical activity?
- Which demographic groups are currently being marginalised or excluded?
- What are the real barriers restricting individuals or groups?
- What can be done to remove or limit the effect of these barriers for individuals or groups?
- How can physical activity be more inclusive?
- How can physical activity allow for diversity?
- How can physical activity utilise the different talents and knowledge of individuals?

Key areas to investigate:

- current policy documents – scrutinise for barriers
- the routine practices of institutes.

Table 6.3 Equity in ethical dilemmas

Engagement refers to both becoming involved in physical activity and maintaining that involvement. In a physical activity context, ethical dilemmas associated with engagement can investigate two areas:

- the social, cultural or environmental factors that limit the opportunities for engagement experienced by an individual
- the personal factors that prevent an individual from engaging in physical activity.

Key social factors to consider when investigating engagement strategies include:

- the role of family through value placed on activity, financial considerations, their involvement, available time and competing priorities
- the role of peers through their interests, engagement levels and support
- the behaviours and attitudes of teachers and coaches.

Table 6.4 Engagement in ethical dilemmas

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Key cultural factors to consider when investigating engagement strategies include: • gender expectations and stereotyping • cultural expectations for the amount and type of engagement • the associated institutes – the policies, strategies and codes of government, sporting authorities, clubs and schools. Key documents might address: – diversity, inclusion or discrimination – funding and sponsorship – resource allocation and maintenance – codes of behaviour – competition structure – development strategies for improving performance and engagement – the distribution of and access to physical, human or financial resources – the role of promotion or media coverage. Key environmental factors to consider when investigating engagement strategies include: • the availability and quality of facilities.
Key individual factors to consider when investigating why people choose to disengage with physical activity include: • the level of enjoyment experienced (feelings of fun or success, their contribution being valued, a sense of inclusion) • their level of confidence (perceived level of ability, possibility to improve and the chances of success) • their level of motivation: Why would I participate? What are the benefits? • their personal values and attitudes towards engagement in physical activities or specific activities • the level of autonomy experienced (do they have control over what they do and how they participate) • the interest in the specific activity • other priorities in life • available time • available finances.
When investigating ethical issues related to engagement, consider all aspects of engagement. This includes the opportunity to: • participate (access to physical activity, and the players, officials and management to undertake games) • develop skills and improve (access to quality teachers, coaches and resources) • be successful – reach higher representative levels, make a career, receive earnings or prestige (access to quality competitions, media, rewards, sponsorship).
Key questions to consider when contemplating equity strategies: • Which demographic groups currently participate in the physical activity? • Which demographic groups are currently being marginalised or excluded? • What are the real barriers restricting access to individuals or groups? • What can be done to remove or limit the effect of these barriers for individuals or groups?

Table 6.4 *(continued)*

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Ethical dilemmas in a class context: Equity

Activity 6.38

Active investigation

Inquiry question: Can physical activity lessons be inclusive of the ability level of all class members?

Engage and understand

1 Collect primary data by tracking individual performance for all class members in a selected physical activity for a number of lessons.

2 Using an appropriate game play analysis instrument, assess the level of individual skills and make an overall evaluation of the ability level for each class member.

3 Make notes on how your teacher accounts for different ability levels in their teaching practice (games and activities).

4 Divide the class into three groups: higher ability, typically ability and lower ability. Have each group reflect on how the skill development needs of their allocated ability level are currently being met, and how they could be improved.

Apply and analyse

5 Analyse the primary data collected by reviewing strengths and weaknesses in individual skills and the range of overall ability levels within the class. Analysis may include presenting data in tables or graphs to identify trends.

Synthesise: Combine different parts or elements (e.g. information, ideas, components) into a whole, in order to create new understanding.

6 In small groups, design a one-lesson strategy (lesson plan) that employs inclusive practices to enhance the skills of all ability levels within your class for your selected physical activity of study. Your group must document the use of the five-stage ethical decision-making framework to devise this ethical strategy. While using the framework, ensure your group undertakes secondary research to synthesise contemporary and inclusive training activities to develop the desired skills. In devising your strategy, consider:

- **a** the different skills that require improvement (addressing everyone's needs)
- **b** how students are organised (individual, ability groups, mixed-ability groups, whole class)
- **c** the amount and range of activities included (addressing student needs, interest levels and enjoyment)
- **d** skill-development activities or game play
- **e** autonomy (student choice verse allocated activities)
- **f** safety and resources (what can safely be undertaken and monitored).

7 Over a series of lessons, implement the strategies devised by each group.

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8 At the completion of each group's lesson, survey class members to identify how inclusive the lesson was in meeting their developmental needs. Possible survey questions may include:
   - **a** To what degree did the lesson meet your overall needs?
   - **b** Did the lesson target the skills on which you needed to focus?
   - **c** Do you feel like you experienced improvement by the end of the lesson?
   - **d** Did the lesson cater for your ability level more than a typical Physical Education class?
   - **e** Did you feel part of the class group?
   - **f** Which aspect of the lesson was most inclusive?

9 You should also develop a rating scale for survey responses (e.g. not really, somewhat, pretty well, extremely well).

10 As a group, collate your post-lesson primary data and analyse the results.

Evaluate and justify

11 In a 200-word evaluative statement, use two pieces of evidence to highlight the effectiveness of your strategy in being inclusive to all ability levels in the class. Make one recommendation that would further enhance your overall strategy.

Ethical dilemmas in a class context: Engagement

Activity 6.39

Active investigation

Inquiry question: Does implementing the fair play values in physical education classes increase student engagement?

Engage and understand

1 Refresh your understanding of the values of fair play outlined earlier in the chapter – respect, friendship, team spirit, integrity, solidarity, tolerance, excellence, care and joy.

2 Collect primary data on the extent to which each of these values is displayed in your Physical Education class during your outside lessons. Some data may have been gathered as part of Activity 6.14 (on pp. 319–20); if not, make observations over a series of physical lessons.

Apply and analyse

3 Analyse your primary data by developing a rating scale and applying it to each fair play value. Also rate the overall enjoyment students experienced in outside physical activity lessons. Identify the five values that are most poorly displayed in your Physical Education class.

(continued)

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4 Divide your class into five groups and allocate each group one of the identified fair play values.

5 Document your use of the five-stage ethical decision-making framework to devise a code of conduct for players in your Physical Education class addressing the fair play value your group is assigned. Your code of conduct is to outline three key areas:
   - **a** a value statement (a short two- to four-sentence statement that explains the value for your class)
   - **b** the code (four dot points that set the expectations for your class)
   - **c** the behaviours (four dot points that provide examples of how to demonstrate the value during the physical activity being studied).

   In devising your code, ensure you consult the class concerning the standard of behaviour that should be aspired to.

6 Collate the codes created from each group to form one code of conduct that addresses the five fair play values selected and promote your code and expected behaviours to all class members.

7 Over a series of physical lessons, implement the code of conduct and emphasise the importance of displaying the example behaviours as often as possible during this period.

8 At the end of the implementation period, collect primary data on the success of the code in improving the fair play values addressed. Consider the following:
   - **a** Was there an increase in the awareness of the fair play values among students?
   - **b** Was there an increase in the behaviours that displayed the specific fair play value?
   - **c** Were there players or behaviours that went against the code displayed?
   - **d** Overall, was there increased enjoyment among students when participating?
   - **e** Overall, was greater integrity demonstrated by students when participating?
   - **f** Overall, did Physical Education students engage more enthusiastically than normal as a result of an increased emphasis on fair play during lessons?

KEY COGNITION

Analyse: Give reasons or evidence to support an answer, response or conclusion; show or prove how an argument, statement or conclusion is right or reasonable.

9 Collate your post-implementation data in an appropriate format.

Evaluate and justify

10 In a 200-word statement using the primary data collected, respond to the inquiry question at the beginning of this activity.

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Ethical dilemmas in a school context: Equity

Activity 6.40

Active investigation

Inquiry question: What ethical dilemmas must be overcome to maximise equity in a competition?

Engage and understand

The class will be creating and implementing a school-wide competition for a selected physical activity.

1 Divide the class into five groups and allocate one to each of the following areas of responsibility:
- **a** competition promotion
- **b** team structure and draw
- **c** competition time and resources
- **d** risk management
- **e** rewards and incentives.

Apply and analyse

2 Each group is to use the five-stage ethical decision-making framework to devise an ethical strategy that maximises equity in its allocated section of competition development. Consider:
- **a** competition promotion (the images and words used to be inclusive of all year levels, genders, ability levels as well as how promotion will best reach all students)
- **b** team structure and draw (How can teams make up guidelines to create fair competition? How will the type of draw maximise participation? Will any rule or scoring adjustments create a fairer more inclusive competition?)
- **c** competition time and resources (When will the competition be held to maximise the opportunity for all school members to participate? What resources will limit the competition – for example, number of playing areas, available referees/umpires?)
- **d** risk management (What guidelines need to be followed and how does this impact on competition structure? What documents need to be completed or people consulted?)
- **e** rewards and incentives. (What prizes or prestige can be awarded as incentives? How will this be funded? What funds are available? Who receives the rewards?)

3 Collate the work from each group, then promote and run the competition.

4 Following the competition, each group is to collect primary data from both participants and non-participants. Consider the following:
- **a** *Participants:* Did your group's allocated area for organisation create a fair, enjoyable and engaging competition? Would participants play again in a similar competition? Would they consider playing outside of school?
- **b** *Non-participants:* What prevented them from playing in the competition? Is there anything about the competition that could be changed to get them playing?

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Analyse: Examine or consider something in order to explain and interpret it, for the purpose of finding meaning or relationships and identifying patterns, similarities and differences.

5 Analyse the primary data collected.

Evaluate and justify

6 Using the PMI table below, reflect on the primary data collected and categorise points that affected the equity experienced by participants and non-participants.

7 From the PMI, identify the three biggest hurdles to creating an engaging and equitable competition.

Plus	Minus	Interesting
Factors that enhanced equity	Barriers that hindered equity	Any points of note about the competition organisation or implementation

Ethical dilemmas in a school context: Engagement

Activity 6.41

Active investigation

Inquiry question: Can targeted ethical strategies reduce the barriers to participation experienced by specific age groups?

Engage and understand

1 *Collect primary data – stage 1:* Identify a year level at your school that currently has poor access to the physical activity being studied or a specific activity chosen by your class. If your school is a P–12 campus, then this may include primary year levels. To identify the year level, you may review the Physical Education curriculum offerings and school sports programs, as well as surveying students concerning their involvement outside of school.

2 *Collect primary data – stage 2:* For the identified year level, survey students regarding reasons for non-participation. Your survey should incorporate questions covering a range of individual, social, cultural and environmental factors that may be creating barriers to participation for this target group (refer to Table 6.4 on pp. 350–1 to assist in survey construction).

Apply and analyse

3 As a class, document your use of the five-stage ethical decision-making framework to devise a two-lesson 'come and try' program for a specific class in the year level identified. Your two-lesson program is to develop enjoyment, skill level and confidence for the selected

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physical activity. Your program may also attempt to address any other barriers identified during the analysis of primary data. For example, if the audience finds the activity boring, then your strategy may need to adapt the rules of the game to make it more appealing and exciting for the players. Ensure you research appropriate secondary sources to provide a wide variety of engaging activities for the players.

4 The class may be broken into small groups and allocated different sections of the program to develop. Organise to implement your two-lesson come-and-try program for a class in the identified year level. Before commencing, survey the targeted students with regard to their level of:

- **a** enjoyment
- **b** skill
- **c** confidence

as well as the likelihood of them participating in the selected physical activity outside the school.

5 Implement the program and collect post-program data on the same questions. Where students still identify that they are not likely to play outside of school, consider asking why.

Analyse: Examine or consider something in order to explain and interpret it, for the purpose of finding meaning or relationships and identifying patterns, similarities and differences.

6 Collate your pre- and post-implementation data in an appropriate format and analyse.

Evaluate and justify

7 Make an assessment of your program's ability to overcome barriers for the specific demographic by selecting one aspect of enjoyment, skill development or confidence, and evaluate how successful the program you implemented was in increasing levels in that area. Ensure you identify positives and negatives from the program that influenced its effectiveness in the selected area.

Ethical dilemmas in a community context: Equity

Activity 6.42

Active investigation

Inquiry question: Is it ethical to overcome poor participation by using strategies that reinforce gender stereotyping?

Engage and understand

Note: For single-sex classes, or for an alternative, this activity may be undertaken using bibs to allocate male and female gender roles. When you reach the Evaluate and justify section, you may draw on other anecdotal primary data which you have experienced outside of the current Physical Education environment.

1 Split the class into males and females.

(continued)

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2 Each group is to use research and the analysis of secondary data to select a physical activity from the current version of the Physical Education syllabus that currently shows increased participation rates for the opposite gender. *If this cannot be done due to class size or undertaking a specific physical activity, then a stereotypically 'gender-neutral' physical activity can be utilised.*

3 Over one or two lessons in the performance environment, each gender group is to experiment with manipulating the playing conditions and rules to make the activity more appealing to their gender. Use the table below to help guide ideas for these changes.

Characteristics of 'female' sport	Characteristics of 'male' sport
Non-contact Distance maintained between participants Limited running space Set positional areas No running with the ball Strict dress requirement	Speed Strength Endurance Agility Physical contact, tackling and violence Risk-taking Open field

Apply and analyse

4 Once your group has finalised its adaptions, implement them in a competitive match for your group. If possible, collect additional data by implementing the game with other Physical Education classes, year levels or groups outside of school (i.e. at a club training session for another sport).

5 After the match, collect primary data relating to enjoyment and engagement.

6 From the data collected and your own experiences, complete the below SWOT analysis specifically looking at rule changes that use gender-based stereotypes as a method of increasing engagement.

SWOT analysis

A SWOT analysis is used to evaluate the strengths, weaknesses, opportunities and threats related to an issue. Once you have done a SWOT analysis, you are better placed to make informed decisions or form an opinion.

Rule adaption based on gender stereotypes	
Strengths	**Weaknesses**
• • •	• • •
Opportunities	**Threats**
• • •	• • •

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Evaluate and justify

7 Reflect on your analysis and examine the five-stage ethical decision-making framework. Make a decision either for or against the statement, 'Using gender stereotypes is an ethical strategy to overcome an imbalance of participation rates'.

Justify: Give reasons or evidence to support an answer, response or conclusion; show or prove how an argument, statement or conclusion is right or reasonable.

8 Justify your stance on this topic in a 400-word persuasive response that uses both primary and secondary data as evidence.

Ethical dilemmas in a community context: Engagement

Activity 6.43

Active investigation

RECOGNISE & EXPLAIN | ANALYSE & SYNTHESISE | EVALUATE | JUSTIFY | MAKE DECISIONS

Inquiry question: How can ethical strategies enhance engagement for community clubs?

Engage and understand

1 As a class, select a physical activity from the current version of the Physical Education syllabus, or use the one currently being studied. Conduct research – both primary and secondary – into the participation rates and current barriers to engagement that may exist. This would include surveying a variety of community members from different demographics to establish barriers to participation. Surveys should include questions exploring personal, social, cultural and environmental factors (refer to Table 6.4 on pp. 350–1 to assist in survey construction).

2 In one lesson, have a representative from a local club or sporting organisation visit your class and speak about the issues they face at a local level in administering a fair, equitable and inclusive competition, and the barriers that they perceive affect participation. Use your primary and secondary data to ask clarifying questions of your guest speaker.

Apply and analyse

Synthesise: Combine different parts or elements (e.g. information, ideas, components) into a whole, in order to create new understanding.

3 Using the five-stage ethical decision-making framework, synthesise the information you have collected to design a strategy for the guest speaker's organisation to increase engagement.

(continued)

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Evaluate and justify

4 Present your strategy in an appropriate format that clearly outlines:

a the target audience – who the strategy is aimed at

b the context – the current situation at the club or organisation, and the details of the engagement strategy

c the outcome – how the strategy will overcome identified barriers to participation for the target audience, provide more opportunities for engagement and create a more inclusive organisation.

An appropriate format may include a video, PowerPoint presentation, brochure or poster that is designed to highlight the importance of undertaking your recommended strategy.

5 If possible, present your strategy back to the guest speaker. Alternatively, present it to your teacher, who may select two or three to be passed onto the relevant club or organisation. Ideally, your class may work with the organisation to actually implement an appropriate strategy at a local level.

Figure 6.20 Communities form around sports and sporting events.

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Chapter summary

- Ethics are the behavioural norms expected from a group concerning 'right' and 'wrong', while integrity is demonstrated when the behaviours of the individual match the expected ethical behaviours.
- Peers, family, coaches, the school, the community and the media all play a role in establishing expected ethical behaviours.
- Ethical violations occur when individuals display behaviour that does not represent the expected standards of a larger group or organisation.
- An individual demonstrates integrity when they consistently display the ethical standards (expectations) set by the social group or organisation.
- Physical activity and sport must maintain high ethical standards and display integrity if they are to maintain or enhance their social and economic value in Australian culture.
- Ensuring fair play values are present in physical activity builds integrity, retains community confidence and increases the value of sport for the Australian people.
- Ethical strategies include policies, guidelines, codes and frameworks that set behavioural expectations and educate all involved in physical activity for the purpose of raising the level of integrity.
- Ethical dilemmas are situations that extend across different areas of morality; therefore, a number of options must be considered to resolve the situation – in many cases, none of the solutions is totally ethically acceptable or preferable.
- To solve ethical dilemmas, organisations should implement an ethical decision-making process to ensure that the solution they reach is equitable, accountable and transparent.

Chapter review

Multiple-choice questions

1 Which of the following identifies a key difference between ethics and integrity?

A Ethics are an individual's value system, while integrity consists of behaviours.

B Ethics are an external view of what is right and wrong, while integrity is the behaviours that reflect our internal view of this.

C Integrity is how we behave in physical activity, while ethics is how we behave in social situations.

D Integrity is demonstrated through the values of fair play, while ethics reflect individual morals.

2 Which of the following does not contribute to the value of physical activity in Australia?

A Physical activity as a vehicle for self-interest

B Physical activity as a medium for community development

C Physical activity as a method of education

D The historical contribution of sport in developing and inspiring our nation

3 To enhance the perception, reputation and standing of physical activity in Australian society, organisations create and mandate:

A ethical strategies.

B integrity guidelines.

C ethical behaviours and personal values.

D behaviours that dictate values to enhance integrity.

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4 Increased economic benefit, increased fame and status for organisations, clubs and players, and increased national status on the world stage are all outcomes of what phenomenon?

A Fair play

B Globalisation

C The integrity policy

D The social media revolution

5 Illegitimate sport performance most accurately reflects which two fair play values?

A Fair competition and team spirit

B Sport without doping and excellence

C Excellence and integrity

D Fair competition and equality

6 Policies and guidelines that most directly affect physical activity at a school and local level address:

A behavioural standards.

B diversity, equity and inclusiveness.

C safety and risk management.

D all of the above.

7 A male netball player, not being able to trial for representative teams as a result of a female-only team policy, is a reflection of which priority area of ethical dilemmas?

A Equity policies in physical activity

B Cultural stereotypes impacting physical activity

C The impact of ability level on physical activity

D Gender inclusion in physical activity

8 When physical activity fails to display fair play values, there is a decrease in:

A enjoyment and engagement.

B equity and transparency.

C ethical standards.

D social expectations.

9 Identify the correct sequence of the ethical decision-making framework.

A 1. Reflect on the effectiveness of the strategy; 2. Identify the ethical dilemma; 3. Evaluate alternatives; 4. Identify possible solutions and/or behaviours; 5. Provide a course of action.

B 1. Identify the ethical dilemma; 2. Identify possible solutions and/or behaviours; 3. Evaluate alternatives; 4. Provide a course of action; 5. Reflect on the effectiveness of the strategy.

C 1. Identify the ethical dilemma; 2. Identify possible solutions and/or behaviours; 3. Provide a course of action; 4. Evaluate alternatives; 5. Reflect on the effectiveness of the strategy.

D 1. Evaluate alternatives; 2. Identify the ethical dilemma; 3. Identify possible solutions and/or behaviours; 4. Provide a course of action; 5. Reflect on the effectiveness of the strategy.

10 An individual is most likely to display unethical behaviours when the situation contains consequences that are:

A high risk – high reward.

B low risk – high reward.

C low risk – low reward.

D high risk – low reward.

Short-answer questions

1 Compare and contrast ethics and morals.

2 Critique the impact social media has on determining ethical behaviours expected by society.

3 Evaluate the level of impact that illegitimate competition has on enjoyment for you as a participant.

4 Using examples, explain how equity can be defined in different ways when evaluating solutions to ethical dilemmas.

5 Justify a recommendation to increase the inclusiveness of different ability levels in your Physical Education class.

Extended-response questions

1 Propose and justify a recommendation that would overcome an issue of equity through more inclusive practices for a specific demographic.

2 Clearly outline the causes of three barriers to engagement for a specific sport in your local area. For each, justify a recommendation that will reduce that barrier.

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Figure 6.21 Family members play an important role in establishing ethical values.

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Unit 4

Energy, fitness and training, and physical activity

Unit description

In Unit 4, students engage with concepts, principles and strategies about energy, fitness, training and physical performance using the three stages of the inquiry approach.

In the first stage of inquiry, students recognise and explain concepts and principles about energy, fitness and training through purposeful and authentic learning about and in a selected physical activity. In the selected physical activity, students explore body and movement concepts and demonstrate specialised movement sequences and movement strategies.

In the second stage, students apply concepts to specialised movement sequences and movement strategies in authentic performance environments to gather data about their personal application of energy, fitness and training concepts. They analyse and synthesise relationships between the energy and fitness demands of the selected physical activity and their personal performance. Students then devise a competition-phase training strategy to optimise performance in the selected physical activity.

In the final stage, students evaluate the effectiveness of the competition-phase training strategy and movement strategies, and justify using primary and secondary data.

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Unit objectives

Objectives	Activity icons
1 Recognise and explain energy, fitness and training concepts and principles about the selected physical activity	RECOGNISE & EXPLAIN
2 Demonstrate specialised movement sequences and movement strategies in the selected physical activity	DEMONSTRATE
3 Apply concepts to specialised movement sequences and movement strategies in the selected physical activity	APPLY
4 Analyse and synthesise data to devise a training strategy	ANALYSE & SYNTHESISE
5 Evaluate training and movement strategies	EVALUATE
6 Justify training and movement strategies	JUSTIFY
7 Make decisions about and use language, conventions and mode-appropriate features for particular purposes and contexts	MAKE DECISIONS

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Chapters in this unit

Chapter
7 Energy, fitness and training for physical activity

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Chapter 7
Energy, fitness and training for physical activity

Chapter description

In Topic 1, students engage in learning that involves the integration of energy, fitness and training subject-matter and the subject-matter for a selected invasion, net and court or performance physical activity.

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Key inquiry questions

- How does the body produce energy for movement at various intensities and durations of exercise?
- What are the components of fitness?
- How can analysis of the energy and fitness demands of particular physical activities and specific player roles contribute to developing specific training activities and programs?
- What data can be gathered to determine the personal fitness and training requirements of various physical activities, and various roles and positions within them?
- What principles of training are needed for effective and efficient training for athletes?
- How can tracking physical responses to exercise help to guide training volume and intensity?
- How does the body adapt to different methods of training?
- What elements are required in an effective training session?
- In what order should exercises be completed during a training session?
- How should an effective training program be planned to ensure optimal performance during competition?

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Key terminology

- aerobic endurance
- aerobic training threshold
- aerobic training zone
- anaerobic endurance
- anaerobic training zone
- circuit training
- concentric contractions
- dynamic flexibility
- dynamic stretching
- eccentric contractions
- fitness
- hypertrophy
- individuality
- isokinetic strength
- isometric contractions
- isometric strength
- isotonic contractions
- isotonic strength
- maximum heart rate
- training zones

Introduction

Being physically educated is concerned with developing knowledge in the biophysical, sociocultural and psychological domains that underpin physical activity and utilising this knowledge to maximise enjoyment, engagement and physical performance for yourself and others. The physically educated become advocates for both the social and physical importance of being physically active.

This chapter explores energy production, components of fitness, and training principles and methodology as key elements within the biophysical sub-discipline of physical activity. Through an understanding of energy pathways, fitness components and training principles, the physically educated can determine how best to prepare athletes for the physical demands of varied physical activities. They can analyse the physical fitness and energy demands of various physical activities and, in turn, design training programs that allow athletes to develop the physical attributes demanded by their sport with maximum effectiveness and efficiency. They learn to evaluate the appropriateness of training strategies for the individual needs of athletes and make justified training recommendations for improving physical performances.

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Inquiry cycle A – stage 1: Engage and understand – energy and fitness

7.1 Energy for activity

An understanding of how the body provides energy for physical performance will greatly enhance attempts to improve physical performances. Training programs can be planned accurately to suit the energy requirements of individual athletes in their chosen activity. This section provides an overview of how energy is provided for muscular contraction and other bodily functions.

Energy

Energy is defined as the capacity to do work. It can take many forms, such as chemical energy (the energy released from the breakdown of chemical compounds), kinetic energy (energy used in producing movement) and potential energy (energy that is stored). Energy to produce bodily movement is provided by the energy stored in food. This energy is released as the digestive system and body cells break down the chemical compounds in foods that contain energy (energy nutrients). Body cells use this chemical energy to perform essential bodily functions. For example, muscle cells convert the chemical energy released from the breakdown of the energy nutrients in food into kinetic energy (movement) and heat.

Fuel for energy

Energy for physical activity and other bodily functions is provided by the chemical energy in food. Through the digestive process, the energy providing nutrients (carbohydrates, fats and proteins) can be broken down to provide our energy requirements. The energy from the breakdown of these nutrients cannot, however, be used directly for muscular contractions and other body functions; rather, it is used by body cells to produce a high-energy compound, adenosine triphosphate (ATP). The energy requirement of each body cell is provided by breaking down ATP, releasing usable energy. The energy provided by carbohydrates, fats and protein allows body cells to produce more ATP. Muscle cells can only store enough ATP for one or two seconds of high-intensity work before the supply must be replenished. The rate at which ATP can be produced determines how much energy is available. The way in which ATP is produced in the muscle cell at varying levels of exercise intensity is the focus of this section.

Figure 7.1 Energy for movement is supplied from the energy nutrients contained in food.

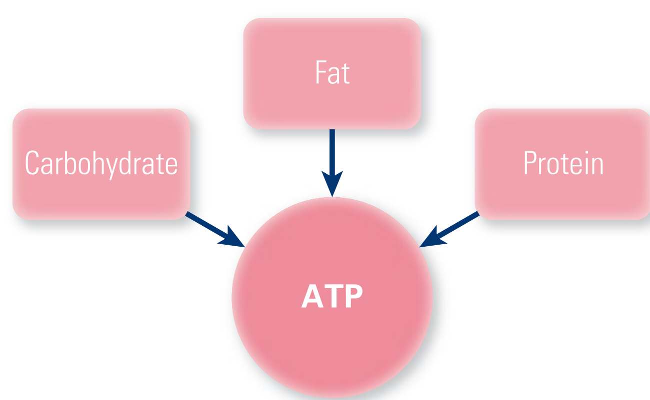

Figure 7.2 Energy sources from food to produce ATP

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Carbohydrates as an energy source

Carbohydrates can be categorised into complex carbohydrates (such as starch) and simple carbohydrates (such as sugar). When eaten, carbohydrates are broken down by the digestive system into **glucose**. Glucose is easily dissolved into the blood, and therefore can be transported to any cell in the body. Glucose is converted to a substance called **glycogen** in order to be stored by muscle cells or in the liver. Muscle cells can use immediate supplies of glucose from the blood or can convert stored glycogen back into glucose to supply the energy to produce ATP. If muscular glycogen stores and liver glycogen stores are adequate, any excess glycogen can be converted to and stored as body fat.

Glycogen is the body's preferred immediately available energy fuel during physical activity, particularly during higher-intensity activity and in the early stages of more prolonged lower-intensity activity. An increased level of physical activity causes the level of glucose in the blood to rise. This glucose can be used immediately by muscle cells in order to produce ATP, or can be used to maintain levels of muscle glycogen. During periods of lower to moderate intensity activity, muscle cells will use muscle glycogen supplies or blood glucose for energy; however, if the activity is maintained and glycogen levels in the muscles begin to decline, fat becomes the main energy source for producing ATP.

Levels of muscle glycogen vary according to a number of factors. Well-planned training for endurance events has two effects on levels of muscle glycogen. First, training causes the body to increase the amount of glycogen that is stored in muscle cells and the liver. Second, training causes the body to use fats as a fuel source in earlier stages of prolonged activity, reserving glycogen for the later stages of the activity. The type of activity also affects muscle glycogen levels. The body can store enough glycogen for approximately one to two hours of intense activity (depending on training) or four to six hours of activity with frequent periods of rest, such as competing in a tournament competition. Recovery (rest periods) also contributes to muscle glycogen levels. When muscle and liver glycogen stores are almost depleted, a rest period of 24 hours (or more after very long endurance activities) is required to replenish supplies. It therefore follows that an inadequate recovery will affect physical performance. Finally, diet plays an important role in how much glycogen is stored. A high-carbohydrate

glucose a type of sugar that is found in plants – especially fruit; supplies an important part of the energy that animals need

glycogen a substance found in the liver and muscles that stores glucose and is important in controlling sugar levels in the blood

Figure 7.3 Food sources of carbohydrates

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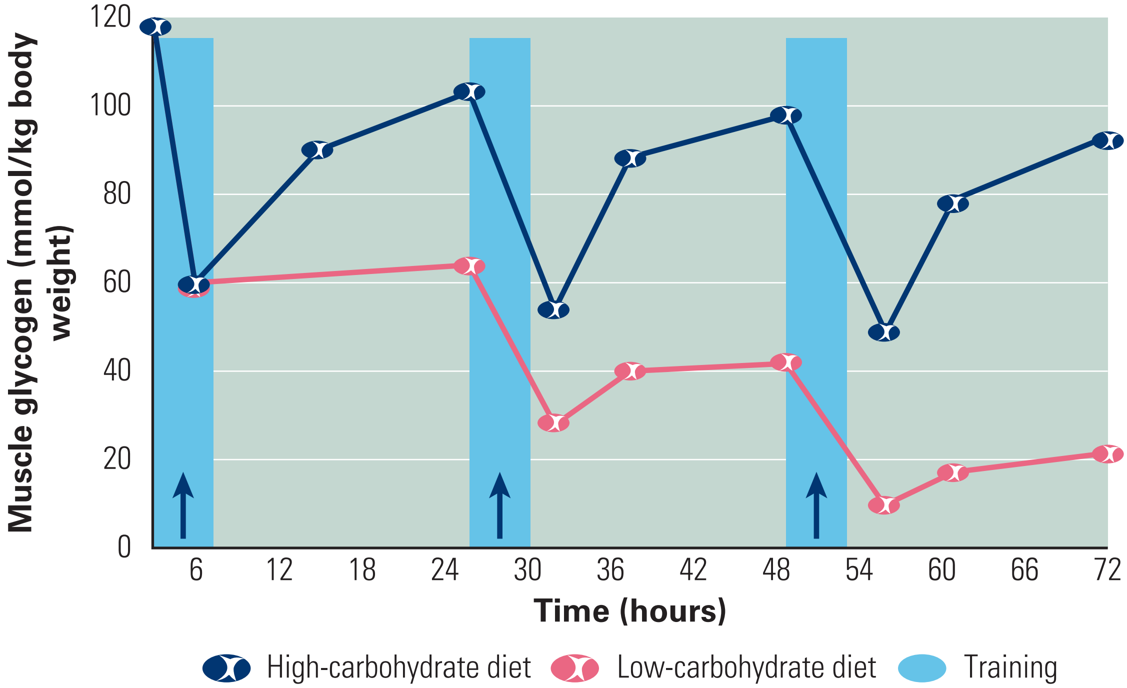

Figure 7.4 Muscle glycogen levels during three successive days of intense training, comparing high and low carbohydrate diets

diet will allow longer periods of sustained exercise before glycogen stored are depleted.

Some athletes use a diet and training method called *carbohydrate loading* before competition to raise their muscle glycogen levels. Earlier methods of carbohydrate loading involved a 'depletion phase' where the muscles were 'starved' of carbohydrates. This involved completing three to four days of intense training on a high-fat and high-protein diet, then switching to a high-carbohydrate diet in the final two days before competition. This 'depletion phase' was difficult for athletes, as they had to train on a diet without carbohydrates – the preferred fuel source for intense exercise.

Modern research has refined the method of carbohydrate loading, which is now more manageable for athletes. Recommended carbohydrate loading involves one to four days of exercise tapering (backing off training loads) while following a high-carbohydrate diet (7–12 g/kg body weight). Muscles normally store 100–120 mmol/kg of glycogen. This method of carbohydrate loading can increase this to around 150–200 mmol/kg. The extra supply of available carbohydrates can improve endurance by allowing athletes to remain at intense exercise levels for longer. It is estimated that a 2–3 per cent improvement in performance over a set distance is possible as a result of correct carbohydrate loading.

Fat as an energy source

Fat in food is broken down by the digestive system into fatty acids, which can be transported in the bloodstream to be used by body cells to produce ATP. Fatty acids that are not immediately required are stored as triglycerides in fat cells. At rest, fat is the major fuel source for the production of ATP, providing up to 80 per cent of the body's energy requirements. During light-intensity activity, fat remains the principal fuel source. Fat contains more energy per gram than carbohydrates but is not so readily available during periods of more intense exercise, where carbohydrates become the major fuel source.

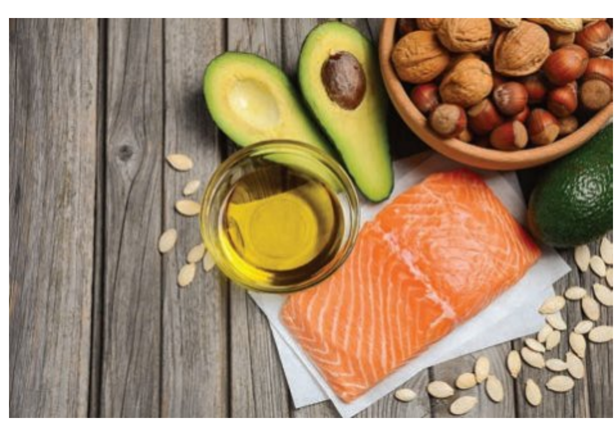

Figure 7.5 Food sources of fat

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Protein as an energy source

Protein is made up of amino acids, which generally are used in the body as the 'building materials' for growth and repair. In normal circumstances, protein accounts for only a very small percentage of the energy used to produce ATP. However, during extended periods of very demanding activity, such as running in a competitive marathon, glycogen and fat stores can become exhausted and proteins are then used to provide energy. An extensive recovery period is required for athletes competing in these types of events.

Figure 7.6 Food sources of protein

7.2 Cellular energy from adenosine triphosphate (ATP)

All the energy for muscular contraction comes from the breakdown of ATP. The ATP molecule consists of an adenosine molecule and three phosphate molecules held together by high-energy chemical bonds. This large molecule is represented in Figure 7.7.

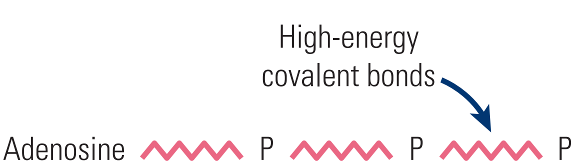

Figure 7.7 The structure of ATP

In order to supply energy, ATP is broken down by splitting one of the phosphate molecules from the group. This causes the energy in the chemical bond to be released and can be used for muscular contraction and other functions of body cells (see Figure 7.8).

This breakdown can be represented by the chemical equation:

ATP (adenosine triphosphate) → ADP (adenosine diphosphate) + P (phosphate) + energy

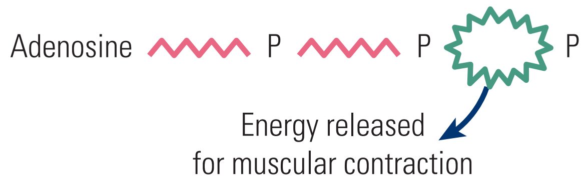

Figure 7.8 Energy provided by the breakdown of ATP

Muscle cells only contain enough ATP for one to two seconds of high-intensity activity. The energy from food (carbohydrates, fats and to a lesser degree proteins) is used to make more ATP by re-joining the free phosphate molecule to the ADP molecule. The production of ATP can be represented by the chemical equation:

ADP (adenosine diphosphate) + P (phosphate) + Energy (from food) → ATP (adenosine triphosphate)

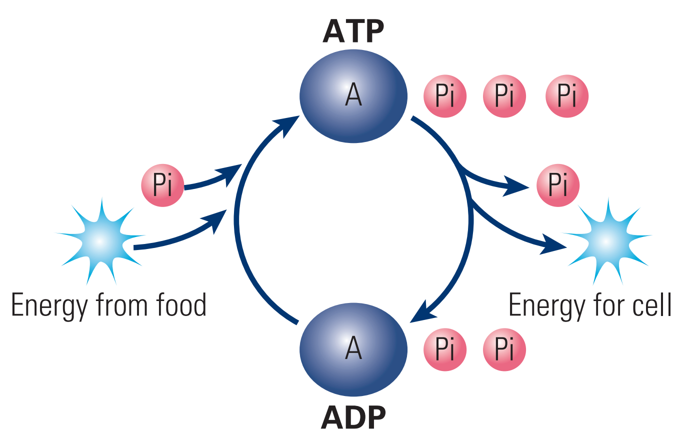

Figure 7.9 The process of breaking down and producing ATP

This process of breaking and remaking ATP turns the energy from the food we eat into energy that can be used for muscular contractions. The body uses three different methods, or energy systems, to produce ATP after it is broken down, depending on how quickly the energy is required and how long the activity will last. For instance, slinging a discus requires high amounts of energy for a short period of time, whereas jogging 5 km requires lower amounts of energy over a much longer period.

Energy systems: An overview

Energy to produce ATP is provided by three energy systems. In muscle cells, these systems work in

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combination depending on the intensity and duration of physical activity.

The first energy system, the *ATP-PC system*, provides energy to produce ATP by using energy from another high-energy compound, phosphate creatine (PC). Energy from the breakdown of PC can be supplied at a very fast rate, and therefore is used during high-intensity activities. Muscle cells can only store enough PC for approximately 10 seconds of intense activity before the supply is exhausted. Muscular supplies of PC are replenished very quickly, however. An almost total replenishment of PC supplies will occur during two minutes of rest or less-intense activity.

The second energy system, the *lactic acid system*, uses energy from glycogen to produce ATP. This process produces energy at a moderate to high rate, and is therefore used during moderate- to high-intensity activities. The by-product of the chemical breakdown of glycogen in this system is called lactate. After periods of moderate- to high-intensity activity, lactate levels rise in the muscle cells. The accumulation of lactate coincides with muscle fatigue, slowing the rate and strength of muscular contraction. The amount of time for which you can continue to produce energy using this system depends on your level of fitness and training, but is generally about 60 seconds at moderate- to high-intensity activity.

The third energy system, the *aerobic system*, uses energy from glycogen and fats in combination with the oxygen we breathe to produce ATP. This system can continue to produce energy indefinitely, provided activity levels are low to moderate; this includes sub-maximal longer duration exercise and most of the energy required for normal resting movement. Levels of fitness and training also determine how much energy can be produced by this system.

The three systems generally are categorised into two groups, according to whether or not oxygen is required in the production of ATP. The ATP-PC system and the lactic acid system do not require oxygen to produce energy and are categorised as *anaerobic* (without oxygen). The aerobic system, however, is dependent on oxygen supplies to produce ATP.

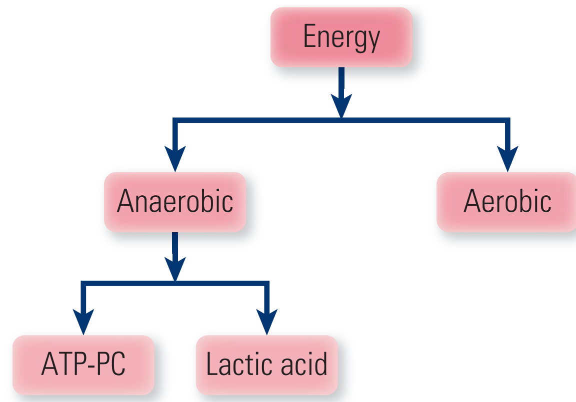

Figure 7.10 Overview of the three energy systems that fuel the resynthesis of ATP

Muscle types and energy production

Muscle fibres are arranged into groups called motor units. Each motor unit contains a number of muscle fibres, which are all controlled by one neuron (nerve cell). Using microscopic examination, it is possible to identify two different types of muscle fibre: slow-twitch fibres and fast-twitch fibres. It is differences in the way these fibres are arranged into motor units that determine which type of fibre they are. Fast-twitch fibres are arranged into motor units where one neuron controls between 300 and 800 muscle fibres. Slow-twitch fibres are controlled by one neuron in motor units of 10 to 100 muscle fibres.

Fast-twitch and slow-twitch muscle fibres vary significantly with regard to the amount of force they can produce, the time over which they can continue to work and the energy system they utilise to produce ATP.

Slow-twitch fibres

Slow-twitch fibres are arranged into motor units that can contain 10 to 100 fibres controlled by the one neuron. Slow-twitch fibres, as the name suggests, are slow to contract but are able to sustain activity for

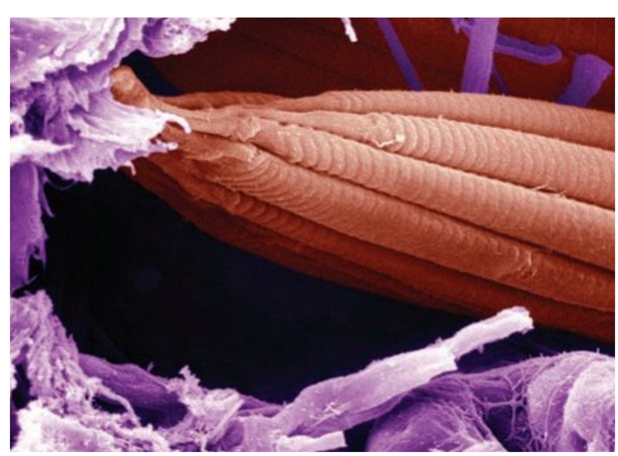

Figure 7.11 Microscopic view of muscle fibres

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Characteristics	Slow-twitch	Fast-twitch 'a'	Fast-twitch 'b'
Speed of contraction	Slow	Fast	Fast
Size of motor unit	Small	Large	Large
Force produced	Low	High	High
Activity type	Aerobic endurance	Aerobic endurance and power/speed	Power/speed
ATP production	Aerobic	Aerobic and anaerobic	Anaerobic
Glycogen stores	Low	High	High
Capillaries	Many	Moderate	Few
Neuron size	Small	Large	Large
Speed of nerve impulse	Slow	Fast	Fast
% in average leg muscle	45	38	16
% in leg muscles of a distance runner	80	14	5
% in leg muscles of a sprinter	23	48	28

Table 7.1 Comparison of muscle fibre types

extended periods. These fibres use predominantly aerobic energy sources in order to produce ATP and therefore are capable of resisting fatigue. Slow-twitch fibres are associated with longer endurance type activities.

Fast-twitch fibres

Fast-twitch fibres are arranged into motor units that contain large numbers (300–800) of fibres. Fast-twitch fibres produce much more force than slow-twitch fibres, so are best suited to activities that require speed and the rapid production of force. In track and field athletics, for instance, the sprints, throws and jumps would utilise predominantly fast-twitch fibres. Fast-twitch fibres use mainly anaerobic energy sources in order to rapidly produce the required ATP.

Research into the differences between muscle fibre types (through a process known as biopsy) has found that fast-twitch fibres cannot be converted into slow-twitch fibres; however, some fast-twitch fibres can take on some of the characteristics of slow-twitch fibres when exposed to endurance training. This has led to a further classification of fast-twitch fibres into fast-twitch 'a' and fast-twitch 'b'. Fast-twitch 'a' fibres are able to take on some slow-twitch characteristics and are considered partially aerobic. Fast-twitch 'b' fibres are totally anaerobic. This implies that world-class marathon runners, no matter how much sprint training they have done, would generally not improve greatly in speed. However, sprinters are able to improve their aerobic endurance significantly with training, which is evidenced by the number of good sprinters who have trained to become capable distance runners.

Muscle fibre recruitment

As a muscle begins to contract, slow-twitch fibres initially are recruited to provide the muscular force required by the activity. If the force required by the activity remains low, then slow-twitch fibres will continue to provide the muscular force. However, if

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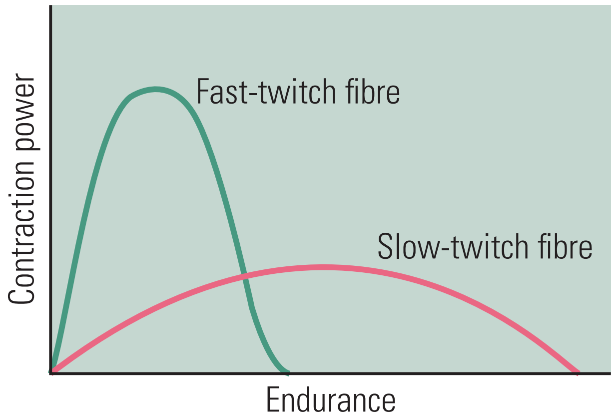

Figure 7.12 The relative contributions of muscle fibre types to physical performance

Activity 7.1

Check-in

1. In groups, discuss how the dietary requirements of an elite athlete may vary from those of an average person.
2. In which sports would athletes benefit from a high fast-twitch fibre count?
3. Conversely, in which sports would athletes benefit from a high slow-twitch fibre count?

the activity requires greater levels of muscular force to be exerted, then fast-twitch fibres are recruited. During activities requiring large amounts of muscular force, all muscle fibre types are utilised.

These muscles fibre recruitment patterns change during longer-duration endurance activities. As this type of activity continues, fast-twitch muscle fibres become increasingly involved in providing muscular force. Because fast-twitch fibres use predominantly anaerobic energy sources, lactate will begin to accumulate and performance will deteriorate. In fact, when fast-twitch fibres begin to be recruited during endurance activities, it usually marks a decline in the level of performance.

Coaches must carefully consider the implications of how muscle fibres are recruited when planning training programs. For instance, low-intensity training will only serve to produce improvements in slow-twitch fibres. Only by varying the intensity and duration of training activities will the training effect on all muscle fibre types be maximised.

7.3 Energy systems

As discussed in the previous section, energy for physical activity is provided by the breakdown of adenosine triphosphate (ATP). Muscle cells only store enough ATP for one to two seconds of high-intensity activity. The following chemical equations represent the breakdown and production of ATP in muscle cells:

$$\text{ATP} \rightarrow \text{ADP} + \text{P} + \text{Energy (for muscle contraction)}$$

$$\text{ADP} + \text{P} + \text{Energy (from energy nutrients)} \rightarrow \text{ATP}$$

Three different energy systems are used to convert the energy from food in order to produce more ATP. This section discusses each of the three energy systems separately, but it should be noted that the three systems do not work in isolation, but rather in varying combinations, depending on how quickly energy is required and the amount of time for which physical activity is continued.

The ATP-PC system

The *ATP-PC system* provides energy anaerobically (without requiring oxygen) to produce ATP, by breaking down a high-energy chemical substance called phosphate creatine (PC). The ATP-PC system can produce high amounts of energy for immediate use by the muscles, but supplies of PC stored in muscle cells last only for about 10 seconds of high-intensity activity. The ATP-PC system is therefore used for activities of short duration that require large amounts of energy – such as throwing a javelin or sprinting to a pass in soccer. In comparison, the aerobic system cannot supply energy at this rate, as it is limited by the time it takes for the body to supply muscle cells with oxygen.

Creatine phosphate is broken down into creatine and phosphate. The energy released from this breakdown is used to produce ATP. This process is represented by the chemical equation:

$$\underset{\text{(creatine phosphate)}}{\text{PC}} \rightarrow \underset{\text{(phosphate)}}{\text{P}} + \underset{\text{(creatine)}}{\text{C}} + \underset{\text{(to produce ATP)}}{\text{Energy}}$$

The ATP-PC system is also referred to as the *phosphate system*, because it uses energy from phosphate

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compounds, and as the *alactate system*, because no lactate is produced.

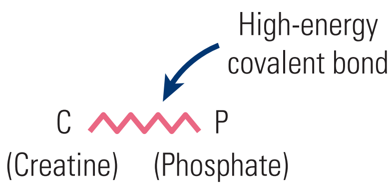

Figure 7.13 The structure of PC

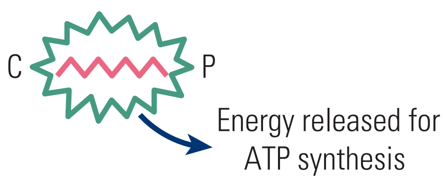

Figure 7.14 Energy provided by the breakdown of PC is used to produce ATP.

Once muscular supplies of PC are exhausted, muscles cannot continue to work at high intensities without a period of rest. It takes approximately two minutes at complete rest for muscular supplies of PC to be almost completely replenished. PC stores can also be recovered during periods of low-intensity work, but the recovery time will be a little longer. This is why you are able to sprint during a game of hockey, and after a period of lower intensity work, you can sprint again. Training programs for athletes involving high-intensity exercises, such as sprints, are completed as intervals, where periods of high-intensity work are followed by two to three minutes of rest. The recovery time allows supplies of PC to be replenished ready for another repetition of high-intensity work.

Although the ATP-PC system is anaerobic, muscular stores of PC are replenished during rest periods using aerobic energy. This is why your heart rate and breathing rate still rise even after a short sprint requiring only alactic energy (energy from the ATP-PC system), as oxygen is required to provide aerobic energy. The role of oxygen in producing aerobic energy, and in recovery, is discussed later in this chapter.

The lactic acid system

The *lactic acid system* also supplies energy to produce ATP anaerobically, but uses glycogen rather than creatine phosphate as an energy source. If an activity continues at a high intensity after the supply of PC is exhausted, the lactic acid system becomes the major source of energy for the production of ATP.

If oxygen is available, glycogen can be used to supply energy by converting it to water and carbon dioxide (the aerobic system), but if energy demands are high, the body cannot supply enough oxygen to the working muscles to meet the demand. The lactic acid system can produce energy by converting glycogen into a substance called lactate without the need for oxygen. This process can be represented in simple form by the chemical equation:

$$\text{Glycogen} \rightarrow \text{Lactate} + \text{Energy (to produce ATP)}$$

The lactic acid system is also referred to as anaerobic glycolysis (as glycogen is broken down without using oxygen) and sometimes as the lactate system.

At low to moderate levels of activity, lactate can be removed from the working muscle at the same rate at which it is produced. This system can last between 30 seconds and three minutes, depending on the intensity of the activity. The less intense the activity,

Figure 7.15 100 m sprinters use primarily alactate energy (from the ATP-PC system).

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the longer the period for which the lactic acid system will supply energy, because it will be producing lactate at a slower rate at the lower intensity levels. However, during high-intensity activities, lactate cannot be removed as quickly as it is being produced.

The point at which lactate begins accumulating in muscle cells coincides with the onset of muscle fatigue, and it becomes impossible to continue at the same intensity of activity without slowing down or resting. This fatigue is characterised by a burning sensation in the working muscles. High-intensity activity can only continue for approximately 60–75 seconds before lactate accumulation occurs, signalling the onset of muscular fatigue. The lactic acid system therefore would be the predominant energy source in a 400 m running race or a 100 m swimming race. Team sports that involve periods of high-intensity activity with intermittent rest periods, such as soccer, rugby, netball and touch football, rely heavily on energy produced by the lactic acid system.

Before high-intensity activity can recommence, the working muscles must undergo a recovery process whereby energy stores, blood oxygen levels and hormone balances are restored and accumulated lactate is converted to usable energy. Lactate is removed from the working muscle during and after periods of moderate to intense activity, and is metabolised back into glycogen in the liver using oxygen supplied by the aerobic system. Like the ATP-PC system (which also recovers using the aerobic system), working in the lactic acid system will cause heart and breathing rates to remain elevated for some time, even after activity has stopped. During this time, the extra oxygen is being used to replenish energy stores in muscle cells and metabolise accumulated lactate. The muscle cells of well-trained

Figure 7.16 Periods of sustained defence in Rugby Sevens would utilise energy from the lactic acid system.

Activity 7.2

Engage-in

Inquiry question: How do working muscles react to extended periods of intense activity?

RECOGNISE & EXPLAIN | ANALYSE & SYNTHESISE | MAKE DECISIONS

Engage and understand

1 Together as a class, stand up with one arm extended vertically and the other by your side.

2 On a starting signal, flex your fingers on both hands to meet your thumb and immediately extend your fingers back to the starting position. Repeat this movement as fast as you can manage for 60 seconds. Try to maintain a ‘sprint’ pace for the entire minute.

Apply and analyse

KEY COGNITION

Apply: Use knowledge and understanding in response to a given situation or circumstance; carry out or use a procedure in a given or particular situation.

3 Describe the feeling in your forearms during the final 15 seconds of activity.

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4 Which energy system would have made the greatest contribution to producing the energy for this activity?
5 What would have been occurring in the working muscles as fatigue began?
6 How did muscular fatigue affect your ability to continue this activity?
7 Was there a difference in muscular fatigue between the arm held vertically and the one by your side?
8 How can this difference be explained?

athletes become more efficient at replenishing energy stores and removing lactate, and therefore are able to continue using this energy system for longer periods. The role of oxygen in producing aerobic energy, and in recovery, is discussed later in this chapter.

The aerobic system

The *aerobic system* supplies energy to produce ATP at rest and during lower- to moderate-intensity activity. Glycogen and/or fat are combined with oxygen to produce energy and the by-products, water and carbon dioxide. This process is represented by the chemical equation:

$$\text{Glycogen or Fat} \rightarrow H_2O + CO_2 + \text{Energy (to produce ATP)}$$

Provided there is adequate oxygen supplied to muscle cells, this process can continue to produce energy indefinitely. However, factors such as muscle soreness, the need for rest, mental fatigue and diminishing levels of glycogen and fat reserves limit continued activity, even at low intensity. The aerobic system is the preferred energy source for activities that require lower intensity over extended periods, such as distance running. Fat is the preferred energy source at rest or during low-intensity activities. Glycogen becomes the preferred fuel source when exercise intensity approaches 60 per cent of maximum heart rate (220 – age).

The aerobic system is also referred to as *aerobic glycolysis* (as glycogen is broken down using oxygen) and sometimes as the *oxidative system*.

If an activity that is predominantly aerobic, such as a 10 km road race, requires the runner to go faster to gain a tactical advantage (surge) or run up a steep

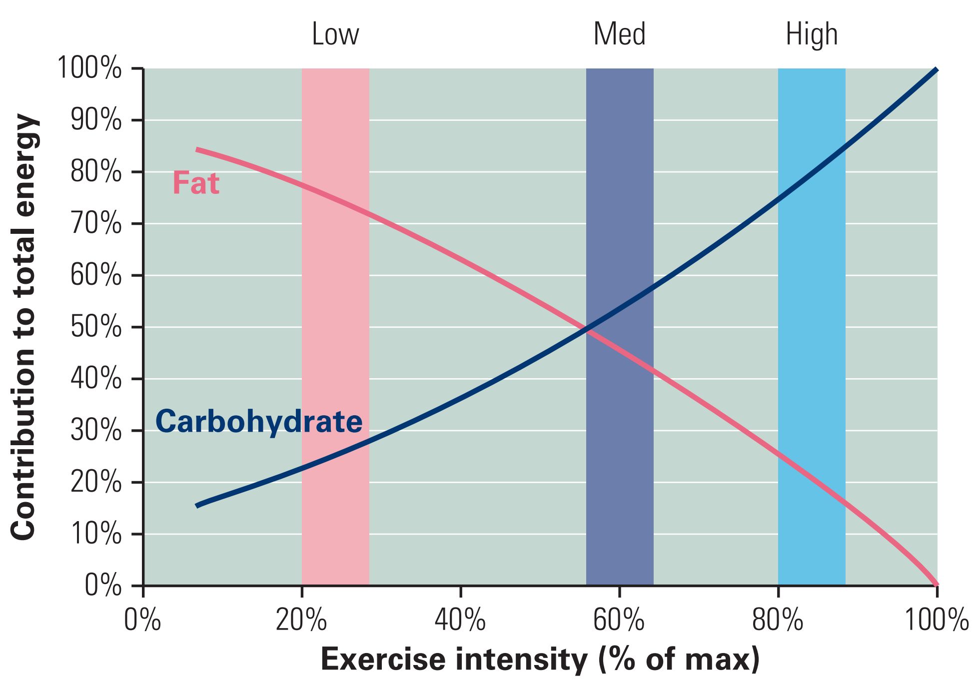

Figure 7.17 The relative use of carbohydrate and fat as a fuel source as determined by exercise intensity

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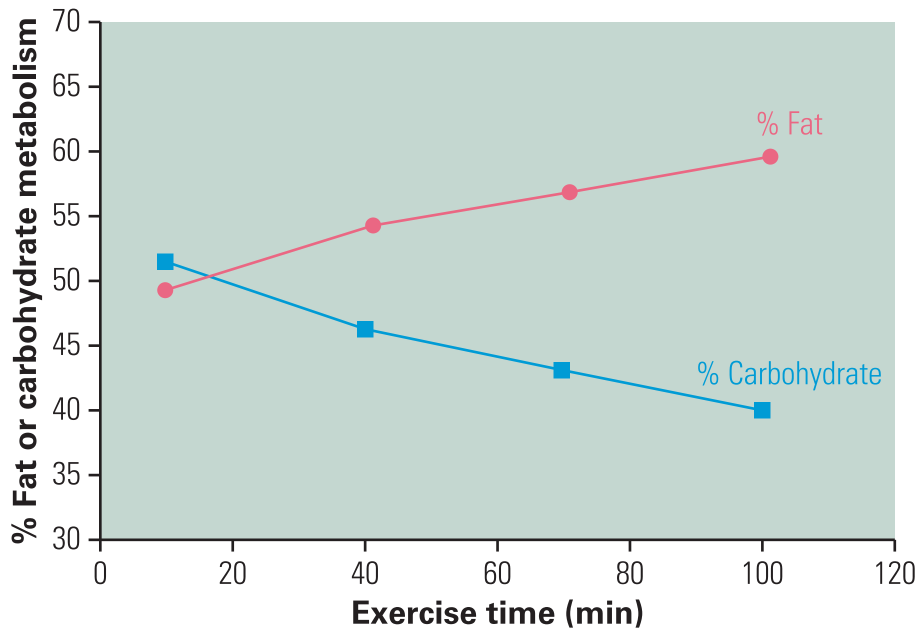

Figure 7.18 The relative use of carbohydrate and fat during prolonged exercise

hill, the body may not be able to supply all the oxygen required to produce aerobic energy. The extra energy required (which cannot be produced by the aerobic system due to insufficient oxygen supplies) will be produced anaerobically by the lactic acid system. If the intensity of the race remains high, lactate levels will begin to rise, signalling the onset of muscle fatigue, and eventually the runner will have to slow down. At the beginning of the race, glycogen is used primarily as a fuel source, but as the race progresses and glycogen supplies are exhausted, fats become the major fuel. This relationship is illustrated in Figure 7.18. When fats become the major fuel source, oxygen demand increases and the athlete will become fatigued more quickly. Proteins are only utilised as a fuel source after extended periods of activity, and when supplies of glycogen and fat are exhausted.

The level of intensity at which energy can no longer be totally supplied by the aerobic system, and therefore lactate accumulation begins, is called the *lactate threshold* or, alternatively, the anaerobic threshold. This threshold varies between individuals, depending on their body's ability to gather and use oxygen. The more oxygen that the body is capable of gathering and using, the higher the intensity of exercise possible without beginning to accumulate lactate in the working muscles. An individual's anaerobic threshold can be raised by training. These issues of oxygen supply and training are discussed in detail in following sections of this chapter.

Activity 7.3

Check-in

1. Many theories exist about the causes of muscle fatigue during exercise, but the exact cause is yet to be fully understood. We understand that muscle fatigue corresponds with an accumulation of lactate in the muscles and blood, but this does not seem to be the cause of the fatigue. Conduct an internet search to explore current ideas about the causes of muscle fatigue while exercising at levels about the lactate threshold.
2. What previously held ideas about the causes of muscle fatigue have been disproven by more recent studies?

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Characteristic	ATP-PC	Lactic acid	Aerobic
Alternate names	Alactate system Phosphate system	Lactate system Anaerobic glycolysis	Oxygen system Aerobic glycolysis Oxidative system
Oxygen use	Anaerobic	Anaerobic	Aerobic
Rate of ATP production	Very rapid	Rapid	Slow
ATP production	Very limited (by stores of PC) Up to 10 seconds of high-intensity activity	Limited (when lactate accumulation occurs) Up to 75 seconds at maximum effort	Unlimited until fuel sources are depleted
Fuel source	Creatine phosphate	Glycogen	Glycogen, fats and possibly proteins
Recovery process	PC stores replenished	Resupply of fuel sources Lactate metabolised	Re-supply of fuel sources
Recovery rate	2–3 minutes at rest or lower-intensity activity	2–5 minutes rest to use system again 30–120 minutes rest for complete recovery	Up to 24 hours to recover fuel stores after bouts of sustained exercise
Use	High-intensity, short-duration activities up to 10 seconds	Intense activity of between 10 and 75 seconds duration	Lower-intensity, long-duration activities or rest

Table 7.2 Summary of the features of the three energy systems

Activity 7.4

Engage-in

RECOGNISE & EXPLAIN ANALYSE & SYNTHESISE MAKE DECISIONS

Inquiry question: How quickly can your body supply energy to produce ATP and how long can these supplies last?

Engage and understand

1. Choose two students to be the subjects for this activity.
2. The subjects are asked to run 400 m, beginning at a sprint pace and trying to maintain that pace for the entire distance.
3. The other students in the class will time the subjects at 20 m intervals over the 400 m. Each of the 20 timers will be given a stop watch and sent to a position on the track.
4. The time is recorded from the beginning of the run until the subject reaches your marker.

(continued)

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5 Calculate the time taken for each interval and the average velocity over that interval.
6 Create a results table similar to the example below to record your data.

Interval	Recorded time		Time for interval		Speed	
	(time recorded from the start to the end of this interval)		(time taken for this interval only – subtract the previous recorded time from this one)		(speed equals distance (20 m) divided by the time taken for the interval)	
	Subject 1	Subject 2	Subject 1	Subject 2	Subject 1	Subject 2
0–20 m						
20–40 m						
↓	↓	↓	↓	↓	↓	↓
380–400 m						

7 Plot a graph of running speed over the 400 m run showing both subjects. (You may decide to use a spreadsheet to record results, perform calculations and create the graph.)

Apply and analyse

Analyse: Examine or consider something in order to explain and interpret it, for the purpose of finding meaning or relationships and identifying patterns, similarities and differences.

8 Describe the speed of the subjects over the 400 m run.
9 At what distance did each subject begin to slow down?
10 Using your knowledge of energy systems, why was it impossible for the subjects to maintain top speed for 400 m?
11 Explain the trends in the graph using your knowledge of the contribution of the three energy systems.
12 Comment on the differences between the two subjects using your knowledge of the energy systems.
13 What would the graph look like if a motor cycle were used for the same task? How is the supply of fuel and oxygen different from that of the human body?
14 Keep this graph for discussion purposes in later sections of this chapter.

Energy systems at work

While it is possible to describe an activity as being predominantly anaerobic or predominantly aerobic, energy for physical activity is usually supplied by a combination of the three energy systems working simultaneously. Figure 7.19 shows the relationship between exercise time and the contribution of the three energy systems. The graph represents the percentage contribution of each system, assuming that the exercise is at the highest possible intensity for the time specified.

In an activity such as track and field, events are usually specific in their energy demands. For instance, the 100 m sprint requires very high amounts of energy for a short amount of time, and would therefore use predominantly the ATP-PC system to provide energy. The jumping and throwing events would also utilise

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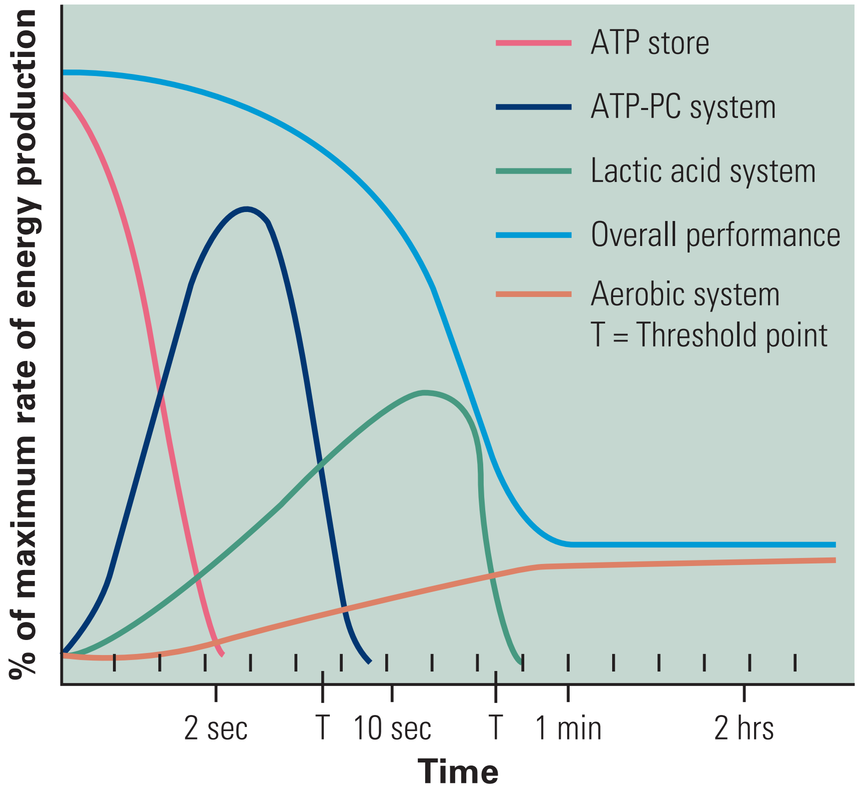

Figure 7.19 Contribution of the three energy systems to providing fuel for ATP production during exercise

Figure 7.20 1500 m running requires training for both aerobic and anaerobic energy systems

almost 100 per cent ATP-PC system energy. Running 400 m would use predominantly anaerobic energy sources, particularly from the lactic acid system, and the 1500 m event uses approximately 50 per cent aerobic and 50 per cent anaerobic energy sources. As the duration of an event increases, so does the percentage of aerobic energy that is used. Individual races above 400 m (which is considered a sprint race) may vary slightly in their energy requirements due to the race tactics employed and the pace of the race in general.

In activities such as team sports, the contribution of each energy system is more difficult to determine, as one game can vary significantly in intensity from the next. Most team sports require a contribution from all three energy systems at various stages of play. Individuals playing different positional roles on the same team may also have varying energy requirements. For instance, the energy requirements of a soccer goal keeper and a mid-fielder would vary significantly.

In a game of hockey, all three energy systems would contribute to produce ATP at various stages of the game, depending on the intensity of activity required at the time. Imagine you have begun the game as a defender. During periods of opposition attack, you require higher amounts of energy, which would be supplied anaerobically. Every time you have to sprint to the ball or provide a clearing hit, your ATP-PC system would provide the high amounts of energy required. As this system is limited to short durations, a short period of lower-intensity activity must follow in order for the aerobic system to replenish PC supplies. If the opposition attack is sustained for much of the game, and your workload is quite intense, a large proportion of your energy will be supplied by the lactic acid system.

When lactate begins to accumulate in muscle cells, the amount of time for which you can maintain this pace is limited and you will show signs of fatigue. At this stage, the coach may make replacements or

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rotate different players into the defending positions. During the brief periods where your team is attacking, your heart rate and breathing rate remain high, as your body is working aerobically to replenish energy stores of PC and glycogen, and metabolise lactate.

As you can see from this discussion, athletes and coaches have to consider the implications of the energy requirements of their sport. An analysis of the energy requirements of an activity will help coaches plan many aspects of training and competition, such as:

- the timing of substitutions during a game, particularly in sports were players can be 'subbed' on and off
- the rest periods required between training sessions, competitions and even training activities
- the tactics used in competition
- the choice of training activities so the energy system combination used in training is specific to the energy requirements of the sport
- the most appropriate diet leading into competition.

Sport	ATP-PC/LA	LA/aerobic	Aerobic
Basketball	60	20	20
Fencing	90	10	
Field events	90	10	
Golf swing	95	5	
Gymnastics	80	15	5
Hockey	50	20	10
Distance running	10	20	70
Rowing	20	30	50
Skiing	33	33	33
Soccer	50	20	30
Sprints	90	10	
1500 m freestyle	10	20	70
Tennis	70	20	10
Volleyball	80	5	15

Table 7.3 Energy system percentage contribution in a variety of sports

Activity 7.5

Check-in

1. In groups, compile a list of 15 sports that are not included in Table 7.3. Discuss the relative contribution of each of the three energy systems to the replenishment of ATP. Consider representing your percentage contributions as a pie graph and compare your graph with those of other groups for further discussion.
2. Add another six sports to the list that could be considered almost exclusively anaerobic or exclusively aerobic.

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Activity 7.6

Engage-in

Inquiry question: What are the energy requirements of the physical activity that has been the focus of your study this term?

Engage and understand

1 Consider the demands of the physical activity that has been the focus of your study this term by describing the following:

- **a** the intensity of physical activity required
- **b** the duration of activity at various level of activity
- **c** changes in the level of activity
- **d** recovery time available
- **e** substitution rules (as applicable)
- **f** varying roles in the activity such as specialist positions.

2 Create a table to summarise your discussion.

Apply and analyse

Analyse: Examine or consider something in order to explain and interpret it, for the purpose of finding meaning or relationships and identifying patterns, similarities and differences.

3 Create an energy contribution bar graph that would represent the percentage energy contributions of the three energy systems for the physical activity that has been the focus of your study this term.

4 In 200 words, justify your analysis by referring to the demands and playing conditions of the activity outlined in your summary table.

7.4 Oxygen delivery, consumption and recovery

The efficiency of each of the three energy systems in terms of producing ATP depends on the amount of oxygen that can be supplied to working muscles during periods of exercise and recovery from exercise. As discussed in the previous section, the anaerobic systems rely on oxygen in order to recover, so the more efficiently oxygen can be supplied, the faster these systems can recover. The aerobic system relies directly on the supply of oxygen in order to produce ATP. As the intensity of an activity increases, the body must supply more oxygen in order to keep producing ATP aerobically. If this oxygen demand cannot be met, a proportion of ATP will begin to be produced anaerobically, and lactate will begin to accumulate. It follows that if the body becomes more efficient at gathering and utilising oxygen, it will be able to exercise at higher intensity without beginning to fatigue and slow down.

This section discusses how oxygen is transported and utilised for physical activity. An understanding of how oxygen is delivered to and utilised by working muscles will allow coaches and athletes to plan accurate and efficient training programs.

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Oxygen collection and transportation

The collection and transportation of oxygen available from the air around us to the muscle cells involves two stages of respiration.

First, **pulmonary** (or external) respiration involves the exchange of gases between the air in the lungs and the blood in the capillaries of the alveoli. The movement of gases (or diffusion) occurs because of the difference in concentration of oxygen and carbon dioxide between the blood and air. Oxygen is in greater concentration in the alveoli so it diffuses into the capillaries, whereas carbon dioxide moves into the alveoli due to its greater concentration in the capillaries. Once the oxygen is diffused into the blood surrounding the alveoli, it becomes attached to the haemoglobin in red blood cells and circulated through the body via the circulatory system. Pulmonary circulation links the oxygenated blood back to the heart, from where it travels throughout the body via the systemic circulatory system. De-oxygenated blood is then returned to the heart to be redirected back to the lungs for another exchange of carbon dioxide for oxygen.

Second, **cellular** (or internal) respiration involves the exchange of gases within the cells of the body. Oxygen concentration is greater in the capillaries so it diffuses into the body cells. Accumulated carbon dioxide in the body cells enters the capillaries, from which it can be circulated back through the heart to the alveoli for release into the lungs.

pulmonary relating to the lungs

cellular relating to the cells in the body

Oxygen consumption

The amount of oxygen needed by muscle cells during physical activity is determined by the efficiency of the athlete's body in utilising oxygen (their level of aerobic capacity) and the requirements for oxygen determined by the intensity of the physical activity. Measurements of oxygen consumption are very important for determining the energy requirements and capacities suitable for different physical activities. At rest, our bodies consume around 0.25 litres of oxygen per minute. During heavy exercise, young women use about 2.3 litres of oxygen per minute and young men 3.4 litres per minute. The reasons for the gender difference are discussed later.

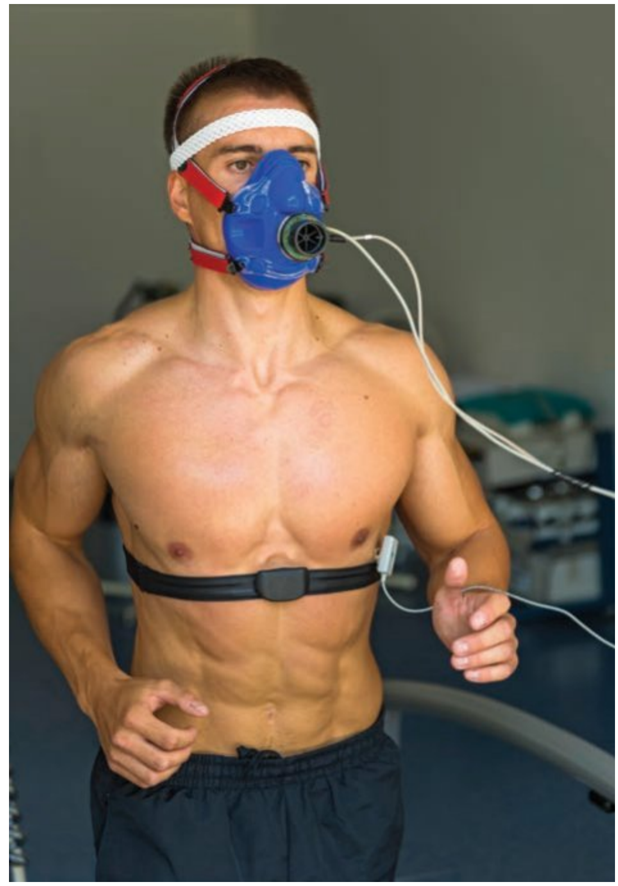

Figure 7.21 Typical oxygen uptake test

Oxygen uptake is the amount of oxygen consumed by the muscle and other cells of the body. Oxygen uptake can be measured using gas analysis equipment to compare the volume of oxygen and carbon dioxide (in litres per minute) breathed in with that breathed out.

The maximum amount of oxygen that can be consumed by the body, or maximal oxygen uptake, is known as *VO_2 max*. This maximum level of oxygen uptake is reached after about five to 10 minutes of exhaustive physical activity. Other terms that are used to refer to VO_2 max include maximum oxygen consumption, maximal oxygen intake, maximal aerobic power and maximum aerobic capacity.

In athletes, testing for VO_2 max is often conducted in a clinic setting during exhaustive exercise – that is, where the intensity of the physical activity is pushed to the maximum tolerable. An athlete's VO_2 max is therefore a measure of how efficiently the body can transport and utilise the available oxygen. However, this type of testing can be dangerous if applied to untrained individuals. Tests that estimate a person's VO_2

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max using sub-maximal exercise have been devised that are suitable for non-elite athletes (such as the 'beep test'). Discussion of various fitness tests is considered later in this chapter.

Undertaking appropriate training can cause the body to adapt so it is able to gather and use more oxygen. Figure 7.23 illustrates VO_2 max levels in elite male and female athletes compared with average male and female levels.

Figure 7.22 Cross-country skiers have one of the highest VO_2 max readings of any athlete.

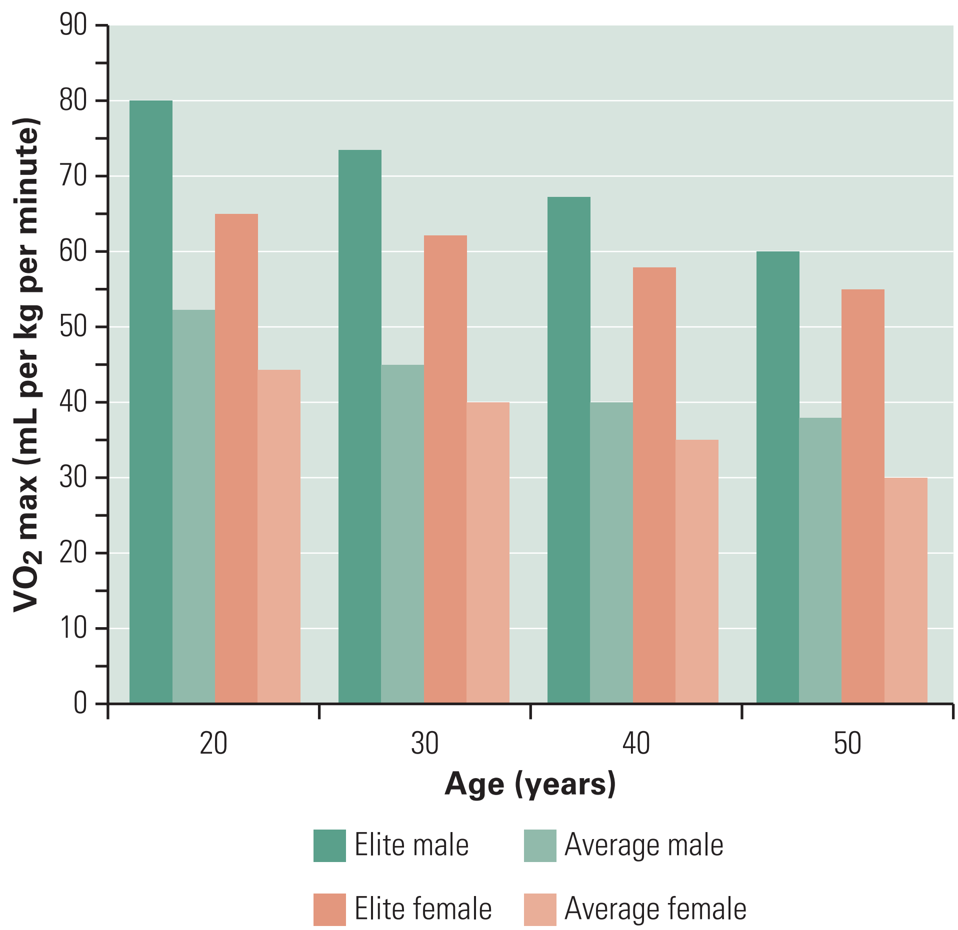

Figure 7.23 VO_2 max of elite and average males and females

Factors influencing oxygen uptake

A number of physiological factors influence an individual's oxygen uptake, and therefore their VO_2 max (see Table 7.4 on the following page). Many of these factors are genetically determined, but can be marginally improved with training. Endurance training, however, has a more significant effect on raising the lactate threshold, which is discussed in more detail in the following sections.

It should be noted that at maximum exercise, the elite athlete is capable of working at a higher intensity than the average athlete.

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Factor	Explanation
Lung ventilation	If the rate and depth of breathing are enough to supply the cells of the body with adequate oxygen and clear them of carbon dioxide, then breathing will remain constant. If oxygen in the blood falls or carbon dioxide rises, the rate and depth of breathing automatically increase until the situation is balanced. During exercise, increased breathing and depth of breathing enable larger amounts of oxygen to be available for the blood to take up and deliver to the working muscles. At rest, the body can take in 6–8 litres of air a minute at a rate of 15 breaths per minute. During exhaustive exercise this can rise to more than 100 litres per minute and 40–50 breaths per minute.
Heart rate	At rest, heart rates range from 50–85 beats per minute. During exercise, the heart rate increases proportionally to the level of intensity, up to the maximum heart rate. An estimation of the maximum heart rate of an individual is given as 220 minus their age.
Stroke volume	The volume of blood expelled from the left ventricle of the heart per beat of the heart is called the stroke volume. Maximum stroke volume is reached at moderate levels of exercise. At rest, an untrained person's, heart pumps out about 70 ml of blood per beat, and during exercise, around 125 ml. An endurance-trained person's heart pumps out around 90 ml of blood per beat at rest, and around 200 ml during exercise.
Cardiac output	The volume of blood expelled from the heart in one minute is known as the cardiac output, which is calculated by multiplying stroke volume (volume of blood per beat) by heart rate (number of beat per minute). At rest, this can amount to 4.6 litres per minute and during exercise, up to 40 litres per minute.
Blood flow	Blood flow to the muscles is increased dramatically during exercise. Not only does the increased cardiac output contribute to the increase, but blood is also directed away from non-working areas of the body to the active muscles.
Arterio-venous oxygen difference	The arterio-venous oxygen difference (a-vO_2 diff) is the amount of oxygen extracted and hence used by a muscle. It is calculated as the difference between the oxygen content of arterial blood arriving at a muscle and the oxygen content of venous blood being carried away from it. During both rest and exercise, arterial oxygen content is 20 ml of oxygen per 100 ml of blood. Resting venous oxygen content is 15 ml of oxygen per 100 ml of blood, but can drop during maximal exercise to 2.5 ml of oxygen per 100 ml of blood. Exercise increases the amount of oxygen extracted from the blood by the muscle by up to three times the amount extracted at rest.
Myoglobin	Within the muscle cells, a substance called myoglobin extracts the oxygen from the blood and makes it available for the oxidisation of glycogen and fat to produce ATP. The amount of myoglobin present influences the rate of oxygen uptake.
Haemoglobin	Haemoglobin is the transportation device of oxygen in the blood. The amount of oxygen collected through the alveoli can increase threefold during strenuous exercise; however, the quantity of available haemoglobin present in the blood will influence the uptake of oxygen by the body.

Table 7.4 Factors that influence an individual's oxygen uptake

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Factor	Explanation
Body size	VO_2 max is more accurately expressed as millilitres per kilogram of body weight per minute (ml/kg/min). All tissues of the body use oxygen, so a larger individual will use more oxygen at rest and during periods of exercise than a smaller individual. Comparisons of VO_2 max using measurements based on body weight take this factor into consideration (VO_2/min/kg).
Gender	In general, females have smaller lung volumes, lower levels of haemoglobin, smaller stroke volumes and less total blood volume than males. VO_2 max values for untrained females can be 20–25 per cent lower than for untrained males; however, the VO_2 max difference between elite female and male athletes reduces to about 10 per cent. If VO_2 max is compared in relation to 'fat-free' or lean body mass, the difference of VO_2 max values between gender is minimal.
Age	Growth and development of the cardio-respiratory system create an increase in VO_2 max. VO_2 max values steadily decrease between 25 and 75 years of age, but level of activity and training intensity as well as heredity, rather than age alone, underlie the gradual decline.
Heredity	Max VO_2 is largely genetically determined. Genetic factors set the limits on how much a person can improve VO_2 max values.

Table 7.4 *(continued)*

Measure	Rest		Sub-maximal exercise		Maximal exercise	
	Average athlete	Elite athlete	Average athlete	Elite athlete	Average athlete	Elite athlete
Heart rate (bpm)	60.00	50.00	128.00	128.00	180.00	175.00
Stroke volume (ml)	70.00	88.00	140.00	172.00	140.00	172.00
Cardiac output (l/min)	4.20	4.40	17.90	22.00	25.20	30.10
Haemoglobin (g/l)	149.00	157.00	153.00	164.00	153.00	164.00
Arterial O_2 (ml/l)	200.00	210.00	205.00	220.00	205.00	220.00
Venous O_2 (ml/l)	120.00	125.00	93.00	97.00	46.00	41.00
a-v O_2 diff. (ml/l)	80.00	85.00	112.00	123.00	159.00	179.00
Oxygen uptake (l/min)	0.35	0.37	2.00	2.700	4.00	5.40
Oxygen uptake (ml/kg/min)	4.30	4.90	25.00	36.00	50.00	72.00
Oxygen uptake (% V O_2 max)	8.00	7.00	50.00	50.00	100.00	100.00
Blood lactate (mmol/l)	1.00	1.00	4.00	3.00	9.00	16.00

Table 7.5 Comparison of typical physiological measures between an average and an elite athlete of similar build

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Oxygen deficit and EPOC

At rest, the body's need for oxygen is low and it can easily be supplied with energy to produce ATP aerobically. However, once physical activity is commenced, more oxygen is required in order to meet the increased energy demands. Because it takes the body time to respond to gather and transport more oxygen to the working muscles, there is a time at the beginning of periods of activity when our body cannot deliver enough oxygen to meet the requirements of the exercise aerobically. During this time, the body is working in *oxygen deficit*. In this stage of oxygen deficit, the ATP-PC and lactic acid energy systems resupply the additional requirements for ATP.

If the intensity of the activity is sub-maximal – that is, the body can supply enough oxygen so the aerobic energy system is capable of producing almost all the ATP required – a steady state is reached. During this stage, a balance between oxygen use and oxygen supply is achieved (see Figure 7.24).

On completion of sub-maximal activity, the body needs to recover the oxygen deficit. Because energy in the initial stages of activity required the use of the anaerobic energy systems (ATP-PC and lactic acid), oxygen is required to restore the body to a resting state. The extra oxygen required during recovery is known as *excess post-exercise oxygen consumption* (EPOC). This oxygen is used to replenish fuel stores (such as levels of PC) and affects other processes required to restore the body to the resting state, such as restoring muscle and blood oxygen stores, restoring hormone balances and the conversion of lactate into usable energy. Once recovery is complete and the body returns to a resting state, the balance between oxygen need and oxygen supply is restored.

An oxygen deficit also occurs when the intensity of activity is raised to a point where the body cannot supply enough oxygen in order to meet energy demands aerobically (working above the lactate threshold). During this higher intensity of activity, the oxygen demands of an exercise exceed the body's ability to supply oxygen, so steady state does not occur and some (or most) of the energy is being produced anaerobically. Figure 7.25 illustrates oxygen requirements at maximal exercise where oxygen demand exceeds supply. The oxygen deficit at this intensity of activity will be greater than the deficit during sub-maximal activity, as will EPOC; a longer recovery time will therefore be needed.

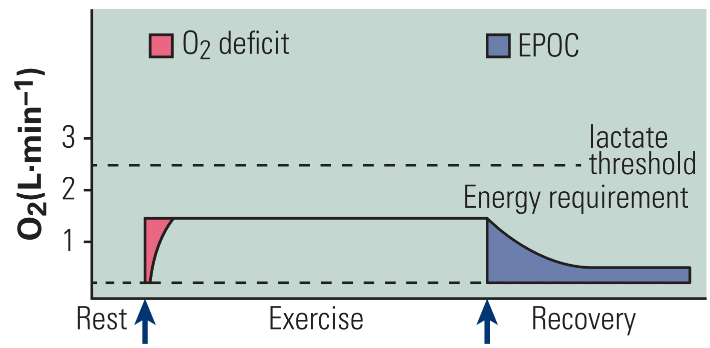

Figure 7.24 Oxygen requirements during rest, sub-maximal exercise and recovery. Steady state occurs when oxygen supply is sufficient to meet oxygen demand.

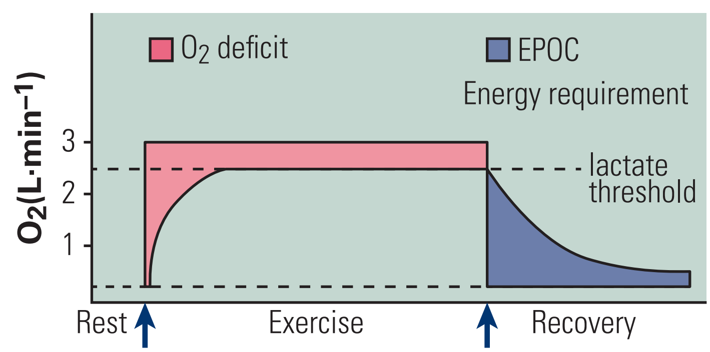

Figure 7.25 Oxygen requirements during maximal exercise (above lactate threshold) and recovery

Oxygen during recovery

During post-exercise recovery, oxygen is still required by the body to return it to its pre-exercise state (excess post-exercise oxygen consumption – EPOC). Upon completion of a 5 km jog, breathing and heart rates do not immediately return to resting levels. The length of time taken to recover is partly determined by the intensity of the physical activity undertaken and the body's response to utilising oxygen during the recovery stage. The greater the exercise intensity, the greater EPOC will be.

During recovery, EPOC assists in replenishing cellular energy stores, metabolising lactate and returning muscles to their pre-exercise state. The recovery of the ATP-PC system through replenishing PC supplies occurs in the initial stage of EPOC. Within 30 seconds of rest or less-intense activity, 50 per cent of PC stores are replenished with an almost complete recovery after two minutes.

The recovery of the lactic acid system to full capacity occurs more slowly in the later stages of EPOC (see Figure 7.26). The greater the exercise effort, the

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more time will be required for full recovery of the lactic acid system. Recovery times of the lactic acid system can be reduced when a light jog or cool down is performed. A 50 per cent recovery of the lactic acid system occurs within the first 15 minutes of recovery but it can take up to (and beyond for greater levels of intensity) 60 minutes for complete recovery.

Gaining an understanding of how our body utilises oxygen assists the development of appropriate training. The next section discusses training zones and thresholds that specifically address the development of aerobic and anaerobic energy systems.

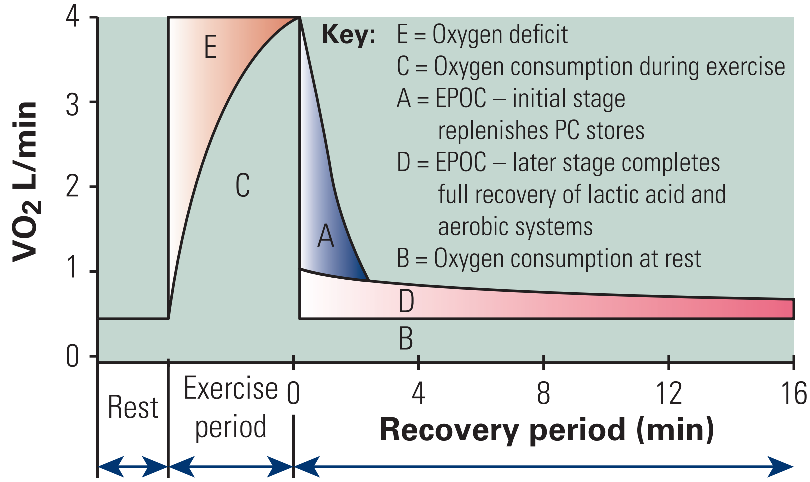

Figure 7.26 Stages of EPOC in post-exercise recovery

Activity 7.7

Check-in

1. Re-examine the graph you created of the 400 m run at sprint pace in Activity 7.4 (on pp. 379–80).
2. At what distance into the 400 m run is it likely that each of the subjects reached their lactate threshold?
3. At what time into the run did this occur?
4. What energy system was the predominant supplier of energy at this point?
5. Is this graph consistent with the known limitations of this energy system?
6. What can be concluded from this graph about the demand for oxygen during this activity?
7. Suggest a training activity that, if completed regularly, could allow the subjects to complete the 400 m sprint in a faster time.

Activity 7.8

Engage-in

Inquiry question: What is the relationship between heart rate response, oxygen demand, exercise intensity and aerobic fitness?

Engage and understand

1. Two people of the same weight, age and gender are both participating in the same exercise activity at the same intensity. Therefore, it could be argued that the oxygen demand should be similar for both subjects. Examine the graph on the following page of the heart rate responses of person A and person B.

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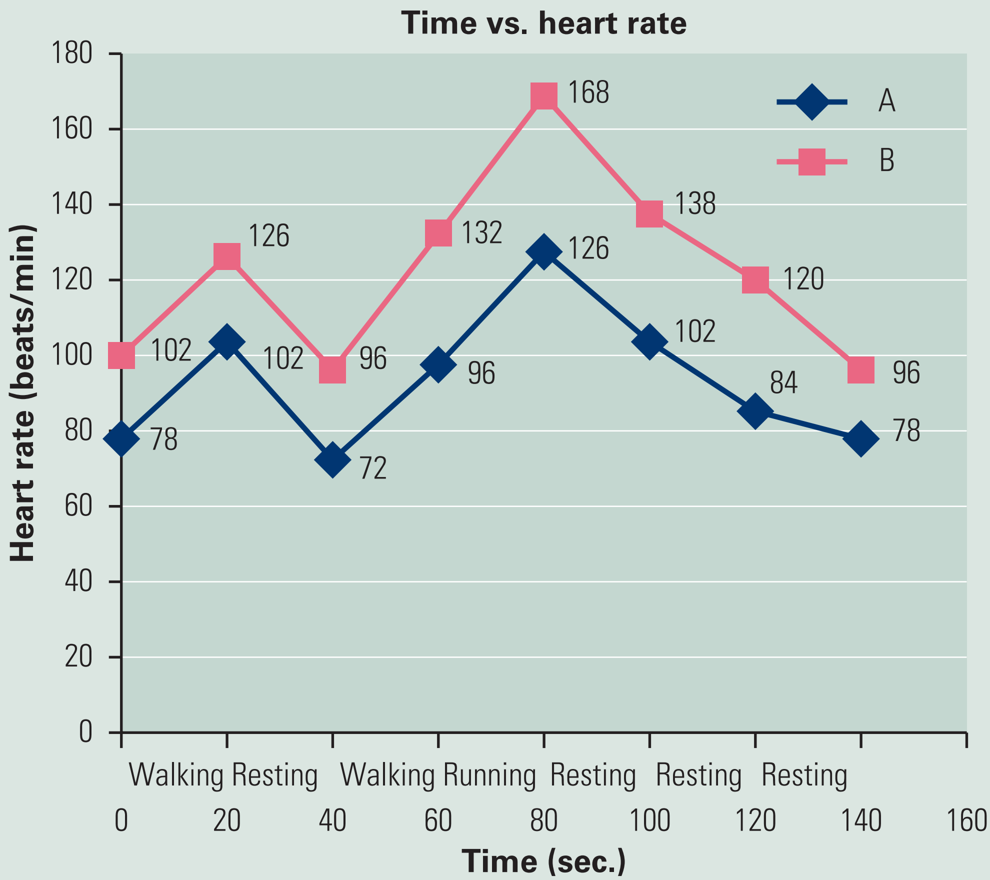

Apply and analyse

Analyse: Examine or consider something in order to explain and interpret it, for the purpose of finding meaning or relationships and identifying patterns, similarities and differences.

After analysis of the heart rate data, consider the following discussion questions:

2 Describe the key differences in the heart rate responses of the two subjects to the same exercise intensity.

3 Considering oxygen deficit and EPOC, explain why the recovery of both subjects occurred faster after the first period of walking (0–20 seconds) than after the walking running set (40–80 seconds)?

4 What can be implied about the relative ability of each of the subjects to gather and use oxygen?

5 What physiological factors may be contributing to these differences?

6 Which subject would you predict has a higher VO_2 max? Why?

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7.5 Lactate threshold and training

As the intensity of exercise increases, so does the demand for oxygen as the working muscles attempt to maintain a steady state. As discussed in previous sections of this chapter, steady state is where all the oxygen demands of the working muscles can be met, and therefore almost all energy (ATP) is being produced by the aerobic system. When the intensity of exercise reaches a level where the body cannot supply all the oxygen required, a proportion of the energy will be produced anaerobically, causing lactate to accumulate. If the intensity of activity remains at this level, muscular fatigue will occur, forcing the athlete to slow down or rest. The level of physical activity where lactate begins to accumulate – that is, where energy can no longer be provided almost totally by the aerobic system – is called the *lactate threshold*. This is also referred to as the anaerobic threshold or the onset of blood lactate accumulation (OBLA). At this level of exercise, blood lactate levels rise sharply, ventilation rates increase, pain levels rise and muscular fatigue sets in.

The lactate threshold is influenced by the body's ability to gather and utilise oxygen, and therefore varies between individuals. If an individual's body is capable of gathering and using more oxygen during exercise, it will be able to remain at a steady state at higher levels of activity. Although many factors that determine the ability to gather and utilise oxygen are genetically determined, training can cause physical adaptations that allow the body to become more efficient at gathering and utilising oxygen, therefore raising the lactate threshold. While a person's VO_2 max is largely genetically determined and only improves marginally with training, training can have a more significant effect on raising the lactate threshold.

Lactate threshold

An individual's *lactate threshold* can be measured by taking blood samples at various stages of exercise intensity and analysing the samples for lactate. When the level of lactate in the blood rises sharply, it indicates the athlete is working at an intensity exceeding their lactate threshold. This corresponds with a sharp rise in the rate of ventilation – that is, the amount of air breathed in and out per minute. Without the necessary laboratory equipment, the

Figure 7.27 Elite endurance athletes have high lactate thresholds, and can therefore exercise at higher intensities without accumulation of blood lactate.

lactate threshold can be estimated using percentage of maximum heart rate or by noting the point at which the rate of breathing can no longer be controlled.

The average athlete will begin working above their lactate threshold when exercising between 50 and 60 per cent of their VO_2 max. At this point, heart rate will be approximately 160–170 bpm. An elite athlete who has been training for an endurance event, such as a marathon, may be able to exercise at up to 80–90 per cent of their VO_2 max before reaching their lactate threshold. This is possible because training has caused a number of physical adaptations in their body that allow more oxygen to be gathered and used efficiently, restricting the production of lactate and replenishing energy supplies more efficiently. The physical adaptations caused by training for various activities are discussed in detail in the following sections of this chapter.

Lactate threshold and physical activity

Endurance activities require the athlete to work on, or at times slightly above, their lactate threshold. If they continue to work above this threshold, lactate will begin to accumulate and they will slow down or need to rest. An endurance athlete with a comparatively higher lactate threshold will be able to work at a higher intensity without accumulating lactate and the onset of fatigue. A high lactate threshold is also a significant advantage in many sports that require a sustained effort over time, but there are many physical activities where the athlete's lactate threshold is of little consequence to their performance.

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aerobic training threshold the level of intensity sufficient to cause a training effect

aerobic training zone the intensity at which your body is using its aerobic metabolism system to produce energy from fat and glycogen

anaerobic training zone the heart rate above which you gain anaerobic fitness; you cross your anaerobic threshold at 80 per cent of your MHR

In activities such as 100 m sprint or weight lifting, energy is supplied predominantly by the ATP-PC system and athletes do not need to remain working long enough to require energy produced by the lactic acid system. The rules of some sports, such as touch football, allow players to work at near-maximal levels for relatively short periods and then substitute with another player, providing a significant recovery period. Yet athletes in these types of activities can benefit from maintaining a high lactate threshold despite being predominately anaerobic. A high lactate threshold will allow them to train and play for longer periods at higher intensity before the onset of muscle fatigue. Early season training in many sports focuses on building an 'aerobic base', raising the lactate threshold of athletes in order to enhance future training gains and on-field performances.

Training thresholds

The objective of any training program is to cause physical adaptations to the body that will enhance a person's training effectiveness, raise sport-specific fitness levels and ultimately improve their performance. In order to produce this training effect, the training program must cause the athlete to work at a level of intensity significantly above the resting state. In the resting state or at low exercise intensities, no training effect will occur as the working muscles and oxygen delivery systems can easily cope with the demand for energy.

The **aerobic training threshold** refers to a level of exercise intensity that is sufficient to cause a training effect. Using heart rate as an indicator of exercise intensity, the aerobic training threshold is approximately 70 per cent of a person's maximum heart rate (but may be higher for a person who trains regularly). Remember that a person's maximum heart rate is considered to be 220 minus their age. If two people are both working at a level of intensity at 70 per cent of maximum heart rate, their bodies are working equally as hard to provide the oxygen required. However, to get to 70 per cent of maximum heart rate, the first person may be an elite athlete running 5 km at a moderate intensity, whereas the second may be an untrained person walking up a set of stairs. When a person is working above their aerobic training threshold, but below their lactate threshold, they are said to be working in the **aerobic training zone**. Exercising in the aerobic training zone is done at an intensity below the lactate threshold and therefore can be maintained for extended periods without fatigue signalled by the accumulation of lactate. As exercise intensity approaches the lactate threshold, the demand for oxygen is increased and the training effect will be greater, provided activity is sustained for a significant length of time. Training intensities above the lactate threshold are in the **anaerobic training zone**.

Coaches and athletes may vary the intensity of training to produce the desired training effect

Figure 7.28 Heart rate monitors are a useful training tool that let athletes exercise within targeted training zones.

Figure 7.29 Aerobic activity is a great way to increase your heart rate.

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that is specific to the particular activity or playing position. Training at or below the lactate threshold (the aerobic training zone) will markedly increase aerobic endurance (raising the lactate threshold and allowing higher intensity of exercise without accumulating lactate). Training in the aerobic training zone will improve or maintain levels of aerobic endurance. Exercising above the lactate threshold will improve anaerobic endurance (improving the efficiency and recovery of the lactic acid system and allowing greater endurance while working above the anaerobic threshold). Exercise at an intensity greater than rest but below the aerobic training threshold will not greatly improve aerobic endurance, but may be useful for maintaining a desired weight and remaining healthy. Training methods and principles used to improve performance in various physical activities are discussed in the following sections of this chapter.

Exercise zones

		Age									
		20	25	30	35	40	45	50	55	65	70
Beats per minute	100%	200	195	190	185	180	175	170	165	155	150
		VO_2 max (maximum effort)									
	90%	180	176	171	167	162	158	153	149	140	135
		Anaerobic (hard-core training)									
	80%	160	156	152	148	144	140	136	132	124	120
		Aerobic (cardio training/endurance)									
	70%	140	137	133	130	126	123	119	116	109	105
		Weight control (fitness/fat burn)									
	60%	120	117	114	111	108	105	102	99	93	90
		Moderate activity (maintenance/warm-up)									
	50%	100	98	95	93	90	88	85	83	78	75

Table 7.6 A guide to percentage maximum heart rate at various exercise zones

Activity 7.9

Check-in

MAKE DECISIONS JUSTIFY RECOGNISE & EXPLAIN

1. Why can percentage of maximum heart rate be used as an indicator of exercise intensity?
2. What determines the point at which an individual moves from exercising in the aerobic training zone and exercising in the anaerobic training zone?
3. Does this point between these two training zones always remain the same or can it change? Why is this the case?
4. To produce a training effect (improvements in aerobic capacity), exercise intensity needs to be in the aerobic training zone or above. What are possible reasons for exercising in the 50–70 per cent of maximum heart rate zone?

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Activity 7.10

Engage-in

Inquiry question: How can percentage of maximum heart rate be used to determine training zones specific to the requirements of various physical activities, and individual needs and capacities?

Engage and understand

1 It is possible to calculate heart rates that can be used as a guide to your training thresholds (see Table 7.6 on the previous page). These calculations are, of course, approximations, as values will vary between individuals due to differences in fitness and previous training. Calculate and record the following.

Maximum heart rate	220 – Age (bpm)
Aerobic training zone	Low value = Max. heart rate × 0.70 (bpm)
	High value = Max. heart rate × 0.80 (bpm)
Lactate threshold	Max. heart rate × 0.8 (bpm)
Anaerobic training zone	Low value = Max. heart rate × 0.8 (bpm)
	High value = Max. heart rate × 0.9 (bpm)
Maximal training zone	Low value = Max. heart rate × 0.9 (bpm)
	High value = Max. heart rate × 0.9 (bpm)

Apply and analyse

Analyse: Examine or consider something in order to explain and interpret it, for the purpose of finding meaning or relationships and identifying patterns, similarities and differences.

2 You are to collect personal heart rate data while performing in the physical activity on which your class is currently focused in this unit. This heart rate data can be used to determine individual and team fitness requirements as well as providing an insight into the energy demands of the activity. Gathering useable heart rate data while performing is ideally done using heart rate monitors. Alternatively, heart rate data can be collected manually by stopping the activity every two to three minutes to take a 10-second count of the carotid pulse. To check your pulse at the carotid artery, place your index and middle fingers on your neck to the side of your windpipe. When you feel your pulse, look at your watch and count the number of beats in 10 seconds. These readings over the duration of the activity can be recorded by a partner.

3 Collect/record your heart rate data for the duration of the active phase of the activity and during the first five minutes of rest after stopping activity.

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4 Produce a personal heart rate response graph for the duration of the activity session (heart rate vs. time). This could involve printing a graph from heart rate monitor data or plotting data collected manually into a spreadsheet or on graph paper.
5 Calculate your average heart rate during the active phase of the activity (not including the recovery phase) and note your maximum heart rate. Average heart rate can be calculated by dividing the sum of all heart rate readings by the number of reading taken during the active phase. If you are using heart rate monitors, this average is usually available using the associated software application.
6 Calculate a class average for both average heart rate and maximum heart rate during the active phase of the activity.
7 Consider the following discussion questions.
   a In which training zone does this activity operate?
   b Did the level of intensity vary over the duration of the activity? Why?
   c Which energy system would have had the greatest contribution to producing the energy for this activity?
   d What implications does this have for training activities and playing tactics?
   e Recommend a training activity that would contribute to developing the specific energy requirements of this activity.

7.6 Components of fitness

An understanding of the range of various fitness components that contribute to physical performance (such as strength, power and endurance) will assist athletes and coaches in determining the specific requirements of the activity being trained for and therefore assist in the design of training programs specific to the activity and individual athletes. This understanding may also assist in making personal choices about the suitability to particular types of physical activities, modifying techniques or tactics to suit individual or team capacities, or choosing playing positions within an activity. Just as various sports have particular energy requirements, differences also exist in the fitness components required to meet the physical demands of the activity. This section discusses the various fitness components that contribute to performances in physical activities.

The term *fitness* is used to refer to the physical performance capacities required to perform in various physical activities. This term can tend to be a little misleading, as people often think of physical fitness merely as being the ability to sustain physical work for longer periods of time (aerobic capacity). However, many other components of fitness contribute to performance and our state of total health. For example, the fitness components required to perform well at sport aerobics are vastly different from those required to perform well at sumo wrestling.

One major consideration when examining the physical capacities required for optimal performance in any given physical activity is the requirement for *endurance*. Endurance refers to the body's ability to sustain a particular level of physical effort. The level of effort required will determine how much energy is required and at what rate – in other words, which combination of energy systems will be used. A 200 m sprinter ideally wishes to maintain sprint pace for the entire distance, and therefore requires endurance of the ATP/PC energy system. Through training, the sprinter would aim to increase the rate of phosphate and glycolytic energy release in order to make efficient use of as much energy as possible in the shortest amount of time. (The sprinter could not ignore aerobic endurance, however, as an enhanced aerobic capacity will allow for larger training volumes and will speed recovery from anaerobic training and performance.) In contrast, a triathlete requires peak endurance of the aerobic energy system in order to maintain a competitive pace.

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The intensity and duration of an activity will determine the type of endurance required. Recovery time may also affect the endurance requirements of an activity. Team games with breaks in play and substitution rules allow for repeated periods of intense physical work followed by periods of recovery. A touch football player, for instance, would use aerobic, lactate and alactate energy during intermittent periods of intense physical work and recovery. Endurance can therefore be discussed in two broad categories: **aerobic capacity** or endurance; and muscular or anaerobic endurance.

aerobic capacity the ability to exercise for extended periods using energy produced by the aerobic energy system

muscular endurance the ability of specific muscle groups to sustain activity at high intensity using energy produced by anaerobic energy systems

Major fitness components

The major fitness components are:

- aerobic capacity
- muscular endurance
- strength
- flexibility
- speed
- power
- agility.

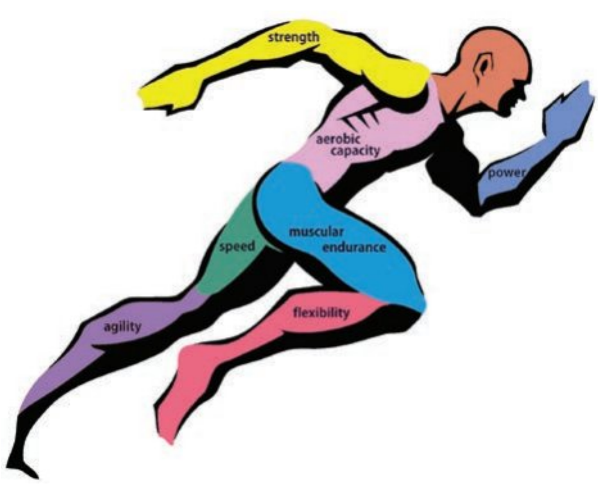

Figure 7.30 An athlete's ability in the major fitness components will determine their physical capacity to perform the movements required for their selected physical activity. Some physical activities require high levels of specific fitness components to maximise performance, while other activities benefit from developing the capacity of several components.

Aerobic capacity

Aerobic capacity (sometimes referred to as aerobic endurance or aerobic power) can be defined as the ability to exercise for extended periods using energy produced by the aerobic energy system. Aerobic capacity is determined by the efficiency of muscle cells in utilising available oxygen, and the efficiency of the circulatory and respiratory systems in collecting oxygen from the inspired air and transporting it to working muscles. Individuals with high levels of aerobic capacity can exercise at higher intensity levels without accumulating lactate (submaximal exercise) and can recover more quickly from periods of activity. It follows that aerobic capacity is an important component of almost all physical activities.

Accurate testing of maximum aerobic capacity requires sophisticated equipment such as a bicycle ergometer or treadmill, and specialised gas analysis devices used in exercise physiology laboratories. However, various submaximal predictive tests have been developed that can be conducted outside of a laboratory setting, such as the 12-minute run test and the 20 m multi-stage shuttle run (sometimes known as the beep test). A range of fitness tests are outlined in the following section of this chapter.

Muscular endurance

Muscular endurance (sometimes referred to as anaerobic endurance) can be defined as the ability of specific muscle groups to sustain activity at high intensity using energy produced by anaerobic energy systems. These activities require energy from alactate (ATP/PC system) and lactate (lactic acid system) sources, and ultimately lead to the accumulation of lactate in the working muscles and blood, and fatigue of the muscle. The ability of specific muscles to store energy sources and recover quickly determine their ability to continue the action – in other words, the muscles level of muscular endurance. Push-ups and chin-ups are examples of activities requiring muscular endurance specific to a particular muscle group. Physical activities with continuous intense movement sequences, such as the contraction of shoulder and arm muscles in kayaking and swimming, require high levels of muscular endurance. Tests of specific muscular endurance may involve push-ups, chin-ups or sit-ups, but where possible should involve the muscle groups specific to the physical activity.

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Figure 7.31 Rowing requires high levels of muscular endurance.

Strength

Strength can be defined as the ability of muscles to exert a force against a resistance in one maximal effort. The greater the muscular strength, the greater the force that can be generated. Factors that contribute to the generation of force by muscles include the cross-sectional area of the muscle, the initial muscle length prior to contraction, the type of muscle fibres (slow-twitch or fast-twitch fibres) and the speed of contraction.

Three types of muscular strength have been identified: *isotonic strength*, *isokinetic strength* and *isometric strength*. Isotonic strength involves the shortening and lengthening of muscle fibres during a specific movement. In the performance of kicking a soccer ball, isotonic strength is displayed in the action of the quadriceps causing flexion at the knee. As discussed in Chapter 2, isotonic muscle contractions may be either **concentric contractions**, where the muscle is shortening under force, or **eccentric contractions**, where the muscle is lengthening under force. Generally, concentric muscle actions apply direct force, whereas eccentric muscle actions control the deceleration of movements or control the speed of movements assisted by gravity.

Isokinetic strength involves muscular contraction at a constant rate; it can be measured using sophisticated equipment that maintains the constant level of exertion of muscular force as the joint progresses through its range of motion. Isometric strength (sometimes called static strength) involves no change in length of muscle fibres, so no joint movement. Although no movement occurs, force is still being exerted by the muscles. In the maintenance of a gymnastics handstand, the arm and shoulder muscles are exerting force against the ground, but no joint motion is occurring. The testing of strength usually involves measuring the maximum force that can be exerted by a muscle group in a single contraction – for example, recording maximum lifts in the weights gym. Strength testing also needs to consider the muscular strength required by the movement sequences specific to the sport. It is recommended that tests of absolute strength involving maximum force should only be used with trained athletes.

Flexibility

Flexibility can be defined as the ability of a joint to move through its full range of motion. Factors that limit the flexibility of our muscles include gender, age, body shape, the surrounding connective tissue and the range of motion of the joint. However, flexibility can be improved through training, which assists not only in improving performance but also in the avoidance of injuries to ligaments, tendons and muscles.

Two types of flexibility have been identified: dynamic (or functional) flexibility and static flexibility:

- **Dynamic flexibility** refers to the range of joint movement possible while moving and contributes to the body's ability to make rapid or quick, repeated movements. The actions of the trunk, lead leg and trail leg of a hurdler illustrate the need for dynamic flexibility.
- Static flexibility refers to the range of motion possible at a specific joint of the body while holding a stationary position. Static flexibility is displayed in the execution of the splits in a gymnastics routine. The splits help to illustrate the range of motion about the hips of the gymnast. The testing of flexibility usually focuses on static flexibility.

Goniometers can be used to help measure the angle between two body segments at their maximum range of motion. A more common method of testing the flexibility of the hamstring muscles about the hip joint is the sit-and-reach test.

strength the ability of muscles to exert a force against a resistance in one maximal effort

concentric contractions the muscles are developing force while shortening to cause movement

eccentric contractions the muscles lengthen in a controlled way under tension to absorb force

flexibility the ability of a joint to move through its full range of motion

dynamic flexibility the range of joint movement possible while moving and contributes to the body's ability to make rapid or quick, repeated movements

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speed the ability of muscles to contract quickly and repeatedly, resulting in fast body motion

power the ability of muscles to generate force and apply it quickly

agility a rapid whole-body movement with change in velocity or direction in response to a stimulus

Speed

Speed can be defined as the ability of muscles to contract quickly and repeatedly, resulting in fast body motion. Speed can be specific to the rate of movement of certain body parts or of the change in position of our whole body. The leg speed of a sprinter contributes to the overall time taken to complete a 100 m event. Moving quickly after serving in tennis, to intercept a return down the line, also illustrates whole body speed. The speed at which any movement can occur depends on reaction time as well as the time taken for muscles to cause the movement. Linear speed (or velocity) is represented as distance per unit time ($v = d/t$) and in physical activity is usually measured in metres per second (m/s).

Power

Power can be defined as the ability of our muscles to generate force and apply it quickly. Power is a combination of muscular strength (force) and speed (velocity):

$$\begin{aligned}\text{Power} &= \text{force}(\text{strength}) \times \text{speed}(\text{velocity}) \\ &= \text{force} \times \text{distance/time}\end{aligned}$$

The ATP-PC energy system is used predominately to help supply the explosive force needed in activities such as the sprint start, javelin throw, shot put, jumping for rebounds in basketball or the take-off for the long jump.

As power is a combination of strength and speed, sometimes the terms 'strength-related power' and 'speed-related power' are used to help identify the major contributing factor. Of the above examples, jumping for rebounds and shot putting are strength-related power activities, whereas the sprint start, javelin throw and long jump take-off could be termed speed-related power activities. For strength-related power testing, a vertical wall jump or standing long jump may be used. Speed-related power may be tested through a 35 m sprint test.

Agility

Agility can be defined as a rapid whole-body movement with change in velocity or direction in response to a stimulus. Power and flexibility are contributing factors in the level of agility we can display. Agility is an important attribute when involved in physical activity requiring movement to avoid an opponent or move to a projectile – for example, basketball, soccer, badminton, volleyball or touch football. A modern understanding of agility recognises the need for an athlete to respond to this stimulus (the opponent or implement), particularly in invasion, and ball and court games, such as those mentioned. It is now widely accepted that agility also involves components of situation recognition, decision-making and reaction time. Traditionally, the Illinois Agility Test is commonly used to test agility. It measures the ability to accelerate quickly, turn and weave through a number of cones in the shortest possible time. While this test is still used to measure 'agility', it more accurately measures change in direction (a subcomponent of agility), as it does not fully replicate the agility required in many physical activities.

Figure 7.32 Sports such as basketball require excellent agility to change direction quickly and evade opponents.

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Additional capacities that affect performance outcomes

While fitness components affect the speed, strength, duration and intensity of movements and can be trained through targeted fitness activities, there are a number of additional capacities that may affect movement performance. These generally involve a significant cognitive aspect and are less responsive to gains through fitness training. These capacities include balance, coordination and reaction time.

Balance may be defined as the ability to maintain the equilibrium of the body while either moving or in a stationary position. *Dynamic balance* is the term used when referring to maintaining balance while moving. *Static balance* is evident when it is necessary to hold a stationary position. Walking involves dynamic balance. This is particularly evident when we observe a young child learning to walk. The maintenance of equilibrium during the execution of a handstand requires the development of static balance.

Coordination may be defined as the ability to link the messages received by the brain from the senses (such as sight and hearing) to our body parts, to produce smooth, quick and efficiently controlled movements. 'Hand–eye coordination' for physical activities such as tennis or netball, and 'foot–eye coordination' for soccer are terms sometimes used to help specify the sense and body part associated in the movements. Performing a dance routine to music is an example of our auditory senses being required to perform in a coordinated manner with the working muscles. A simple catch-and-throw test, involving catching and throwing a tennis ball against a wall, is an example of a coordination test.

Reaction time can be defined as the time it takes to respond to a stimulus. The time taken from the firing of the starter's gun (stimulus) to the initial push against the blocks when running or swimming is an example of reaction time. On average, this time is around 170 milliseconds. However, in many team ball sports, it is difficult to determine whether fast response times are due to an athlete demonstrating superior reaction times or a refined ability to anticipate play, and therefore respond earlier.

Sport-specific fitness requirements

The majority of sports rely on a combination of fitness capacities. Very few sports require the development of a single fitness component. Some sports, however, require a wider range of fitness capacities than others. Javelin throwers, for example, require good arm speed and core power, whereas sports like Rugby League rely on speed, endurance, strength, power, flexibility and agility. The relationship between the reliance on the fitness components of strength, speed and endurance is often used to determine the training needs of particular sports. This relationship is represented graphically in Figure 7.33. The extent of the reliance of a particular sport on these qualities can be represented at a point in the triangle. Rugby League (RL), for example, would rely in close to equal part on all three components, whereas running a marathon (M) would rely mostly on endurance.

coordination the ability to link the messages received by the brain from the senses to our body parts to produce smooth, quick and efficiently controlled movements

reaction time the time it takes to respond to a stimulus

Understanding the fitness demands of a specific physical activity is essential for developing specific and effective training sessions and programs. This reflects the training principle of *specificity*, which will be discussed later in the chapter, and is achieved through comprehensive game play analysis to ascertain the movement requirements for successful performance.

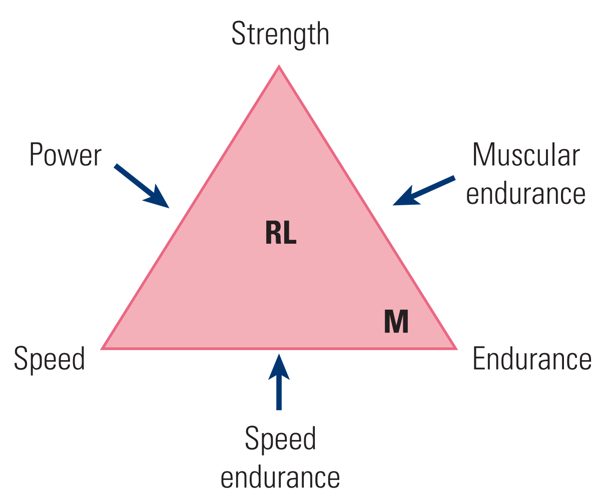

Figure 7.33 The relationship between strength, speed and endurance

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Activity 7.11

Check-in

1 In a small group, choose one physical activity from each of the following syllabus categories.

- net and court
- invasion
- striking and fielding
- target
- performance
- aesthetic.

2 Draw a strength/speed/endurance triangle (see Figure 7.33 on the previous page) on a whole page. Discuss the relative strength, speed and endurance requirements of each of your selected activities. When your group has reached a consensus, indicate the placement of the activity on the triangle.

Activity 7.12

Engage-in

Inquiry question: What are the specific fitness requirements of various physical activities, including the physical activity that is the focus of your study this term?

Engage and understand

1 Identify the physical capacities most necessary for the following physical activities. What aspects of each activity helped you make your selection?

a badminton player
b tennis player
c volleyball player
d Australian Rules Football player
e basketball player
f futsal player
g netball player
h touch football player
i water polo player
j 100 m sprinter
k javelin thrower
l distance swimmer.

Apply and analyse

Apply: Use knowledge and understanding in response to a given situation or circumstance; carry out or use a procedure in a given or particular situation.

2 Consider the physical activity that is the focus of your study this term. Rate the importance of each fitness component to successful performance in your activity on a scale of 1 to 5, with 1 being not important to 5 being very important.

3 What is the relationship of the reliance on speed, strength and endurance of this activity?

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4 Does the importance of the various fitness components vary during the activity? Why? Why not?
5 Does the importance of the various fitness components vary with different playing positions in this activity? If so, how?
6 What tests could be used to measure a person's suitability for this activity, or a specific playing position within the activity?

Measuring personal fitness capacities

A range of simple fitness tests can be used to profile the physical capacities of athletes. The specific fitness requirements of the sport or physical activity would determine the range of tests to be conducted. The results of these tests can be used to highlight specific fitness components that could be targeted for improvement and guide a coach's planning of group and individual training programs.

Fitness testing

The battery of fitness tests shown in Table 7.7 can be used to develop a personal fitness profile across a range of fitness components. Other tests may need to be included to measure physical capacities specific to a particular physical activity. Raw scores on fitness tests can be compared with age- and sex-specific norms in order to rate performances and target areas for improvement.

Aerobic capacity: 20 m multi-stage fitness test (beep test)

The 20 m multistage fitness test (MSFT) is a commonly used test of aerobic capacity. It is also known as the 'beep test'.

The beep test can be used as a way of estimating maximal oxygen uptake (VO_2 max). Online conversion tools can be located to convert beep test results into an estimated VO_2 max, and rate this against age-based norms.

Fitness component	Fitness test
Aerobic capacity	20 m multi-stage fitness test (beep test) 12-minute run test
Muscular endurance	Sprint fatigue test One-minute sit-up test
Speed	35 m sprint test
Agility	Illinois agility test
Power	Vertical jump test (lower body) Basketball throw test (upper body)
Flexibility	Sit-and-reach test

Table 7.7 Fitness tests for various fitness components

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Equipment	Flat non-slip floor at least 25 m long and wide enough for the number of participants, markers, 20 m tape, beep test audio recording, audio device					
Procedure	This test involves continuous running between two lines 20 m apart in time to recorded beeps. Instructions and protocols for this test are contained on the audio recording. These must be adhered to closely to get a reliable result.					
Scoring	The athlete's score is the level and number of shuttles (20 m) reached before they were unable to keep up with the recording according to test protocols. Pay careful attention to the last level and shuttle number you were able to complete.					
Performance norms	Very poor	Poor	Fair	Average	Good	Very good	Excellent
Male	<5/2	5/2–7/1	7/2–8/5	8/6–10/1	10/2–11/5	11/6–13/10	>13/11
Female	<4/5	4/5–5/7	5/8–7/2	7/3–8/6	8/7–10/1	10/2–12/7	>12/7

Note: Quoted norms provide a guide to the quality of performance for the 17–18 year age group and may be based on research from a wider or slightly older age group.

Table 7.8 20 m multi-stage fitness test protocols and norms

Alternately, an estimate of VO_2 max (measured in millilitres of oxygen per kilogram of body weight per minute – ml/kg/min) can be calculated by substituting beep test results (level number and shuttle number) into the following formula, where LN is the level number and SN is the shuttle number.

$$VO_2 \max(\text{ml/kg/min}) = 3.46 * (LN + (SN/(LN * 0.4325 + 7.0048))) + 12.2$$

VO_2 max norms (ml/kg/min)	Very poor	Poor	Fair	Average	Good	Very good	Excellent
Male	<30	30–36	37–41	42–46	47–51	52–60	>60
Female	<28	28–32	33–37	38–41	42–46	47–56	>56

Note: Quoted norms provide a guide to the quality of performance for the 17–18 year age group and may be based on research from a wider or slightly older age group.

Table 7.9 VO_2 max norms

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Aerobic capacity: The 12-minute run test

The 12-minute run test is a commonly used test of aerobic capacity that is very easy to set up and administer.

Equipment	400 m athletics track or another running circuit of known distance				
Procedure	Run continuously around the track/course aiming to run as far as you can in 12 minutes. If you need a break from running, at least keep walking so that you are still covering distance.				
Scoring	The athlete's score is the number of metres covered in the 12-minute duration of the test. Observers tally the number of laps and part laps completed. Multiply this by the track distance to give the distance covered in metres.				
Performance Norms	Poor	Fair	Average	Good	Very good
Male	<1600	1600–2199	2200–2399	2400–2800	>2800
Female	<1500	1500–1799	1800–2199	2200–2700	>2700

Note: Quoted norms provide a guide to the quality of performance for the 17–18 year age group and may be based on research from a wider age group or slightly older age group.

Table 7.10 The 12-minute run test protocols and norms

Muscular endurance: Sprint fatigue test

The sprint fatigue test is designed to measure the muscular endurance (anaerobic capacity) of the muscles involved in running. This test is a good indicator of general muscular endurance and the capacity of muscles to provide energy using the lactic acid system.

Equipment	Straight 30 m track with 10 m stopping distance at each end of the track, two stop watches, markers
Procedure	The subject will complete sets of 10 × 30 m sprints at maximum speed, starting each 30 m sprint at 30-second intervals. Markers are placed 30 m apart on a sprint track to show the start and finish points. Two more markers are placed 10 m past the start and finish and are used to indicate the slow-down zone at each end. Two time keepers and a recorder are required. One timer records the time taken for each sprint and one signals the start of each sprint at 30-second intervals. On the go signal, the two stopwatches are started simultaneously, and the subject sprints at maximum speed for 30 m, ensuring that they do not slow down before reaching the finish line. One stopwatch is used to time the sprint of each interval; the other continues to run. The time keeper measuring the time for the sprint calls the time for the first sprint to the recorder and resets the stopwatch ready to record the next sprint. The subject uses the 10 m to the next marker to slow down, turn and return to the 30 m finish marker, which then becomes the next start line. The next sprint will be in the opposite direction. Each 30 m sprint starts 30 seconds after the previous run started. This continues until the 10 sprints are completed; therefore sprints start at 30 seconds, 1 minute, 1.5 minutes, 2 minutes, etc. after the start of the first sprint. The recorder will have noted the time taken for each of the 10 sprints.

Table 7.11 The sprint fatigue test protocols and norms

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Scoring	The athlete's sprint fatigue index is calculated by taking the average time of the first three sprints and dividing this by the average time for the last three sprints. Convert this to a percentage by multiplying by 100. For the vast majority of people, this should return a value between 75 and 95%. The higher the score, the higher the anaerobic capacity of the subject.			
Performance norms	Poor	Average	Good	Very good
Male and female	<80%	80–84%	85–89%	>89%

Note: Quoted norms provide a guide to the quality of performance for the 17–18 year age group and may be based on research from a wider or slightly older age group.

Table 7.11 *(continued)*

Muscular endurance: The one-minute sit-up test

The one-minute sit-up test measures muscular endurance of the abdominals and hip-flexor muscles. This can be used as an indicator of general muscular endurance; however, other tests of muscular endurance (such as the flexed arm hang test and the one-minute push-up test) can be used to measure the endurance of other muscle groups that may be more specific to particular sports.

Equipment	Carpeted or cushioned floor space, stopwatch.						
Procedure	Lie with your knees bent at approximately 90 degrees with feet flat on the ground. Rest your hands on the front of your thighs. Keeping your back as straight as possible, raise high enough for your hands to slide along your thighs to touch the tops of your knees. Then return to the starting position. A partner can be used to secure your feet to the floor.						
Scoring	The athlete's score is the number of correctly performed sit-ups performed in one minute. A partner rather than the test subject should conduct the count.						
Performance norms	Very poor	Poor	Fair	Average	Good	Very good	Excellent
Male	<25	25–30	31–34	35–38	39–43	44–49	>49
Female	<18	18–24	25–28	29–32	33–36	37–43	>43

Note: Quoted norms provide a guide to the quality of performance for the 17–18 year age group and may be based on research from a wider or slightly older age group.

Table 7.12 The one-minute sit-up test protocols and norms

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Speed: 35 m sprint test

The 35 m sprint test measures running speed over a straight 35 m track. More specific tests of speed would be required for swimming or cycling speed testing.

Equipment	Straight 35 m track with adequate stopping distance, stopwatch				
Procedure	Subjects need undergo a suitable sprint warm-up for at least 10 minutes before undertaking this test. Use a three part starting command – take your mark, set, go signal. Complete the 35 m course as fast as possible, taking care not to slow down before the finish. Subjects complete three trials of the test with adequate rest (at least five minutes) between trials.				
Scoring	The athlete's score is the best time in seconds taken over three trials of the 35 m sprint.				
Performance norms	Poor	Fair	Average	Good	Very good
Male	>5.60	5.30–5.60	5.10–5.29	4.80–5.09	<4.80
Female	>6.20	5.90–6.20	5.60–5.89	5.30–5.59	<5.30

Note: Quoted norms provide a guide to the quality of performance for the 17–18 year age group and may be based on research from a wider or slightly older age group.

Table 7.13 The 35 m sprint test protocols and norms

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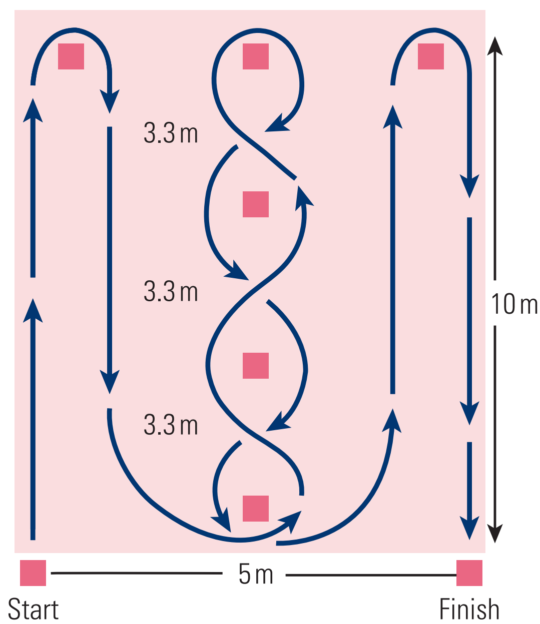
Agility: Illinois agility test

The Illinois agility test measures the ability to change direction with speed by measuring the time taken to run through a course of markers that requires constant changes in direction.

Equipment	Flat non-slip surface at least 15 m x 10 m, eight markers, stopwatch
Procedure	Subjects should lie on their front (head to the start line) and hands by their shoulders. On go, the athlete gets up as quickly as possible and runs around the course as indicated in the diagram, without knocking the cones over, to the finish line. Subjects may require a trial or two to become used to the direction of running the course. 
Scoring	The athlete's score is the best time in seconds to complete the course, taken over three trials.

Performance norms	Poor	Fair	Average	Good	Very good
Male	>19.3	18.2–19.3	16.2–18.1	15.2–16.1	<15.2
Female	>23.0	21.8–23.0	18.0–21.7	17.0–17.9	<17.0

Note: Quoted norms provide a guide to the quality of performance for the 17–18 year age group and may be based on research from a wider or slightly older age group.

Table 7.14 The Illinois agility test protocols and norms

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Power (lower body): Vertical jump test

The vertical jump test measures the muscular power of the lower body.

Equipment	Space adjacent to a wall, chalk, measuring tape
Procedure	 There are alternative methods to measure vertical jump. The vertical jump test can be measured using a specialised piece of equipment called a Vertec, where the subject jumps up to displace vanes that indicate the height achieved. The Vertec is adjusted so the lowest vane is at the height of the subjects extended arm and fingers. Alternately, vertical jump can be measured by the subject jumping to place a chalk mark as high up a wall as possible. Whichever method is used, the vertical jump test is usually performed starting in a standing position side on to the Vertec or wall, and bending the knees immediately prior to jumping off both feet. (This test is sometimes performed off one leg, with a step into the jump, or with a run-up off two feet or one foot, depending on the relevance to the sport involved.)
Scoring	The athlete's score is the difference between the height achieved by the jump and the height of the subject's raised arm with fingers extended measured in centimetres. The recorded score is the best achieved over three trials.

Performance norms	Very poor	Poor	Fair	Average	Good	Very good	Excellent
Male	<21	21–30	31–40	41–50	51–60	61–70	>70
Female	<11	11–20	21–30	31–40	41–50	51–60	>60

Note: Quoted norms provide a guide to the quality of performance for the 17–18 year age group and may be based on research from a wider or slightly older age group.

Table 7.15 The vertical jump test protocols and norms

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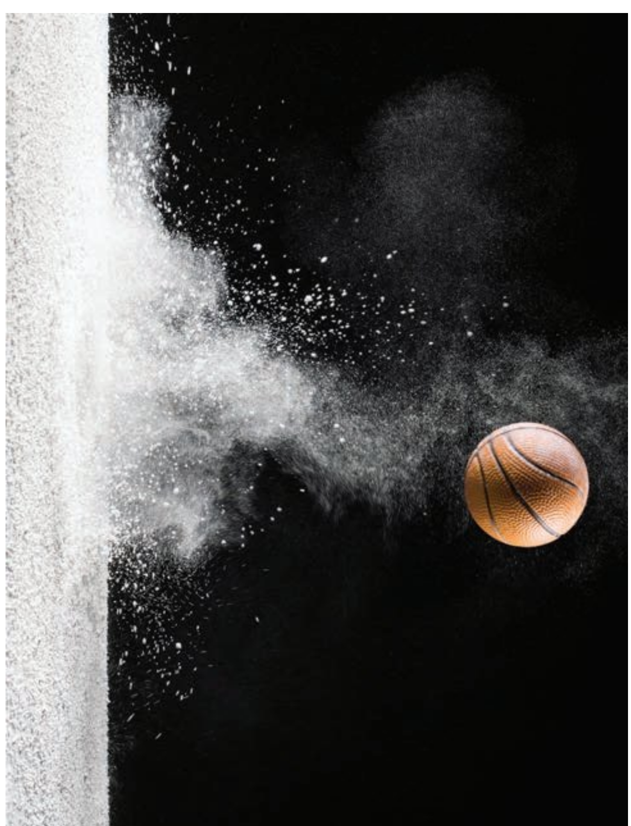
Power (upper body): Basketball throw test

The basketball throw test measures the muscular power of the upper body.

Equipment	Solid wall with 15 m free space in front, basketball, measuring tape.			
Procedure	The subject sits on the floor with legs fully extended, feet comfortably apart and back firmly against a solid wall. The ball is held with the hands on the side and slightly behind the centre of the ball, with the ball touching the centre of the chest. The forearms are held parallel to the ground. The subject throws the basketball with a chest pass as far as possible. The subject may require a few trial throws to learn the optimal angle of release to achieve the best result.			
Scoring	The athlete's score is the best distance recorded in metres, taken over three trials.			
Performance norms	Poor	Fair	Good	Very good
Male	<6.0	6.0–7.2	7.3–8.1	>8.1
Female	<5.1	5.1–6.1	6.2–6.9	>6.9

Note: Quoted norms provide a guide to the quality of performance for the 17–18 year age group and may be based on research from a wider or slightly older age group.

Table 7.16 The basketball throw test protocols and norms



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Flexibility: Sit-and-reach test

The sit-and-reach test measures the flexibility of the spine and hamstrings.

Equipment	Sit-and-reach box (or a 1 m rule could be used)						
Procedure	The subject sits on the floor with legs fully extended and the soles of the feet flat against the box. Shoes should be removed. With the palm facing downwards, the subject reaches forward as far as possible with both hands along the measuring line (or rule). Both hands must remain level rather than one reaching out further than the other. After two or three practice reaches, the subject reaches and holds the position for two seconds while the distance is recorded. Subjects need to hold the maximum stretch position for a valid result.						
Note	To produce a reliable result over a number of tests, the same warm-up should be used each time the test is applied. This test could be done immediately after a test of aerobic endurance, providing a consistent warm-up procedure.						
Scoring	The score is measured to the closest centimetre. The level of the feet is considered the zero point. A positive score would indicate the subject has reached past the level of the feet.						
Performance Norms	Very poor	Poor	Fair	Average	Good	Very good	Excellent
Male	<–20	–20 to –9	–8 to –1	0–5	6–16	17–27	>27
Female	<–15	–15 to –8	–7 to 0	1–10	11–20	21–30	>30

Note: Quoted performance norms are listed as a guide only for the 17–18 years age group but may be based on research from a wider age group or slightly older age group.

Table 7.17 The sit-and-reach test protocols and norms

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Sample personal fitness profile

Table 7.18 shows a sample of a personal fitness profile that could be constructed to record fitness results and used to determine individual and team training priorities. The battery of tests used needs to be matched to the specific fitness and energy requirements of the sport. For example, including a test of upper body strength may be highly relevant for a Rugby League team but not as relevant for a cyclist.

Subject name:		**Date:**	
Fitness component	**Selected test**	**Result/score**	**Rating**
Aerobic capacity	Beep test		
Aerobic capacity	12-minute run test		
Muscular endurance	Sprint fatigue test		
Muscular endurance	One-minute sit-up test		
Speed	35 m sprint test		
Agility	Illinois agility test		
Power (lower body)	Vertical jump test		
Power (upper body)	Basketball throw test		
Flexibility	Sit-and-reach test		

Table 7.18 Sample personal fitness profile

Activity 7.13

Check-in

1 Select a sport from the same category as the physical activity that has been the focus of your study this term.

2 Create a list of five fitness tests that would best measure the specific fitness and energy demands of the activity. The tests you choose could come from the tests outlined in the previous section of this chapter or other suitable tests you have found in research literature.

Inquiry cycle A – stages 2 & 3: Apply and analyse; Evaluate and justify – energy systems and fitness

In this section of the chapter, you will be required to use the knowledge and understanding established about energy, fitness and training to investigate, propose and implement justifiable training strategies designed to optimise performance in the physical activity that has been the focus of your study this term. These training strategies will be developed using primary and secondary data about the specific energy and fitness demands of the physical activity, and personal and team training priorities.

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7.7 Analysing the energy and fitness demands of physical activity

The physical demands of specific physical activities determine which fitness components should be the target of training activities. The energy requirements of physical activities also guide decisions about the types of training activities that will best prepare athletes for performance. Primary and secondary data sources can be used to make justifiable decisions about suitable training activities. Decisions about training activities also need to consider the physical capacities of individual athletes. This is usually done by conducting a range of fitness tests that relate to the physical demands of the activity.

A range of data can be considered in determining the physical demands of particular physical activities and specific roles or playing positions within them.

Data collection could include:

- rating the importance of each of the components of fitness to determine training priorities
- plotting the movement of athletes while in authentic performance environments (such as competition) to determine suitable training activities that replicate movement patterns involved in the activity
- measuring the heart rate responses of athletes while in authentic performance environments to identify appropriate training zones
- calculating work-to-rest (W:R) ratios to determine suitable recovery times in training activities
- investigating existing analyses of the demands of the physical activity in research literature
- investigating recommended training activities for the physical activity in research literature.

Specific movement sequences unique to different physical activities and playing positions may also guide decisions about what specific data to collect. For example, calculating a W:R ratio in the performance of a sprint race would not be useful.

Activity 7.14

Active investigation

Inquiry question: What are the specific physical demands of the physical activity that has been the focus of your study this term?

Engage and understand

1 Collect primary and secondary data by doing the following:

a Create a table of the components of fitness. Based on your experience performing in the activity, rate the importance of each of the fitness components.

b Complete a player movement observation. On a diagram of the playing area, plot the movement of one player over a short period of competitive play. Indicate on the diagram the intensity of movement being performed.

c Collect heart rate data for a number of players. This could be done manually or using heart rate monitors. Identify players' maximum heart rates and average heart rates to determine the training zone in which they are predominantly working. It may be appropriate in some physical activities to measure players in varying roles or positions. Class averages of average and maximum heart rate can be calculated.

(continued)

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d Calculate the W:R ratio of several players. This is done by observing a player during competition over a fixed time span and measuring the time (in seconds) that they spend at rest. You may need to agree on what is considered to be 'at rest' in this particular activity. Use two stopwatches, one to start and stop during periods of rest (measuring a total 'time at rest') and one to measure the duration of game play. The 'time at work' can be calculated by subtracting 'time at rest' from the duration of game play. Class averages of 'time at work' and 'time at rest' can be used to calculate a W:R ratio. Express the ratio in its simplest form.

e Conduct a literature search to investigate research relating to the physical demands and recommended training priorities of the physical activity.

2 Your class could split into groups to conduct this investigation. Each group could collect one of the data sets listed above and report its findings to the whole class. Decisions about the physical demands of the activity can be based on these reports.

Apply and analyse

KEY COGNITION *Apply: Use knowledge and understanding in response to a given situation or circumstance; carry out or use a procedure in a given or particular situation.*

3 Through examination and analysis of the primary and secondary data collected, discuss the following questions:

a Which components of fitness are the most important contributors to successful performance in this activity?

b What are the specific energy demands of this activity? Does this vary for players in different roles or positions?

c Towards which training zone would training activities need to be targeted?

d What does the W:R ratio of this activity imply for recovery times required in training sessions and activities?

e What training activities should be considered to develop player capacities for the demands of this activity?

Evaluate and justify

KEY COGNITION *Justify: Give reasons or evidence to support an answer, response or conclusion; show or prove how an argument, statement or conclusion is right or reasonable.*

4 In a 200–300 word evaluative report, recommend three fitness training priorities for inclusion in pre-season training for this activity. Justify each of your recommendations using evidence gathered from primary and secondary data sources.

Analysing personal fitness and performance data

After coaches and/or athletes have determined the fitness and energy demands of a particular physical activity, they need to analyse the physical attributes of individual athletes in these particular areas of demand. Various fitness tests and measures are used to determine an athlete's areas of strength and priorities for improvement. Therefore, the tests that are used need to measure the physical demands specific to the activity. Activity-specific personal fitness profiles can guide decisions about training priorities for teams and individuals, allow coaches to determine suitable training activities specific to the demands of the activity and the needs of the athletes, allow coaches and athletes to set training goals and allow for the monitoring of progress towards these goals.

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Activity 7.15

Active investigation

Inquiry question: How can a personal fitness profile guide decisions about training priorities and activities?

Engage and understand

1 Using your research findings in Activity 7.14 (pp. 411–12) regarding the physical fitness and energy demands of the physical activity that has been the focus of your study this term, construct a list of fitness tests that could be used to determine your fitness training priorities. You may choose to select fitness tests solely from those described earlier in this chapter or include some other tests that are specific to the physical demands of the activity.

2 Discuss the selection of tests in small groups or as a class, and decide on a battery of five to seven tests to be used by the group. More than seven tests may become difficult to manage.

3 Construct a personal fitness profile similar to the sample in Table 7.18 (on p. 410) based on the agreed battery of tests. This profile can be used in the collection of your results. You may consider developing a spreadsheet to record your results over time in order to monitor training progress and goals.

4 Conduct the first round of testing. This will probably require several lessons to complete. You will need to plan carefully:

- individual roles in conducting testing
- equipment required
- recording methods
- testing schedule
- catch-up testing.

5 Once testing is complete, scores can be converted into ratings using available norm data. Individual test data can be entered into personal and/or class recording systems such as a spreadsheet.

Apply and analyse

Analyse: Examine or consider something in order to explain and interpret it, for the purpose of finding meaning or relationships and identifying patterns, similarities and differences.

6 Analyse both your individual results and the results of others in the class. This may involve calculating class averages for each test.

7 Consider the following discussion questions:

a What are your personal fitness training priorities for improvement based on your profile?

b What training activities may be included in a training program to address your priorities?

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c What are the training priorities for the class as a whole?
d Are the class training priorities similar to your personal priorities?
e How may training priorities vary for individuals in difference playing roles or positions?

Evaluate and justify

Sythesise: Combine different parts or elements (e.g. information, ideas, components) into a whole, in order to create new understanding.

8 Based on your initial personal fitness profile, construct a set of fitness training goals. Your goals should set an achievable target for improvement in a suitable time period. You need to set sub-goals at intervals leading towards your final goal. These can be used to check progress, adjust goals if necessary and keep you motivated to achieve your goals.

Inquiry cycle B – stage 1: Engage and understand – training programs

7.8 Training principles

A number of training principles should be considered, no matter what type of training you undertake. The most significant are the principles of:

- specificity
- individuality
- progressive overload
- variety
- frequency
- intensity
- duration.

Specificity

The principle of **specificity** refers to the need for training to target the essential components of fitness, energy systems and movement patterns required for a selected physical activity. For example, a marathon runner would train primarily to develop their muscular endurance and aerobic endurance. Most of the training would involve completing long slow-distance (LSD) efforts in order to improve their ability to transport oxygen and nutrients throughout their body during exercise. In contrast, a 100 m sprinter would target their training on the development of their ATP-PC energy system, speed, power and reaction time. As well as working on refining technique, their training would focus on strengthening the large leg, lower back and core muscles critical for generating the required forces. In designing fitness activities for training using the principle of specificity, it is essential to have a clear understanding of the energy and fitness requirements, as well as the position-specific movements for the activity. This understanding can be achieved through comprehensive game analysis.

Individuality

In addition to targeting the specific demands of a physical activity, training should be performed to meet the needs of the athlete and take their situation into consideration. **Individuality** reflects the need for a training program to be written to consider the personal needs, goals, fitness levels, motivation and skills strengths, weaknesses and goals of the athlete. During a strength and conditioning session, it would be pointless for two athletes with different levels of strength to lift the

specificity training that is relevant to the energy systems, position-specific movements and fitness requirements of an activity

individuality training that considers the personal needs, goals, fitness levels, motivation and skills of an athlete

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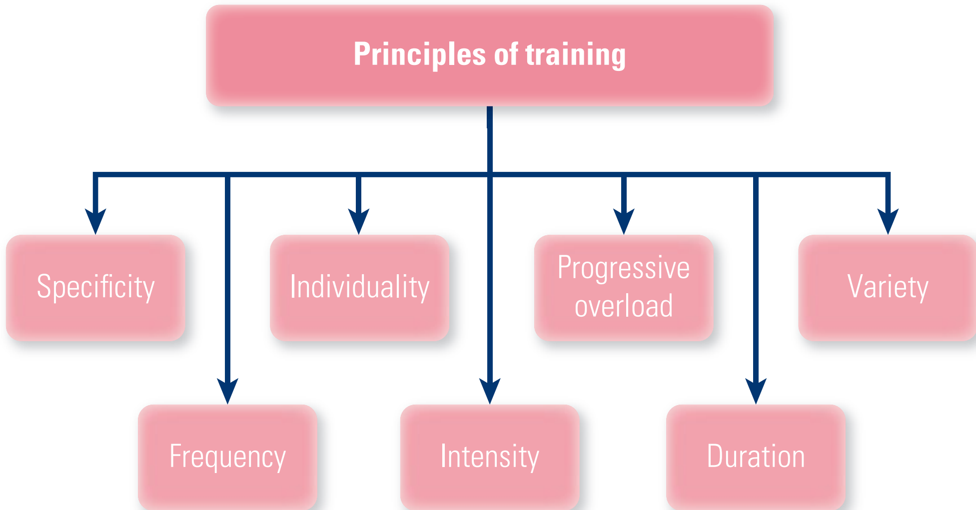

Figure 7.34 Principles of training

same weight the same number of times. Either the weaker athlete would struggle to complete the set effectively and be at risk of injury, or the stronger athlete would find it too easy and not experience enough stress to facilitate adaptation within their body. To design effective training activities that target individuals, it is important to have a clear understanding of their fitness and skill levels, as well as their needs, goals and motivation. This knowledge can be gained through regularly fitness testing and developing a productive coach–athlete relationship.

Figure 7.35 Specific training programs should target the essential components of fitness, energy systems and movement patterns required for a selected physical activity, such as running in track events.

Activity 7.16

Check-in

1. Explain the difference between specificity and individuality.
2. Identify the most importance energy systems and components of fitness required in your current physical activity.
3. Compare the importance of identified energy systems and components of fitness for two different positions or disciplines of your current physical activity.
4. For each of the following physical activities, explain whether including 'bench press' exercises into a training program would follow the principle of specificity:
   - **a** tennis
   - **b** touch
   - **c** long jump
   - **d** netball
   - **e** shot put.
5. Identify three individual training needs that are different from those of one of your training partners.

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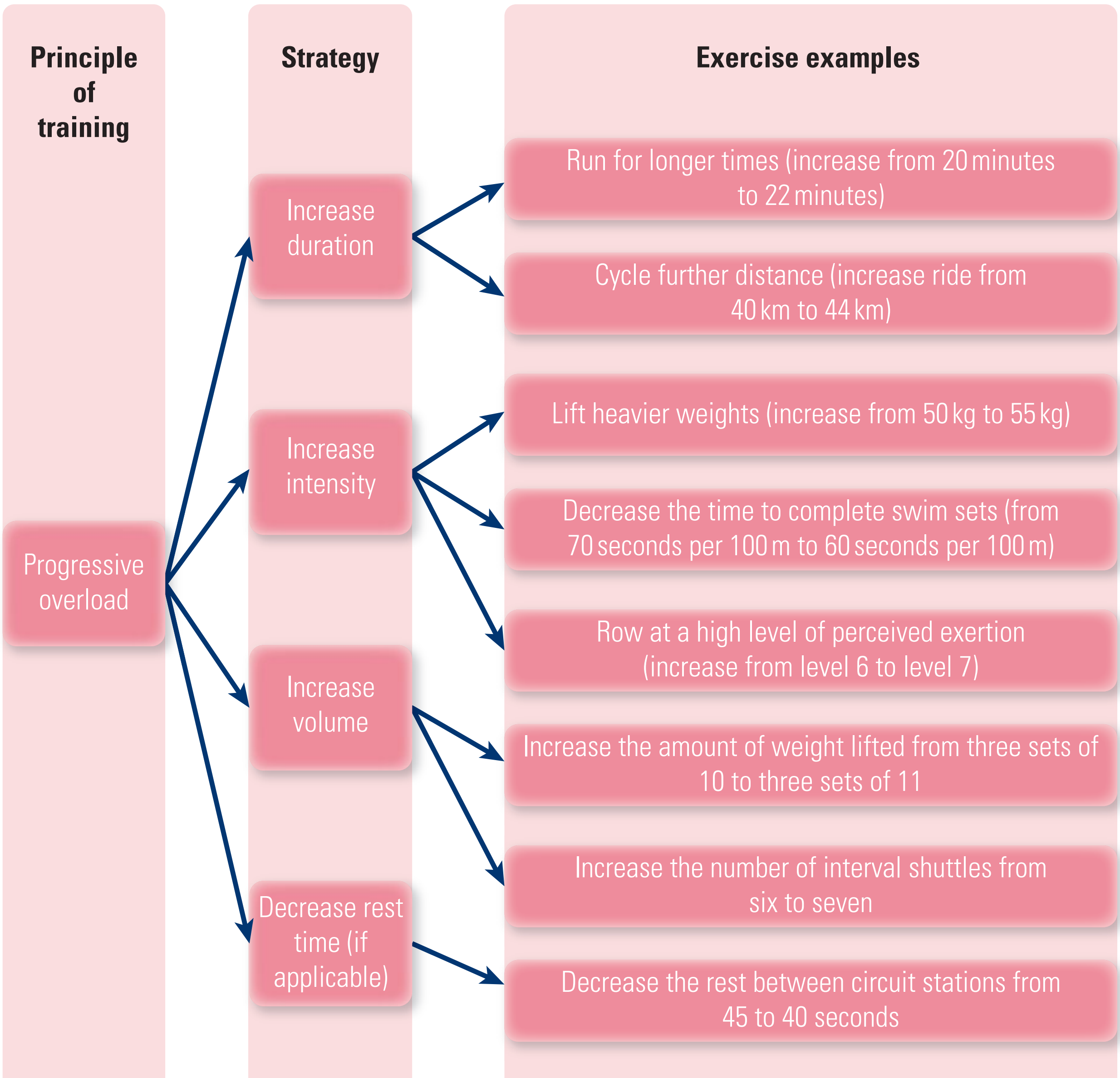

Figure 7.36 Training strategies

Progressive overload

After exercise, the body undergoes a period where it repairs and replenishes the essential tissues and systems that have been used. Following adequate rest, the body is then more prepared to deal with the demands of the training session and will find it easier to cope. This concept is known as **adaptation**, as the body changes to account for the physical demands it has experienced. This process continues until the body feels comfortable with the training. To facilitate continued improvement throughout

adaptation physiological changes due to the stress of exercise

KEY MESSAGE Training needs to get progressively harder to produce continued adaptations.

KEY MESSAGE Effective training is specific to the requirements of the physical activity.

KEY MESSAGE Effective training targets the individual needs and goals of each athlete.

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a training program, it is important to plan gradual increases in the physical demands of the training. This is known as **progressive overload**. Although fast progression is desirable, it is important to avoid **overtraining**. This will will occur if the increase in duration, **volume** and intensity is too rapid. The '10 per cent rule' is a good guideline to follow when determining how much overload should be done. That is, the changes made to training demands should not exceed 10 per cent of the previous effort.

progressive overload the planned, gradual increase in training load to ensure that fitness continues to be optimised

overtraining impaired physical, emotional and psychological responses due to the training intensities exceeding recovery

volume the number of repetitions or sets completed

frequency the number of times training occurs in a given period

detraining reduction in fitness gains due to extended rest periods

intensity the magnitude of exertion required

Variety

Variety in training can be achieved by changing training methods or the application of training principles. It can also refer to a change in the training venue or training partners. Incorporating variety into a training plan can lead to increased motivation and concentration, as it reduces the boredom associated with repetitive activity. Additionally, training in a variety of ways will condition the body to adapt to a range of physical movements. Variety is commonly incorporated during the off-season or when recovering from injury. Examples could include incorporating boxing to maintain aerobic fitness for a netball team, or a soccer player doing Pilates to improve core strength.

Frequency

Adaptation will only occur after repeatedly subjecting the body to stresses greater than it is used to. However, an athlete needs to balance the amount of training they do with ample recovery time to fully adapt. **Frequency** refers to the number of training sessions completed over a given period – for example, a week. Overtraining occurs when the training frequency does not allow adequate rest and time for the body to recover effectively. This can result in increased risk of injury and illness, and decreased performance in training and competitions.

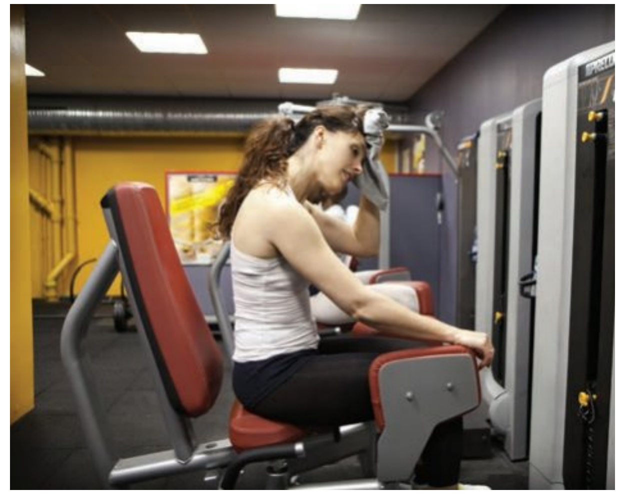

Figure 7.37 Rest time is essential for any training program to allow the body to recover.

However, having too much rest between training sessions can result in a loss of adaptive gains, known as **detraining**.

The recovery time required is specific to the nature of the training and/or competition. Heavy weights sessions or plyometric training will place a large amount of stress on the muscles and joints, requiring adequate rest between sessions. The recommended frequency for this type of training would not exceed once or twice per week for each muscle group. Conversely, low-impact or non-weight bearing activities like swimming do not place as much stress on the muscles and would result in the body recovering much faster. This can be reflected in a higher frequency of training for swimmers: their training can be conducted twice daily and top swimmers will perform 11 sessions a week in the pool.

Intensity

Intensity refers to the magnitude of exertion required to complete set movements – in simple terms, how hard an athlete trains. To achieve maximum benefit from training, the intensities used in training should be specific to the energy systems and components of fitness required for the chosen physical activity. Measuring and monitoring training intensities can be done using:

- target heart rates
- perceived exertion
- percentage of maximum strength or speed.

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Target heart rate

With technological advances in fitness tracking, it is becoming easier to track heart rates during physical activity. **Training zones** are used as a guide for athletes to ensure that they are working at the intensities needed to train the required energy systems. Most heart rate trackers allow athletes to set training zones and provide alerts when not training in the specified zones. Monitoring heart rates can also be achieved through counting their pulse for a period of time and converting to beats per minute (bpm).

training zone specific intensity range that identifies the dominant energy system use

maximum heart rate the highest safe heart rate at maximal exercise; MHR = 220 – your age

Figure 7.38 Devices such as a Fitbit can help to monitor heart rate.

Calculating target zones for individual athletes

According to the earlier principle of individuality, individual differences need to be recognised when establishing actual training zone heart rates for the purpose of setting appropriate training intensity. Primary training zones rely on knowing or predicting an athlete's **maximum heart rate** to calculate percentages. Maximum heart rates can very according to age, gender, level of fitness, ethnicity and the overall health of the heart. The most accurate way to determine the maximum heart rate of athletes is to subject them to VO_2 max tests (beep test, yo-yo

Purpose	Target zone	Intensity % (MHR)	Duration (minutes)	Benefits
High performance	Anaerobic zone (very hard)	90–100	< 5	Develops maximal performance and speed, and is only recommended for fit athletes
Performance	Threshold zone (hard)	80–90	2–10	Develops speed endurance and maximising performance capacity
Fitness	Aerobic zone (Moderate)	70–80	10–40	Improves aerobic fitness by making the heart stronger, enhancing lung capacity and improving efficiency of clearing lactic acid
	Endurance zone (light)	60–70	40–120	Improves basic endurance and strengthens the body in preparation for more intense exercise
Health Improvement	Recovery zone (very light)	50–60	20–40	Aids recovery and maintains a healthy heart by maintaining blood flow

Table 7.19 Heart rate zone training

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test) that gradually push them towards exertion. Less accurate predictions of maximal heart rate can be determined using age-predicted maximum heart rate (APMHR) calculation below:

Age predicted maximum heart rate = 220 – age

Using this equation would suggest that a 17-year-old athlete would have a maximum heart rate of 203 beats per minute.

Target training zones can be calculated by finding the respective percentages of an athlete's maximum heart rate. However, the Karvonen method of calculating an athlete's heart rate is considered a more accurate measure for target heart rates as it is more specific to the VO_2 max of each individual. **Heart rate reserve** can be calculated by subtracting the **resting heart rate (RHR)** from the maximum heart rate. Target heart rates can then be determined by adding the percentage of heart rate reserve to the resting heart rate. Essentially, this value indicates the amount of variance in the athlete's heart rate, and can provide a more individualised prediction of target heart rate.

heart rate reserve the difference between an athlete's maximum and resting heart rates

resting heart rate (RHR) the number of times the heart beats per minute when at rest

Activity 7.17

Engage-in

RECOGNISE & EXPLAIN | ANALYSE & SYNTHESISE | EVALUATE | JUSTIFY

Inquiry question: How accurate are age-predicted calculations in determining maximum heart rates for your class?

*This activity should only be completed by healthy athletes in the company of others.

Engage and understand

1 Determine and record each person's resting heart rate (RHR). This needs to be done following a long period of rest.
2 Use the APMHR equation to determine the maximal heart rate values for each person in your class.
3 Determine and practise a method for calculating measuring heart rates (heart rate trackers, pulse counting).
4 Review the protocol for completing the selected VO_2 max test.

Apply and analyse

KEY COGNITION

Analyse: Examine or consider something in order to explain and interpret it, for the purpose of finding meaning or relationships and identifying patterns, similarities and differences.

5 Following a suitable warm-up, complete the VO_2 max test. Record each person's highest heart rate (if using the pulse counting method, this should be done as soon as the exercise finishes).
6 Analyse maximal heart rates achieved during the VO_2 max test. Explain the differences between the predicted and recorded MHR values for the class.

Evaluate and justify

7 Write a sentence justifying how accurate the APMHR calculation was in estimating maximum heart rate values.

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Example: Calculate the heart rate training zone for the following athlete:
- maximum heart rate (MHR) = 206 beats per minute
- resting heart rate (RHR) = 60 beats per minute
- desired training intensity = 80–90% (threshold training zone)

% Maximum heart rate	Karnoven method
Step 1: Calculate the lower limit of the training zone: 80% of 206 = 0.8 × 206 = 164.8 beats per minute **Step 2:** Calculate the upper limit of the training zone Target heart rate = 90% of 206 = 0.9 × 206 = 185.4 beats per minute	**Step 1:** Calculate the heart rate reserve (HRR) by subtracting the resting heart rate (RHR) from the maximum heart rate (MHR) HRR = MHR – RHR HRR = 206 – 60 HRR = 146 beats per minute **Step 2:** Calculate the lower limit by adding the desired percentage of HRR to the RHR. Target heart rate = 80% of HRR + RHR = (0.8 × 146) +60 = 116.8 + 60 = 176.8 beats per minute **Step 3:** Calculate the upper limit Target heart rate = 90% of HRR + RHR = (0.9 × 146) + 60 = 131.4 + 60 = 191.4 beats per minute

The variance between heart rate targets can be seen when exercising. The values for % HRM are lower than % HRR; however, there is significant overlap. Fitter athletes with higher VO_2 max values also have lower resting heart rates. The variance between the two methods of calculating target heart rates would decrease.

Table 7.20 Calculating the heart rate training zone

Activity 7.18

Check-in

1. In your own words, explain how the Karnoven method is used to calculate target heart rates.
2. Calculate the target heart rates using the % MHR method for the following athletes:
   a. 85% intensity (MHR= 200)
   b. 60% intensity (MHR= 185)
   c. 95% intensity (MHR= 205).
3. Calculate the target heart rates using the Karnoven method for the following athletes:
   a. 70% intensity (MHR 200, RHR 75)
   b. 80% intensity (MHR 190, RHR 90)
   c. 55% intensity (MHR 195, RHR 85).
4. Calculate the % MHR and % HHR for an athlete who is training at an intensity of 170 bpm (MHR 200, RHR 70).

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Rate of perceived exertion

A simpler form of monitoring training intensities involves relying on the athlete's perception of their effort. The **rate of perceived exertion**, or RPE, scale can be used to regulate training intensities by having athletes monitor their internal physiological responses. As exercise intensities increase, the body works harder to continue the supply of oxygen to the muscles. As a consequence, less oxygen is available in the lungs and it becomes more difficult to talk. Table 7.21 shows the relationship between ratings of perceived exertion and the ability to talk.

rate of perceived exertion the level of intensity an athlete believes they are experiencing

Zone	Exertion scale	Exertion level	Talk test	Range (% of MHR)
High performance zone	10	Severe	Can't talk; gasping for breath	93–100
	9	Strenuous/ severe	Can't talk; very heavy breathing	86–92
Performance zone	8	Strenuous	Only able to speak in syllables; very heavy breathing	81–85
	7	Vigorous/ strenuous	Broken sentences; heavy breathing	76–80
Fitness zone	6	Vigorous	Can only complete one or two sentences; heavy breathing	68–75
	5	Moderate; vigorous sweat	Can carry on a conversation; heavy breathing	61–67
Health improvement zone	4	Moderate; sweat	Can carry on a conversation; moderate breathing	56–55
	3	Moderate; no sweat	Can carry on a conversation; light breathing	51–55
Inactive	2	Light	Normal breathing; can talk normally	46–50
	1	Very light	Normal breathing; can talk normally	40–45

Table 7.21 Rate of perceived exertion

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Activity 7.19

Engage-in

Inquiry question: How accurate is the rate of perceived exertion scale in monitoring intensities?

RECOGNISE & EXPLAIN | ANALYSE & SYNTHESISE | EVALUATE | JUSTIFY

Engage and understand

1 Split the class into three groups.
2 Review the suggested physiological responses associated with RPE scales 4, 6 and 8.
3 Select a suitable method for recording heart rate. This should only be recorded at the end and not during the exercise.

Apply and analyse

4 Following a suitable warm-up, complete three to five minutes of running or walking at an RPE of 4.
5 Record the highest heart rate reached and calculate the % MHR for this level.
6 Repeat steps 4 and 5 twice more for RPE of 6 and RPE of 8 respectively.

Evaluate and justify

KEY COGNITION

Evaluate: Make an appraisal by weighing up or assessing strengths, implications and limitations; make judgments about the ideas, works, solutions or methods in relation to selected criteria; examine and determine the merit, value or significance of something, based on criteria.

7 Evaluate the accuracy of your perceived level of exertion by comparing your heart rates with the suggested % MHR ranges in Table 7.21 on the previous page.

Percentage of maximum strength

When considering resistance training, intensities are measured using a percentage of the maximum weight an athlete can lift once. This is also known as their 1RM or one **repetition maximum**. High-intensity training would result in the athlete only being able to lift the weight once or twice. Obviously, as the intensity decreases the ability to complete more **repetitions** increases. Knowledge of an athlete's 1RM score can be used to plan the amount of weight to lift for the desired number of repetitions. Inversely, knowing the number of times an athlete can lift a certain weight can be used to predict their 1RM. Test for 1RM can be completed using free weights or machines, and can be conducted for a range of resistance exercises.

The following is the protocol for testing 1RM:

1 Complete a warm-up set of six to 10 repetitions. Rest for three minutes.
2 Complete a 3RM set (approximately 80 per cent of predicted 1RM). Rest for three minutes.
3 Increase the weight to 5 kg below predicted 1RM–rest for three minutes.
4 If the previous lift is successful, increase the weight by a further 5–10 per cent; if unsuccessful, decrease the weight by 5–10 per cent. Rest for three minutes.
5 Repeat this process until the maximum weight for one repetition is reached.

repetition maximum the maximum weight an athlete can lift over a prescribed number of repetitions

repetitions the number of times an exercise is completed

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Activity 7.20

Active investigation

How effective are % 1RM predictions in determining multiple repetition weights?

Note: this activity should only be completed by healthy athletes in the company of others trained in correct lifting and spotting techniques for the chosen exercise.

Engage and understand

1 Collect secondary data by conducting background research into 1RM data used by athletes in your chosen physical activity.

2 Choose an exercise to test an athlete's 1RM, preferably one that will assist in the specific development of movements in the chosen physical activity. Common examples include: bench press, squat, lat pull-down, triceps press or leg extension.

3 Allocate class members to five groups (4RM, 6RM, 8RM, 10RM, 12RM), ensuring at least one person in each group is willing and able to complete two repetition maximum tests.

Analyse and apply

4 Conduct a 1RM test using the protocol outlined previously in this chapter.

5 Use Table 7.22 on the following page to determine the recommended weight required for the allocated repetitions for your group

6 After at least 30 minutes' rest (preferably on a different day), complete as many repetitions of the exercise as you can with the selected weight.

7 Collate results from other groups.

8 Analyse and interpret the primary data by developing a series of graphs and tables that demonstrate the main findings. Some examples of graphical displays are:

- column graphs that show results of predicted and actual number of repetitions completed
- line graph representing the number of repetitions and the variance between predicted and actual repetitions.

Evaluate and justify

Evaluate: examine and determine the merit, value or significance of something, based on criteria.

9 In a paragraph, evaluate the effectiveness of a 1RM test in predicting the weight required for multiple repetition sets. Use both primary and secondary data to justify your evaluation.

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Figure 7.39 Knowing an athlete's 1RM score can be used to plan the amount of weight to lift for the desired number of repetitions.

Duration

The length of the training session or activity is known as the **duration**. Depending on the activity, this may range from five minutes to five hours. The less intense the activity, the longer the duration can be. These lengthy sessions will develop muscular endurance. Short, hard efforts are used to develop muscular strength, power and/or speed. It is important to train for a sufficient time to achieve the appropriate physiological response, whether it is for strength or endurance. A trap for some athletes is that they train for too long and do too much of a given activity, often resulting in intensities

duration length of the training session

Maximum number of repetitions performed per set	% of 1RM	To predict 1RM, multiply weight by:
1	100	1.00
2	95	1.05
3	93	1.08
4	90	1.11
5	87	1.15
6	85	1.18
7	83	1.20
8	80	1.25
9	77	1.30
10	75	1.33
11	70	1.49
12	67	1.54

Table 7.22 Testing 1RM

KEY MESSAGE Training intensity can be manipulated in a variety of ways.

KEY MESSAGE The Karnoven method of calculating % HRM accounts for individual difference.

KEY MESSAGE It is recommended that resistance training intensities are linked to percentage 1RM.

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that are below what is required to receive training benefits for the component of fitness being targeted. For example, there is little benefit in training for 60 minutes at 75 per cent intensity doing resistance training or sprint training activities when trying to target power or speed. Training should focus on appropriate quality and intensity of movement rather than quantity. Guidelines for duration are provided in the next section on training methods.

7.9 Training methods

Continuous training

continuous training sub-maximal training completed over a long period without pause

long slow distance training a form of continuous training of moderate intensity, performed over an extended duration

tempo training a type of aerobic training at or just below the anaerobic threshold

Continuous training is used mostly by low-level athletes and those training for racing endurance sports like distance running, cycling, rowing and swimming. Continuous training involves prolonged periods of repetitive exercise that is generally completed at a steady pace and lasts longer than 20 minutes. Athletes utilising continuous training would normally incorporate both **long slow distance training** and **tempo training** efforts into their training regimes.

Long slow distance (LSD) training involves exercising at an intensity that could be maintained for a very long period of time. Sometimes referred to as marathon pace, LSD training is conducted in the aerobic training zone at an intensity between 70 and 80 per cent of maximum heart rate. Training at this intensity is considered vigorous (REP of 6 or 7) and the heart rate range falls between the aerobic and anaerobic thresholds. LSD training generally last for between 30 and 120 minutes. This type of training is beneficial to an athlete, as it helps them to increase their muscular endurance and biomechanical technique. Exercising at this intensity also improves their ability to transfer oxygen and nutrients to the working muscles and their ability to utilise fat as the primary fuel source.

Continuous training at or just below the lactate threshold is called tempo training or threshold training. It requires an intensity of about 85 per cent of an athlete's maximum heart rate and is perceived as strenuous exercise resulting in an RPE of 8 as it is a comfortably hard pace. At this intensity, the body is training at or just below the anaerobic threshold and adapts by improving its ability to clear lactic acid from the muscles more effectively. Continued training at this level will result in increasing the lactate threshold and ultimately the intensity of work that can be done using aerobic energy. Because of the higher intensity, the duration of tempo training is less than LSD training.

Figure 7.40 Cyclists utilise continuous training and long slow distance training.

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Activity 7.21

Engage-in

Inquiry question: How can physiological responses be used to determine target heart rates for tempo training?

Engage and understand

1 Recall your maximum and resting heart rates determined during Activity 7.17 (on p. 419).

2 Select an appropriate continuous activity that can be completed for 10–15 minutes without interruption.

3 Select a suitable method for recording heart rate.

Apply and analyse

> *Apply: Use knowledge and understanding in response to a given situation or circumstance; carry out or use a procedure in a given or particular situation.*

4 Following a suitable warm-up, commence 10–15 minutes of exercise at your tempo pace, applying the following physiological responses as a guide:It is hard to say two or three words like 'steady pace'.

- The working muscles have a slight burning sensation.
- Your rate of perceived exertion is about 8.

5 If using a heart rate tracking device, monitor your heart rate until it plateaus or remains steady. Continue monitoring until the end and record the highest rate at which it plateaus. This will indicate your tempo training heart rate.

Note: If using the pulse counting method, determine your heart rate immediately after the exercise.

6 Conduct a warm-down at a lower intensity for three to five minutes.

7 Calculate both the % MHR and % HRR of your tempo training intensity.

8 Explain how your results compare with the suggested rating of 85 per cent intensity. Can you think of any reasons for variations?

Fartlek training

A variation of continuous training involves running at differing intensities above and below your lactate threshold by switching between, jogging, running, sprinting and even walking. **Fartlek training** is an effective training method for improving lactate threshold and the body's ability to recover from hard efforts while still working.

Derived from the Swedish word for 'speedplay', fartlek training is effective for most team sports that continuously use aerobic energy but have regular anaerobic efforts interspersed. Examples of these sports include netball, soccer and touch football. The intervals of fartlek training can be determined by marking out set distances or by using time periods of elevated intensity that can be indicated by a whistle or alarm. For example, a netball team may complete a fartlek session where they jog along the sidelines of the court

fartlek training a series of high-intensity bursts followed by low-intensity recovery periods

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high-intensity interval training (HIIT) interval training that includes periods of very high or maximal effort and longer rest periods

and sprint the baselines. Alternatively, a soccer team may complete continuous laps of the field with five-second sprints signalled after each 30 seconds of jogging. Ideally, applying the principle of specificity, the work-to-recovery ratio would replicate distances and the ratio of high-intensity work to lower level recovery would be similar to that found during competition for the targeted physical activity. For example, Figure 7.41 replicates the periods of continued aerobic movements in high-intensity sprints interspersed throughout. This replicates the physical demands of a netball player who would be tracking a defender off the ball before sprinting to get an intercept and establish court position.

Interval training

Interval training is another method used when training the anaerobic energy systems. It incorporates defined periods of exercise followed by periods of rest. Well-trained or elite athletes would benefit more from using interval training compared with continuous or fartlek. It allows the athlete to complete multiple high-intensity (above 95 per cent) training efforts to produce adaptations in strength and speed. The intensity and duration associated with intervals should be specific to the physical activity. The rest periods adhere to the recommended work-to-rest ratios associated with the predominate energy systems involved.

KEY:
Jog (60% RPE)
Sprint (95% RPE 9)

Distance runner:
800 m jog at 70% (RPE 6)
100 m fast jog at 85% (RPE 8)
800 m at 70% (RPE 60)
200 m intense run 90% (RPE 9)

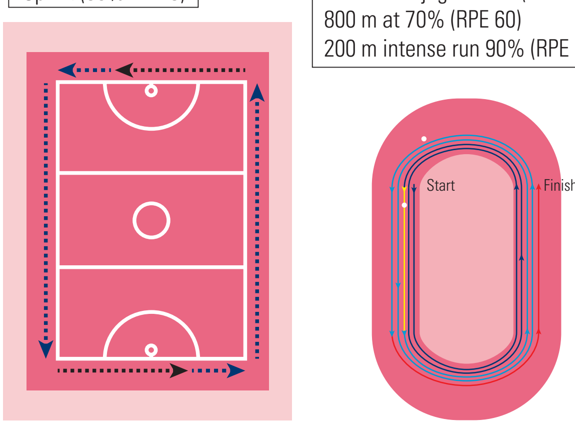

Figure 7.41 Fartlek training examples

Figure 7.42 High-intensity interval training includes periods of high-intensity efforts followed by periods of rest.

One of the most effective forms of training for improving physical performance in athletes is known as **high-intensity interval training (HIIT)**. As the name suggests, it includes periods of high-intensity efforts followed by periods of rest. HIIT training sessions can encompass a range of exercises, but may only last for 20–30 minutes. If completed properly, HIIT produces physiological adaptations similar to continuous training sessions with double or triple the duration. Unlike other types of training, HIIT produces increases in both anaerobic and aerobic capacities. Aerobic adaptations as a result of HIIT include increases in stroke volume, cardiac output and ultimately VO_2max. Although the exercise is conducted above the anaerobic threshold, the cardiovascular system reacts during the rest period in order to clear lactic acid and replenish the energy stores in the muscles in preparation for the next bout of high-intensity exercise. Prolonged exposure to this stress results in increased efficiency and shorter recovery times. Another benefit of HIIT is that the muscle tissues develop a greater density of mitochondria, allowing for more ATP to be produced. To achieve benefits associated with HIIT, it is essential that adequate recovery times are used between both training sets and training sessions. Without proper recovery, athletes will be unable to push themselves to maximal effort required for the gains associated with HITT.

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Energy system	Intensity (%)	Duration	Work-to-rest ratio
ATP-PC	95–10	5–10 seconds	1:12 to 1:20
Lactic acid	80–95	15–30 seconds	1:3 to 1:5
Aerobic	65– 80	60–180 seconds	5:1 to 1:2

Table 7.23 Work-to-rest ratios for specific energy systems

A specific form of HIIT is **sprint interval training** (SIT). Most commonly associated with cycling and running or rowing, SIT involves periods of sprinting interspersed with periods of active recovery. An example of a SIT workout would involve exercising flat out for 30 seconds and then completing active rest for three minutes before repeating.

Another variation of interval training is **aerobic interval training**. In contrast to HIIT, aerobic interval training focuses on longer duration intervals of work with shorter recovery periods. This type of training is effective at rapidly building aerobic endurance. Generally, work intervals range from two to five minutes and are conducted as close to the anaerobic threshold as possible. This is followed by a much shorter rest period of 30 seconds to one minute and repeated throughout a workout that usually lasts for approximately 30 minutes.

sprint interval training a form of HIIT that involves bursts of sprinting interspersed with rest

aerobic interval training interval training performed with longer durations and shorter rests, with intensities close to the anaerobic threshold

KEY MESSAGE

Continuous, fartlek and interval training can target different training zones.

KEY MESSAGE

Training at or above the anaerobic threshold will produce the greatest aerobic gains.

KEY MESSAGE

Adequate recovery time is required between very high-intensity efforts.

Activity 7.22

Active investigation

RECOGNISE & EXPLAIN | ANALYSE & SYNTHESISE | EVALUATE | JUSTIFY | MAKE DECISIONS

Inquiry question: How do heart rates fluctuate during HIIT and aerobic interval training?

Note: This activity should only be completed by healthy athletes in the company of others.

Engage and understand

1 Select at least two members of the class with comparable fitness levels to complete the interval training protocols on the following page.

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2 Determine a suitable mode of exercise (cycling, running, rowing) that both students can use to maintain consistency.

3 Determine a suitable method to record heart rate data at key points throughout the session – for example, record heart rates:

- at the start, middle and end of each rest period for the HIIT participant(s)
- at the start, middle (if possible) and end of each work period for the aerobic interval participant(s).

4 Collect secondary data by conducting background research into predicted fluctuations in heart rates during interval training.

Interval training protocol

HIIT protocol		Aerobic interval protocol	
Time (minutes after start)	**Intensity**	**Time (minutes after start)**	**Intensity**
0:00–0:30	Maximal effort	0:00–3:00	RPE 8
0:30–4:30	Rest	3:00–3:30	RPE 6
4:30–5:00	Maximal effort	3:30–6:30	RPE 8
5:00–9:00	Rest	6:30–7:00	RPE 6
9:00–9:30	Maximal effort	7:00–10:00	RPE 8
9:30–13:30	Rest	10:00–10:30	RPE 6
13:30 – 14:00	Maximal effort	10:30–13:30	RPE 8
14:00–18:00	Rest	13:30–14:00	RPE 6
18:00–18:30	Maximal effort	14:00–17:00	RPE 8
18:30–25:00	Gradual cool down	17:00–17:30	RPE 6
		17:30–20:30	RPE 8
		20:30–25:00	Gradual cool down

Analyse and apply

5 As a class, instruct the athlete through their respective interval training and record their heart rates in a suitable table.

6 Calculate each athlete's 85 per cent target heart rate using either the MHR or Kavonen method.

Examine: Investigate, inspect or scrutinise carefully; inquire or search into; consider or discuss critically an argument or concept in a way that uncovers the assumptions and interrelationships of the issue.

7 Examine the primary data by developing a combined line graph showing the fluctuations of heart rates during the two types of interval training.

(continued)

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Evaluate and justify

Evaluate: Examine and determine the merit, value or significance of something, based on criteria.

8 In a paragraph, evaluate the effectiveness of each training protocol for each athlete. You should use primary and secondary data to justify your evaluation.

With any type of interval training, variations to duration, intensity and/or volume of work or rest will ensure that this training method meets both the fitness demands of the physical activity (specificity) and the fitness levels and goals of the individual (individuality). Interval training modifications to account for specificity and individuality include:

- varying the *duration* of the work interval
- varying the *intensity* of the work interval
- varying the duration of the rest interval
- varying the *volume* of the training (the number of times each interval is repeated).

Circuit training

An effective method of developing a range of fitness components and game-based skills in one session is the use of **circuit training**. The name 'circuit training' refers to how the session is set up rather than the types of exercise involved. Typically, a variety of exercises are completed in a given timeframe or following a prescribed number of repetitions. Completing multiple stations with minimal rest periods in between maintains a high heart rate and results in both strength and aerobic conditioning being completed in the one training session.

A well-balanced circuit would allow for continued high-intensity workout without the risk of muscular fatigue. This is achieved by ordering stations in a way that allows activated muscle groups a chance to rest before they are required again. That is, it would be good to follow body weight squats with an upper-body exercise like push-ups or a core exercise like plank holds rather than another leg exercise.

circuit training
training that involves progressing through a number of exercise stations

Circuit training can take many forms, based on the availability of equipment, the specific requirements of the physical activity and the individual needs of the participants. The difficulty of the circuit can be manipulated through:

- increasing the volume (adding more stations or the number of times the circuit is completed)
- increasing the duration of stations
- increasing the intensity of work required at each station (adding weight, increasing distance or height)
- reducing the rest time between each station.

Figure 7.43 Circuit training

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Type of circuit	Body weight/free weight	Gym	Sport-specific (basketball)
Instructions	• 30 seconds work • 30 seconds rest • Complete as many repetitions as possible • Complete two rounds	• Work with a partner – reps working – reps rest (partner working) • Move to station after both have finished one set • Complete four rounds	• 45 seconds work • 15 seconds rest • Complete as many repetitions as possible • Complete two rounds
Order of exercises	1 Push-ups 2 Bicep curls (dumbbells) 3 Crunches 4 Front squats (barbell) 5 Bench dips 6 Back extensions 7 Tuck jumps 8 Upright row (dumbbells) 9 Laying leg raises 10 Weighted lunges (dumbbells) 11 Medicine ball twists 12 Burpees	1 Bench press 2 Seated row 3 Leg press 4 Hamstring curls 5 Lat pull-down 6 Shoulder press	1 Lay-up drives (return to outside three-point line) 2 Continuous board touches 3 Through-the-legs dribble (sideline to sideline) 4 Feet shuffles from restriction circle to outside the three-point line 5 Dribbling through cones (left hand up, right hand back) 6 Set shots from the corners 7 Shuttle runs (base line to top of key) 8 Dribbling court laps (jog the sidelines and sprint the baselines)

Table 7.24 Examples of circuit training

Activity 7.23

Check-in

1. Explain the two different methods used in circuit training to progress athletes from one station to the next.
2. Why is it important to consider the order of exercises in a circuit?
3. In groups of two to four, design a 20-minute circuit training session that incorporates at least 10 different stations and would develop the performance capabilities of the students in your class. Consider the type, intensity and duration of each training activity. Clearly explain how you incorporated the principles of specificity and individuality into the circuit.
4. For each activity in your circuit, explain one way in which progressive overload could be applied.

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Flexibility training

Some sports, such as gymnastics, swimming and dancing, and some athletics events require intensive flexibility training to increase the normal range of motion around a joint for the athlete to perform at a high level. Many other athletes require flexibility training to maintain a normal range of motion. One of the contributing factors to impaired range of motion around a joint is muscle tightness. Training that helps to minimise this tightness is important, because it:

- improves movement capacities and resultant performance
- reduces the chance of injury
- improves posture and muscle balance.

Static stretching is a method of gradually releasing tightness and increasing the length of the muscles while the body is at rest. The ideal intensity of a static stretch is the point where the athlete feels mild discomfort but never pain. The end point of these stretches should be held for between 15 and 30 seconds. Athletes such as gymnasts and dancers, who depend on high levels of flexibility, would benefit the most from these stretches. However, this type of flexibility training is not recommended when preparing for a performance that involves running or jumping. Studies have shown decreases in muscle strength and power immediately after static stretching. Furthermore, static stretching is beneficial when completed five to 10 minutes after a workout or performance. This is because muscles and tendons all have greater elasticity following exercise, when the increased movement and blood flow have made these tissues more pliable. As a result, the extra tension provided through static stretching at this stage will produce greater adaptions in flexibility.

Another, more strenuous, method of flexibility training is known as **proprioceptive neuromuscular facilitation** (PNF) stretching. This involves engaging the use of a partner or fixed resistance to further increase the range of motion of a joint. A typical PNF stretch would involve stretching and holding the target muscle or group of muscles to the point of mild discomfort before activating it against a resistance. This resistance can come in the form of a partner, a stretching band, a towel or even a bench. Following the activation phase, the muscles are relaxed and the joint is extended through a slightly greater range of motion. Due to the more intense nature of this stretch, only one stretch per muscle group is required, and a rest period of up to at least 48 hours should be allowed between PNF stretching routines.

proprioceptive neuromuscular facilitation advanced flexibility training that involves both stretching and contracting the muscle

Figure 7.44 Static stretching gradually releases muscle tightness.

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	PNF hamstring stretch	Method
Partner as resistance		1 With one leg remaining flat on the ground, extend the leg to be stretched until a mild discomfort is felt in the hamstring. Hold this position for 10 seconds.
Band as resistance		2 Activate the muscle by pushing against the resistance for six seconds. The resistance should be strong enough to prevent movement.

Table 7.25 Hamstring stretches

The majority of athletes participating in active, fast-paced sports such as tennis, volleyball, soccer, netball, basketball and touch football would incorporate **dynamic stretching** into their training routine. Dynamic stretching involves gradually and repeatedly moving parts of the body in a controlled manner through their full range of motion. Leg swings, walking lunges and arm swings are all examples of dynamic stretches. A dynamic stretching routine that mimics the movements associated with the physical activity is the most beneficial form of stretching to be used prior to training or a game. Dynamic stretching is beneficial because it:

- increases blood flow to the muscles and joints
- prepares the body for the movements involved in the activity
- improves efficiency and performance
- minimises risk of injury.

Resistance training

A form of exercise that incorporates specific muscle contractions to move or hold weight is known as resistance training. Resistance training is key for athletes wishing to develop muscular strength, muscular power, muscular endurance or **hypertrophy**.

dynamic stretching the use of momentum and active muscle contractions to increase a joint's range of motion

hypertrophy an increase in muscle size

isotonic contractions when the length of a muscle changes when contracting

Types of muscular contractions

Muscle contractions during exercise can be categorised as isotonic, isometric or isokinetic. **Isotonic contractions** are the most common type of contraction used in resistance training.

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Activity 7.24

Engage-in

Inquiry question: How much increased range of motion can be gained through PNF stretching?

Engage and understand

Note: Stretching should always be completed to the point of discomfort but never pain.
A goniometer is a device that measures the range of motion at a joint. If one is not available, there are many instructional videos on YouTube that show how to make your own. There are also applications for smart devices that conduct these measurements.

1 Familiarise yourself with the hamstring PNF stretch protocol outlined on the previous page.

2 When laying on your back, use a goniometer to measure the range of hip flexion when completing:

  a an active stretch (moving the muscle to its full range of motion without assistance)

  b a passive stretch (use the assistance of a partner or band to progress the range of motion).

3 Record the results for both legs.

Apply and analyse

Investigate: Carry out an examination or formal inquiry in order to establish or obtain facts and reach new conclusions; search, inquire into, interpret and draw conclusions about data and information.

4 Use the protocol in Table 7.25 on the previous page to measure the range of hip flexion produced following the activation phase.

5 Represent your data by using a column chart comparing the active, passive and PNF range of motion.

6 Calculate the percentage increases from:

  a the active-to-passive stretch

  b the passive-to-PNF stretch.

This type of contraction is defined by the constant tension applied throughout the movements, and can further be classified as concentric contractions and eccentric contractions. Traditional bicep curls, triceps extensions, leg extensions and hamstring curls are all examples of *concentric contractions*, as the muscles producing the movement shorten as they contract.

These contractions are the most common in resistance training. For example, when completing bicep curls, the bicep muscle shortens as it contracts and produces flexion at the elbow. On the other hand, *eccentric contractions* involve the muscles lengthening as they contract. Eccentric bicep curls typically use assistance to lift a heavy weight so that the elbow is flexed before slowly lowering the weight unassisted. The controlled lowering of the weight is achieved through the constant contraction of the muscle as it lengthens, and the elbow extends. It is believed that the heavier weights and slow, controlled nature of eccentric contractions result in increases in strength adaptations due to the more intensive damage done to the muscles. However, as the resistance force

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Figure 7.45 Plank holds are an example of isometric exercise.

lengthening the muscle is greater than the force being produced to shorten the muscle, there is an increased risk of injury.

Isometric contractions refer to muscle contractions that do not produce changes in muscle length. Most notably, these contractions involve holding the body or object in a specific position for a period of time. Examples of isometric exercises would include plank holds and wall sits, as the body is not moving but the muscles are constantly contracting to maintain its position. Isometric exercises have been shown to improve strength; however, these gains are restricted to the muscles activated during the holding phase. Typically associated with the development of core strength, it is recommended that isometric training complements other training types that involve moving joints through a range of motion.

Isometric contractions when a muscle contracts but its length does not change

isokinetic contractions a type of muscular contraction where the muscles remain in motion

Finally, **isokinetic contractions** involve muscle contractions that move the limbs at constant speed throughout a movement. Although a range of movement is possible, this type of contraction is rare in sports. It is mostly reserved for rehabilitation as the force exerted by the muscles can be controlled more closely.

Sources of resistance for training

The source of the resistance during training is generated in four main ways:

- body weight
- resistance bands (therapy bands, resistance tubes, flat bands)
- weight machines (pin loaded, plate loaded)
- free weight (dumbbells, barbells, kettle bells, medicine balls).

Body weight and resistance band training are simple and effective ways of completing high-repetition, low-intensity training. Added benefits of these two methods of training are that they are cheap and can be done almost anywhere with limited specialist equipment. This type of training is most beneficial for athletes wanting to improve their muscular endurance or during recovery periods. However, if an athlete wanted to train at higher intensity in order to gain increases in strength, size and power, more substantive resistance would be needed in the form of weights. Weight machines are designed with specific movements in mind, and the amount of weight can be changed by inserting a pin into a weight stack or adding addition weight plates. These are recommended for beginners as the guided movements minimise the risk of joints being placed in unstable or dangerous position. Free weights, including dumbbells, barbells and kettle bells,

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Advantages	Disadvantages
• No cost • Can be completed in most places • Minimal equipment required for a range of exercise.	• Insufficient weight to train at higher intensities • Can only make slight variations to intensity as this is determined by the body weight of the individual



Table 7.26 Body weights as a method of resistance training

Advantages	Disadvantages
• Relatively cheap • Can be completed in most places • Can be used for a variety of exercise • Can make moderate variations to intensity by using thicker bands.	• Insufficient resistance to train at higher intensities • Variable resistance makes it harder to complete the end phase of movement • Potential for injury if the band snaps or is released from an anchor point.

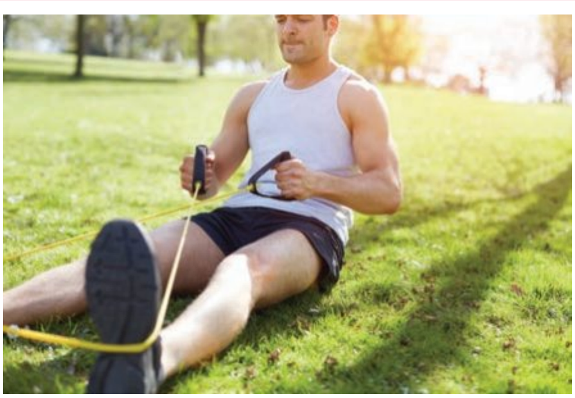


Table 7.27 Resistance bands as a method of resistance training

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Advantages	Disadvantages
• Stable movements make them safer for beginners to use • Can overload to high intensities	• Expensive • Limited to specific muscle groups • Take up a lot of space



Table 7.28 Machine weights as a method of resistance training

Advantages	Disadvantages
• Wide range of exercises that cater to whole body workouts • Are available in various weights to effectively overload intensity • Can be used and stored in limited space	• Can be expensive to purchase sets with ranges of weights • Can be hazardous if correct technique is not maintained • May cause clutter in the gym space.



Table 7.29 Free weights as a method of resistance training

are preferred by more experienced athletes, as they require the additional activation of stabilising muscles and therefore result in more functional strength gains.

Specific resistance training goals

When incorporating resistance training into a fitness program, it is important that the training is specific to the athlete's desired training adaptations. The specific adaption goal of resistance training determines the intensity, volume, duration and rest associated with their training. For athletes wishing to develop their strength, higher intensities (% 1RM) are required. However, due to the large amount of physiological stress placed on the body, only a limited number of repetitions can be completed. Furthermore, a greater period of rest between both sets and sessions is required to allow for sufficient recovery.

In comparison, training to improve muscular endurance on the other hand is exemplified by more repetitions using much lighter intensities. Although the volume is similar, the lower intensity results in a shorter rest time between sets. Finally, hypertrophy training involves a higher training volume while maintaining a relatively high intensity. The slow, controlled contractions result in the ability to complete more repetitions per set and more sets

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during a session. This method is considered optimal in producing increased **muscle fibre recruitment**, which is essential for muscle growth.

Training for power involves manipulating the balance between the resistance intensity and the speed of muscular contraction. Typically, the intensities required when training muscular power are less because the explosive speed with which the muscles are contracted to complete each repetition is much faster. Training in this way also inflicts large amounts of physiological stress on the body, which limits the number of effective repetitions (volume) and requires similar rest periods to strength training.

muscle fibre recruitment the increased use of muscle fibres as a result of resistance training

	Load (%1RM)	Speed of contraction	Repetitions	Sets	Rest
Muscular strength	Very heavy > 70–85%	Moderate to slow	1–6	2–6	2–5 mins
Muscular hypotrophy	heavy >85%	Moderate	6–12	3–6	2–3 mins
Muscular endurance	Moderate or light 50–70%	Moderate	15+	2–3	1–3 mins

Table 7.30 Weight training guidelines

Method	Description	Load (%1RM)	Sets	Reps	Rest	Example of sport that uses this method
Speed-strength method	Light resistance, focus on fast acceleration	10–20	5–15	6–10	30 sec–2 min	High jump
Strength-speed method	Balance between fast acceleration and heavy resistance	30–70	5–20	3–10	30 sec–2 min	Rugby League
Maximum explosive strength	Slow acceleration, focus on very heavy resistance	80–100	5–15	1–5	2–10 min	Olympic lifting

Table 7.31 Weight power training methods

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Functional movement	Exercise	Muscle groups trained
Jumping and running	Squats and Olympic lifts	Gluteals, quadriceps and hamstrings
Kicking	Leg (knee) extensions and legs raises	Quadriceps and his flexor
Pushing or throwing forwards	Bench press, flat dumbbell fly and triceps pushdown	Pectoral and triceps
Pulling	Lat pull-down and seated row	Latimus dorsi, rear deltoid and other back muscles
Twisting, bending and straightening the trunk	Various Swiss ball or Pilates exercises	Abdominal, transverse abdominal, obliques and erector spine

Table 7.32 Specificity and exercise selection

Plyometric training

Plyometric training is a specific type of high-impact training that is used to develop strength, speed and power. It includes movements that require rapid force production, such as power jumping and bounding.

Plyometric exercises all have a period of rapid deceleration where the muscles are lengthened as they contract (eccentric contractions), followed by a period of rapid acceleration where the muscles shorten as they contract (concentric contractions).

Imagine that an athlete is trying to jump as high as they can; naturally they are going to bend down by flexing their knees immediately before jumping. As the knee is being flexed, the quadriceps muscle is responsible for controlling the motion and contracts eccentrically on the way down. At the bottom of the movement, the quadriceps quickly become the main force for extending the leg and contracts concentrically as knee extends and pushes the body vertically. If this movement is completed quickly, the elastic energy stored in the muscle during the eccentric phase is transferred into a greater concentric force and ultimately a higher jump. This is known as the stretch shortening cycle, as it involves the same muscles being stretched before shortening to produce a movement. For greater intensities, well-trained athletes may increase the intensity of their training by increasing the continuation of the exercise, incorporating resistance or using gravity to increase the load during the deceleration phase.

plyometric training a form of training that involves jumping and bounding

Increases in maximal force production do not occur if the muscles are fatigued. Plyometric training, like other forms of high-intensity training, should be completed no more than two or three times per week with adequate rest days in between. Between each set, one to two minutes of rest or a work-to-rest ratio of 1:10 is required. In terms of training volume, it is not recommended that the number of explosive ground contacts exceed 80–100 repetitions for a young athlete and 120–140 for an experienced adult athlete. Training progressions should focus on increasing the volume of the training load before increasing the frequency or intensity. This will ensure that the athlete has sufficient technique and neuromuscular control over the movement. Common plyometric exercises include:

- *box jumps* – jumping from the ground onto a raised box or platform
- *depth jumps* – dropping off a box or platform, landing, then jumping again
- *bounding* – continual single or double leg jumping without pause; can be completed as a means to traverse a distance or over stationary lines/objects
- *dynamic push-up* – completed like a normal push-up but with an explosive force lifting the hands off the ground before landing again.

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Activity 7.25

Active investigation

Inquiry question: How does the intensity of load in the stretch shortening cycle impact vertical jump height?

Note: This activity should only be completed by healthy athletes in the company of others.

Engage and understand

1 As a class, become familiar with a suitable protocol for determining vertical jump heights.

2 Conduct a suitable warm-up with specific focus on the activation and mobilisation of the leg joints and muscles.

Analyse and apply

3 Measure the vertical jump of each athlete using the following protocol variations:

- **a** *Load–unload jump:* Starting in an upright position with arms straight up above the head, flex at the knees and hips into a squat position before immediately jumping as high as possible. This should be a fluid movement with no pause. Record the results.
- **b** *Load–pause–unload jump:* Following adequate rest, assume the same starting position as the test above. This time, lower the body into the squat position and hold for three seconds before jumping as high as possible.
- **c** (Optional) *Increased load–unload jump:* Set the test up so that the athlete can record their jump height after dropping off a 30 cm high box or platform. Assume the same starting position as above, this time standing on the box or platform. Step off the box and land on two feet and continue with the downward motion into the squat position before immediately jumping back up as high as possible. This should also be a fluid movement with no pause. Record the results.

4 Analyse and interpret the primary data by developing a series of graphs and tables that demonstrate the main findings. Examples of graphical displays could include:

- column graphs that show results of the jump heights following the three different protocols
- tables showing the percentage increase or decrease between protocol i. and the other protocols.

Evaluate and justify

Justify: Give reasons or evidence to support an answer, response or conclusion; show or prove how an argument, statement or conclusion is right or reasonable.

5 Evaluate the impact that the pause during the technique and dropping from height have on the force production of the legs and overall jump height. Use both primary and secondary data to justify your response.

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Circuit training and resistance training are both effective in conditioning muscles for physical activities.

Muscle contractions can be categorised based on the movement of the muscles when contracting.

Plyometric training uses the stretch shortening cycle to generate great muscular force.

Inquiry cycle B – stages 2 & 3: Apply and analyse; Evaluate and justify – training

7.10 Designing and evaluating training programs

All good training sessions involve the following three key components: the warm-up, the conditioning phase and the cool down. The duration of worthwhile warm-up and cool down sections of a training session are likely to be constant. Therefore, varying the duration of a session directly impacts the length of the conditioning phase.

The warm-up

Warming-up properly before physical activity is essential to prepare the body for the anticipated physical demands. An effective warm-up is beneficial, as it improves physical performance and reduces the risk of injury. Specifically, completing a 10–15 minute warm-up before a game will result in an increase in the physiological and psychological readiness of the athlete. In 2007, Dr Ian Jeffreys suggested that the structure of an effective warm-up should follow the RAMP protocol, which recommends that a warm-up should comprise three important sequential phases.

Phase 1	R	Raise the heart rate
Phase 2	A	Activate key muscle groups
	M	Mobilise key joints
Phase 3	P	Prepare to perform

Table 7.33 RAMP protocol

Phase 1: Raising the heart rate

Raising the heart rate of an athlete results in an increased blood flow around the body. In particular, muscles receive more blood. Traditionally, this involved completing arbitrary laps of a court or field at a slow pace. However, due to the lack of specificity, this is not considered time efficient. Rather, a series of low-intensity dynamic movements more closely related to the demands of the activity should be incorporated. These could include:

- dynamic run-throughs (10–20 m) – for example:
  - high knees
  - fast feet
  - heel cycles/butt kicks
  - power skips
  - grapevine
  - sideways shuffle steps
- planned change of direction movements – for example:
  - weaving drills
  - cutting drills.

Figure 7.46 Dynamic stretches incorporated into a warm-up prepare the body for the conditioning phase of the training session.

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Increases in heart rate and subsequent increases in blood flow are important, as the working muscles receive the required oxygen and nutrients. Additionally, increasing the blood flow to muscles also increases the internal temperature of muscles, and means they are more elastic and able to contract faster and with a greater force. Another benefit is the release of synovial fluid within the joints. This acts as a lubricant and allows joints to move more freely during exercise.

Phase 2: Activating and mobilising

The activation of muscles and the mobilisation of joints during this phase should be related directly to the movements required during the physical activity. For example, if a physical activity involves running, it would be essential to activate the necessary muscles to mobilise the hip, knee and ankle joints. This could be achieved by completing a series of dynamic movements such as lunges, squats, tuck jumps or leg swings that progressively take the joints through their full range of movement.

The major advantage of this phase of the warm-up is that it further reduces the risk of injury and prepares the neuromuscular pathways for the anticipated movements. That is, there is more efficient communication between the nervous system and the muscles that are being activated. This results in faster and stronger muscular contractions during a performance. This is also the phase of warm-up where athletes would incorporate any specific exercises that they require as part of a recovery or injury-prevention protocol.

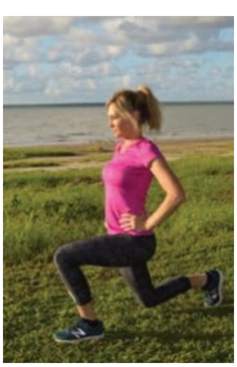
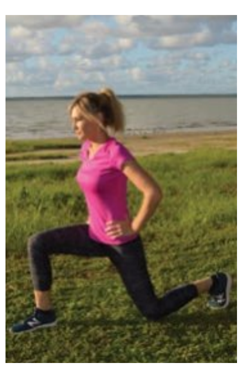
Dynamic movement	Target muscles	Technique
Inchworm  	Hamstrings, gluteus maximus, gastrocnemius, soleus, erector spinae	• Start with feet and palms flat on the ground and the body making a V shape with the buttocks in the air. • While keeping the feet still, slowing walk the hands out until the body is in the push-up position. • Walk the feet in towards the hands to return to start position.
Lunge walk  	Quadriceps, hamstrings, gluteus maximus	• Take a large step forward, planting the front foot flat and facing forward. • Keeping the torso vertical, flex the front knee and hip as the back knee is lowered to the ground. • Stand up with feet together and then repeat with the opposite foot forward.

Table 7.34 Dynamic movement techniques

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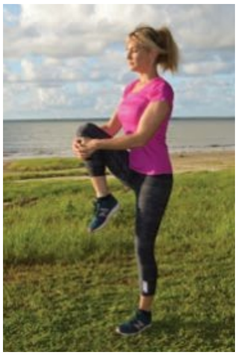
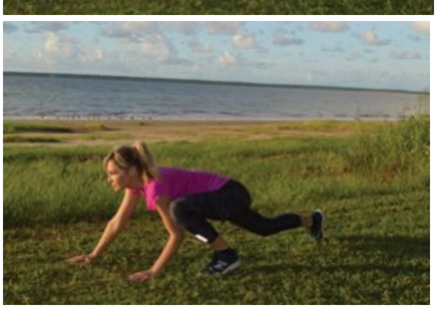
Dynamic movement	Target muscles	Technique
Knees to chest  	Gluteus maximus, hamstrings	• Stand upright with feet shoulder width apart. • Take a small step forward. • Flex the rear leg at the hip and knee. • Use both hands to grip the shin and raise the knee further towards the chest while maintaining a vertical spine. • Lower the leg and complete a small step forward. • Repeat with the opposite leg.
Inverted hamstring stretch  	Hamstrings, gluteus maximus, erector spinae, hip adductors, hip abductors	• Stand upright on one foot and raise the arm on the same side up above your head. • Keep the back straight and flex at the hips. Push the raised leg backwards. • When the stretch is felt, slowly return to the starting position.
Spiderman plank crawl  	Internal obliques, external obliques, erector spinae, gluteus maximus, hamstring, quadriceps, gastrocnemius, biceps femoris	• Start in a push-up position with straight arms. • Simultaneously move one arm forward while externally rotating the opposite leg and moving the knee towards the outside of the stationary elbow. • Continue with the opposite arm and knee.

Table 7.34 *(continued)*

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Dynamic movement	Target muscles	Technique
Lying leg crossovers  	Hip adductor muscles, gluteus medius, gluteus minimus, erector spinae, internal obliques, external obliques	• Lie flat on your back (supine position) with arms out to the side. • Lift one leg and slowly lower the leg to the ground on the other side of the body. • Keep shoulders flat on the floor. • Return to start and repeat on the other side.
Scorpions  	Erector spinae, hip abductors, Internal obliques, external obliques, gluteus maxims, quadriceps	• Start by lying face down (prone position) with arms out to the side. • Bend one leg at the knee and lift off the ground. • Slowly lower the leg to the ground on the other side of the body. • Keep shoulders flat on the floor. • Return to start and repeat on the other side.
Arm swings  	Latissimus dorsi, anterior and posterior deltoids, pectoralis major	• Stand upright with feet shoulder width apart and one arm extended out to the side of the body and other flexed across the chest. • Alternate arm positions continuously.

Table 7.34 *(continued)*

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Dynamic movement	Target muscles	Technique
Side bends 	Latissimus dorsi, internal and external obliques	• Stand upright with arms by the sides. • Slowly slide one arm down the side of the thigh towards the knee. • Bring the other arm up overhead. • Hold for one second before returning to the start position and repeating on the opposite side.
Open and close the gate 	Transverse abdominis, gluteus maximus	• Stand on two feet with hands on hips. • Raise one leg so the thigh is parallel and making a right angle to the torso. • Externally rotate the hip joint so the knee is facing out to the side and lower the foot. • Raise the same leg back up to a right angle and internally rotate until back in front of the body. • Return to the start and repeat on opposite leg.

Table 7.34 *(continued)*

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Badminton warm-up

Raising the heart rate

Progress through the following court run procedure starting at position A

1 Run from A to B
2 Run from B to C
3 Back step from C to A
4 Side step right from A to D
5 Run from D to B
6 Run from B to E
7 Back step from E to D
8 Side step left from D to A

Intensity: Progressing from 50% to 80%
Duration: complete 8–10 sets with 1:1 work:rest ratio

Activate and mobilise

Complete 10 times per side

1 Leg swings
2 Lying leg crossovers
3 Scorpions
4 Arm circles

Complete across the court and back

5 Lunge walk
6 Knees to chest
7 Inchworms
8 Spiderman crawl

Preparation

Partner drills
Completed 20 times each

1 Net shots
2 Overhead clears
3 Underarm clears

Combinations
Completed 10 times each

4 Clear to drop shot
5 Short serve to clear to smash

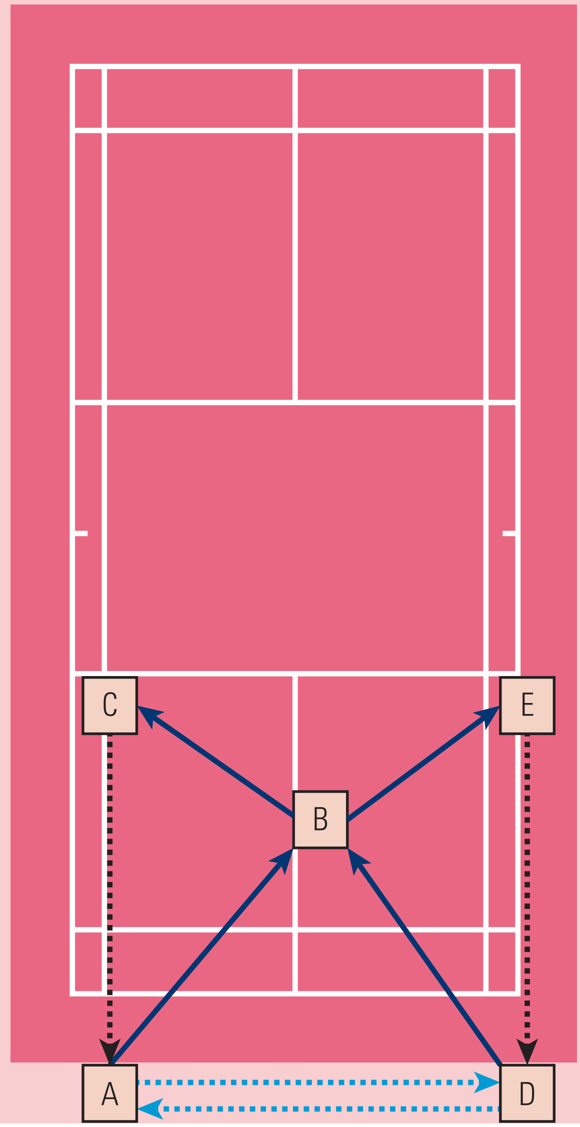

Figure 7.47 Badminton training – an example of the three phases

Phase 3: Preparation

The preparation phase incorporates drills or skills that would be required during the performance. This is the most specific phase of a warm-up and would likely involve the use of equipment required for a competition. For example, a touch football team would likely set a drill where they could practise passing and catching at pace. This phase not only amplifies the muscle memory required for the skills of the sport but also assists in regulating arousal and concentration levels.

Conditioning

The conditioning phase of a training session is where specific and individualised training activities occur. These activities should clearly reflect the specific goals of teams and/or individuals, and can include a combination of sport-specific conditioning, skill development and strategy development. Planning considerations should include the ability of the athletes, timing within the season, the available equipment and the order of exercises.

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Activity 7.26

Engage-in

Inquiry question: What is involved in an effective warm-up for a chosen physical activity?

Engage and understand

1 List the key physical movements required of a selected physical activity (e.g. running).

2 Describe the key joint movements involved in these actions (e.g. knee extension).

3 Identify the key muscle groups responsible for the joint movements (e.g. knee extension produced by quadriceps).

Apply and analyse

Apply: Use knowledge and understanding in response to a given situation or circumstance; carry out or use a procedure in a given or particular situation.

4 Apply RAMP protocol to design an effective warm-up that targets the specific requirements of your physical activity.

5 Complete the warm-up individually or as a group.

6 Analyse the effectiveness of the warm-up using a SWOT analysis.

Strengths	Opportunities
Threats	Weaknesses

It is recommended that high-intensity training efforts should be completed at the start of the session. This is because the body's ability to produce high-intensity efforts will reduce due to fatigue. For example, an athlete may struggle to reach top speed during sprint intervals if they have previously completed lower intensity threshold training. The local fatigue and accumulation of lactic acid resulting from the threshold training would inhibit the ability to generate maximum force. Likewise, plyometric exercises such as box jumps and depth jumps are much less effective in stimulating power adaptations if completed under conditions of fatigue.

In terms of resistance training, complex multiple joint movements activating large muscle groups should be performed first. That is, exercises like squats and bench press or power movements like the Olympic lifts should be completed before any isolation exercises completed on smaller muscles. The athlete's performance during a bench press will clearly be inhibited if their triceps are fatigued from previously completing isolated triceps extension.

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This is because the damage already inflicted on the triceps muscles would stop them from generating the required force to support the high-intensity effort produced by the non-fatigued muscles.

Although fatigue is not ideal for developing specific strength and power adaptations, it is useful when developing sport-specific endurance. For example, a volleyball coach may decide to incorporate jump-specific plyometric training at the end of their training session. Even though this is not going to efficiently improve the athlete's leg power and respective jump height, it will serve the purpose of replicating a game scenario where jumping is required even when fatigued. This same concept is often also used when executing set plays or essential skills. That is, athletes may be required to practise specific skills and solve problems while fatigued as this will prepare them for periods late in performance situations where effective decisions and execution are vital skills.

Cool down

Effectively cooling down following a training session is important to aid recovery and reduce the risk of injury. Typically, a cool down comprises a low- to moderate-intensity continuous activity for at least five to 10 minutes, followed by 5 to 10 minutes of static stretching. Low- to moderate-intensity continuous exercise at the end of a training session ideally replicates the activity that has just been completed. An effective cool down routine can aid the body's recovery in numerous ways.

First, it facilitates the effective recirculation of blood that has pooled in the lower limbs during the exercise. Obviously, active muscles require greater blood flow to supply oxygen and nutrients. If vigorous activity suddenly ceases, the majority of this excess blood remains in these muscles. This can result in periods of dizziness and even fainting as a result of not enough blood returning to the heart and then the brain.

Additionally, this continued circulation of blood is an essential method of clearing lactic acid from the active muscles. By doing this, an athlete can minimise muscle soreness and speed up recovery times. Static stretching following a workout is important for reducing muscle tension and returning muscles back to their resting length. Static stretching is most effective during a cool down, as the muscles are already warm and more likely to produce a greater range of motion. When completing static stretches, it is recommended that the stretch order progresses up the body from the feet. More time may be spent on the main muscle groups being activated as a result.

Activity 7.27

Check-in

1 Recall the benefits of completing low-intensity continuous activity following a game or training session.
2 Explain the benefits of completing static stretches as part of a cool down.
3 What is the recommended timeframe for holding a static stretch?
4 Construct a list of static stretches you would use when cooling down in a selected physical activity. Remember to order stretches from the bottom to the top of the body.

KEY MESSAGE

The RAMP protocol is an effective guide to follow when designing warm-ups.

KEY MESSAGE

High-intensity conditioning exercises should be placed prior to fatigue at the start of a session.

KEY MESSAGE

Low-intensity continuous activity during the cool down is essential for clearing lactic acid from the working muscles.

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Designing a training program

In order to ensure that athletes are performing their best during competitions, a well-structured training plan is required. For athletes competing across a season, a long-term annual plan is usually developed. Sometimes referred to as a **macrocycle**, an **annual plan** is designed to ensure that athletes have the best chance of achieving their goals. Specifically, annual plans work towards having the athlete peaking during the most competitive periods of the season. To facilitate this, the annual plan is segmented into different training phases using the concept of **periodisation**. Each training phase, or 'period', has a specific focus identified to progress the athlete towards peaking at the essential time.

macrocycle a complete training cycle from start to finish

annual plan a year-long macrocycle that varies training in response to competition and non-competition phases, as well as targeting times when peak performance is required

periodisation process of using blocks of training to systematically develop an athlete's fitness and skill levels

mesocycle a training block that lasts for four to eight weeks and has a specific training focus

microcycle the smallest block of training – usually one week in length, with a specific focus

Typically, an annual plan for a competitive athlete progresses through four phases that reflect the specific training methods, intensities and volumes required. The four overall phases of a training cycle are:

- preparatory phase
- pre-competition phase
- competition phase
- transition phase.

These phases consist of smaller training periods known as **mesocycles**, which usually last for between four and six weeks. Each mesocycle will have a specific focus to prepare the body in a way that reflects the stage of the season – the period of the annual plan that is being enacted. Furthermore, each mesocycle consists of multiple shorter phases known as **microcycles**, which provide a more specific week-long training focus for the athlete's individual training sessions.

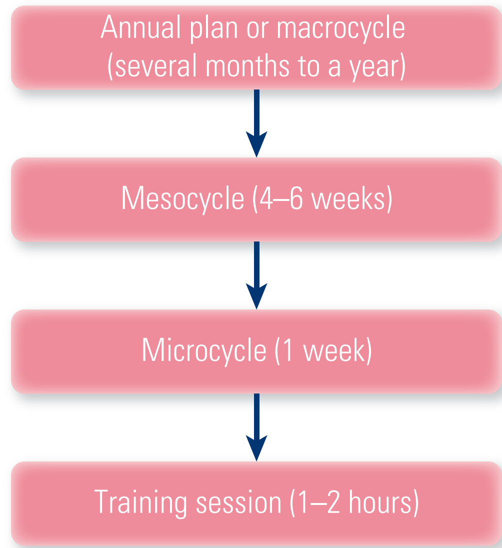

Figure 7.48 A structured training plan

Preparation phase

As the names suggest, this phase is focused on preparing an athlete for the physical demands of the competitive season. It typically involves two distinct mesocycles known as the *general preparatory phase* and the *specific preparatory phase*.

The general preparatory phase is focused on developing base levels of aerobic and muscular endurance required for impending training loads. Typically, this phase of training involves a lot of training variations that are low intensity and high volume. Weight training sessions during this phase would typically focus on developing muscular hypertrophy, and athletes will

<table>
<tr><th colspan="7">Annual plan</th></tr>
<tr><td>Training phase</td><td colspan="2">Preparation phase</td><td rowspan="2">Pre-competition</td><td colspan="2">Competition</td><td rowspan="2">Transition</td></tr>
<tr><td>Mesocycle</td><td>General preparation</td><td>Specific preparation</td><td>Maintenance</td><td>Peaking</td></tr>
</table>

Figure 7.49 Components of an annual plan

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be learning or refining new skills consistent with their physical development and prior ability.

In contrast, it is the responsibility of the specific preparation phase to develop sport-specific fitness to get the body ready for competition. The intensity of the training will increase, and the focus will primarily be on building necessary strength, speed and power required for the sport. As a result of the increased intensity, lower volumes of training are utilised to avoid overtraining.

Pre-competition phase

The final phase of preparation before a competition is known as the pre-competition phase. The focus of training is to transfer the fitness developed during the preparation phase into the competitive performance. That is, the athlete aims to maintain the strength and speed gains achieved during the preparatory phase and to develop specific match fitness that will enhance their performance. To accomplish this, very high-intensity training is required accompanied by increased duration to simulate the physical demands of the performance.

Figure 7.50 Pre-competition phase

As each training session places large amounts of stress on the body, increased recovery time between sessions is required. This is achieved through increased rest days or the inclusion of low intensity training sessions. The final microcycle of this phase typically involves a much lighter workload to eliminate fatigue and allow full recovery before the competition. This process is known as tapering, and it allows for the replenishment of depleted muscular glycogen stores caused by the ongoing training.

Competition phase

During the competition phase, the focus is on maintaining the fitness levels developed through the preparation phase and working towards peak fitness during the most important parts of the competition. Often when aiming to maintain fitness during the competition phase, a delicate balance is required between volumes and intensities that are high enough to maintain fitness levels, yet low enough to allow adequate recovery between fixtures. An athlete participating in weekly matches is adding another very high-intensity session to their training load. Subsequently, this would require additional rest time. The intensity of performance and corresponding rest will vary immensely between sports. Modern technology, including heart rate monitors and Global Positioning System (GPS) trackers, can be used by coaches to carefully track an athlete's intensity and workload during a performance and can adjust training accordingly. Performance analysis is also key during the competitive phase for identifying areas requiring technical improvement for team and individual skills.

Maintaining an adequate balance between training intensity and volume in the lead-up to the most important phases of competition will assist in the athlete reaching an optimal state of physiological, psychological and emotional readiness to perform. Again, training during the competition phase will vary according to the number of times the athlete is required to produce peak performance. A soccer player would want to develop their peak fitness levels during the finals series of a competition. In contrast, a

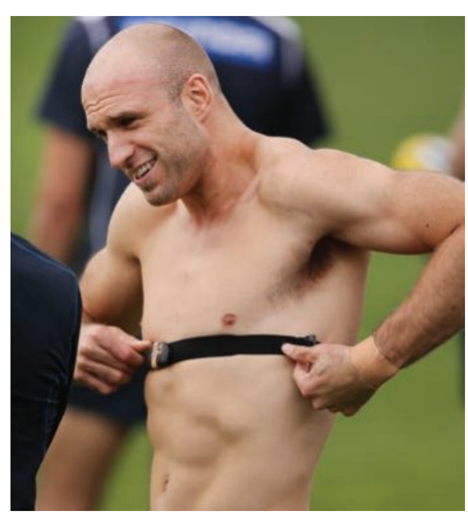

Figure 7.51 GPS trackers can be used by coaches to carefully track an athlete's intensity workload during a performance and training can be adjusted accordingly.

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Mesocycle phase	Conditioning training	Skill training	Intensity	Volume
Pre-competitive	Maintenance phase to retain preseason conditioning Develop 'match fitness'	Stress-proofing skills and strategies Application to game environments	High	Moderate
Competitive (peaking)	Tapering phase	Mental rehearsals and visualisation drills Complete performance practice	Competition day/s – very high Rest days – very low	Low
Competitive (maintenance)	Minimal training only to retain conditioning and to avoid overtraining and injury	Addressing errors being made in competition Maintenance of skill base and reinforcing exact technique and execution	Competition day/s – very high Rest days – very low Training days – moderate	Moderate

Table 7.35 Training focus of the pre-competitive and competitive mesocycle

swimmer would want to peak many times throughout the season as they compete in multiple competitions such as local, regional and state championships. Typically, there is a definitive tapering period preceding the peaking stage to allow the athletes the opportunity to freshen up before their competition.

Transition phase

A longer restorative period of active rest typically occurs between the end of the competition phase and the commencement of the next macrocycle. This is known as the main transition phase, and is characterised by decreased training intensities and volume. It promotes both physical and mental recuperation, and is also the period where athletes are able to undergo rehabilitation of injuries.

Fitness training in the transition phase is often steered away from the specific physical activity and embraces the concept of cross-training. This involves an athlete participating in different recreational activities from those for which they have been training. For example, a netballer may take up lower intensity activities like swimming or cycling during this phase as opposed to continuing with training that targets the continued development strength and power. The downside of cross-training is that the reduced specificity will deplete the athlete's fitness levels in the components most essential for their sport. If the transition period is extended, the preparation period for the following season would need to be lengthened to regain the lost levels of fitness. It is recommended that the transition phase last no longer than four to six weeks.

Designing an effective training session

The effective design of group or individual training session is influenced by a range of key factors. Understanding these factors will assist in ensuring the adequate implementation of suitable methods, intensities and duration of training activities that will facilitate desired training adaptions. These factors include:

- availability of time, equipment or facilities
- performance analysis
- the focus of the current mesocycle
- level of fitness of the athlete(s)
- level of ability of the athlete(s).

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Phase	Frequency of sessions	Duration of sessions	Intensity of sessions	Weekly training volume
Preparation 2–4 weeks	High	Short	Low–moderate	Low
Base training (8–16 weeks)	High	Medium–high	Moderate	Moderate initially progressing to high at the end of the phase
Specific preparatory phase (4–12 weeks)	Moderate–high	Medium–high	High	Moderate
Tapering (1–3 weeks)	Moderate progressing to low	Moderate progressing to short	High–moderate	Moderate progressing to low
Competition	Race at 1000 per cent (Heats at 90–100% depending on what is required for qualification)			
Transition or off-season	Low	Short	Low	Low

Table 7.36 A periodised training program for an athlete preparing for a single sporting performance

Mesocycle: Competition phase for a badminton player						
Component of session	**Phase**	**Description of training activity**	**Purpose**	**Intensity (%1RM, %HRM, RPE)**	**Duration Work: Rest**	**Volume Time, sets, reps**
Warm-up	Raise	Court runs	Raising the heart rate increases blood flow	Starting at 50%, building to 80%	1:1	10 reps
	Activate and mobilise	Dynamic stretches (A) **1** Leg swings **2** Lying leg crossovers **3** Scorpions **4** Arm swings	Progress joints through full range of motion	80%	2:1	Complete 10 times per side
		Dynamic stretches (B) **1** Lunge walk **2** Knees to chest **3** Inchworms **4** Spiderman crawl				(B) 1 x across court and back
	Prepare	Partner drills (A) **1** Net shots **2** Overhead clears **3** Underarm clears	Prepare athlete to perform specific skills and movement	80–85%	1:1	(A) 20 reps
		Partner drills (B) **1** Clear to drop shot **2** Short serve to clear to smash				(B) 10 reps

Table 7.37 Sample training session plan

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Mesocycle: Competition phase for a badminton player						
Component of session	**Phase**	**Description of training activity**	**Purpose**	**Intensity (%1RM, %HRM, RPE)**	**Duration Work: Rest**	**Volume Time, sets, reps**
Conditioning	Activity 1	Shadow play sprints • Start in the middle of the court • Have a partner identify a corner, sprint there, play an appropriate shot return to the middle • Repeat when athlete has returned to the middle • Complete four sprints per set	Increase speed and agility	95–100%	1:5	4 reps per set 15 sets
	Activity 2	Multi-feed rally • Start in the middle of the court • Have a partner continuously feed shuttles onto the court • Shuttles should be fed as soon as the return shot is made and should vary in placement	Develop aerobic and muscular endurance	85–95%	1:3	Play 20 shuttles 15 sets 1 minute rest between sets
	Activity 3	1 vs. 2 rally Play against two opponents (operating on one side of the court each)	Develop aerobic endurance, reaction time, agility and decision-making under fatigue	80–95%	1:	10 minutes standard play
Cool down	Low-intensity cardio	Jogging around the venue	Slowly lower heart rate, clear lactic acid from muscles	50% HRM	5 mins	1 set
	Static stretching	Calf stretch Quadriceps stretch Hamstring stretch Gluteal stretch Hip flexor stretch Lower back stretch Abdominal stretch Chest stretches Shoulder stretch Bicep stretch	Return muscles to original length	Light	15–30 sec	3 sets (each side)

Table 7.37 *(continued)*

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Activity 7.28

Engage-in

Inquiry question: How do the intensity and duration vary in different mesocycles?

Engage and understand

1 Compare the suggested intensities and duration required for training sessions in the general preparation, specific preparation and the competition (focusing on maintenance) phases.

Mesocycle	Intensity	Duration
General preparation		
Specific preparation		
Competition		

2 Produce column graphs that represent the specific intensities and durations identified in the table above.

Apply: Use knowledge and understanding in response to a given situation or circumstance; carry out or use a procedure in a given or particular situation.

Apply and analyse

3 Select one of the mesocycles above and research typical training activities associated with a chosen physical activity during this phase.

4 Apply your knowledge of the training principles associated with the competitive phase of training to three selected training activities.

Activity	Description	intensity	How will this be measured? (1RM, %HRM, RPE)	Duration of work	Duration of rest
1					
2					
3					

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A training season is broken down into smaller periods, each with a specific focus.

Tapering before progressing to a new period of training allows the body to be repaired and replenished.

An effective training session should synthesise a range of training considerations.

Activity 7.29

Active investigation

Inquiry question: What information is required to plan and implement effective strength and conditioning sessions for athletes during the competitive phase of training?

Engage and understand

1 Select a physical activity to design a one-hour training session to take place during the competition phase.

2 Collect primary and secondary data to identifying key factors that will influence the design of the training session.

3 Collate this data using the planning considerations template on the following page.

Analyse and apply

Synthesise: Combine different parts or elements (e.g. information, ideas, components) into a whole, in order to create new understanding.

4 Synthesise the collected data and construct a detailed session plan for your selected physical activity.

5 Participate in the training session, ensuring that you monitor the duration and intensity of the exercise being completed.

Evaluate and justify

6 Use primary and secondary evidence to justify the effectiveness of your training session. Consider the following:

- **a** Were all activities completed within the designated timeframe?
- **b** Were the activities completed at the planned intensities?
- **c** Were work and rest periods completed for the planned duration?

(continued)

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Physical activity mesocycle

Identify type of training	Key factor	Considerations	Training recommendations/ activities	
	Availability of time, equipment or facilities	Session duration	1 hour	Allow 15 minutes for warm-up 35 minutes conditioning 10 minutes for cool down
		Is all required equipment available?	Yes/no	
		Has the facility been booked?	Yes/no	
	Performance analysis	ATP-PC %	%	
		Lactic acid %	%	
		Aerobic %	%	
		What are the primary fitness components of the activity?		
		What key skills or movement patterns need continued development?		
Identify duration, intensity and volume of training	The focus of the current mesocycle	What is the conditioning focus for the phase?		
		How will you monitor intensity?		
		What are duration and volume recommendations?		
		What is the skill focus for the phase?		
	Level of fitness of the athlete(s)	Fitness strengths		
		Fitness weaknesses		
	Level of ability of the athlete(s)	Skills/strategies the athlete(s) can execute successfully		
		Skills/strategies the athlete needs to develop further		

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Chapter summary

- Energy for muscular contraction and other bodily functions is provided by the breakdown of ATP, a high-energy compound.
- Muscle cells can only store limited amounts of ATP, and more must be produced in order to continue physical activity.
- The energy required to produce more ATP is provided by carbohydrates, fats and proteins in our diet.
- Carbohydrates (glycogen and glucose) are the preferred fuel source for intense physical activity.
- Fats are the preferred fuel source at rest and after an hour or more of continuous activity.
- Proteins are generally only used as a fuel source if supplies of glycogen and fat are exhausted.
- Three systems of energy production work in combination to produce ATP, depending on the intensity and duration of activity.
- The ATP-PC system and the lactic acid system do not require oxygen in order to produce energy, so are classified as anaerobic. Energy is supplied at a fast rate but only lasts for a limited time.
- The aerobic system requires oxygen in order to produce energy, which is supplied at a slow rate for an indefinite amount of time.
- Fast-twitch muscle fibres use predominantly anaerobic energy sources to produce ATP, and therefore produce large amounts of force but fatigue quickly.
- Slow-twitch muscle fibres use aerobic energy sources to produce ATP, and therefore produce smaller amount of force but are more resistant to fatigue.
- Slow-twitch muscle fibres are recruited first in producing muscular force, but as more force is required, fast-twitch fibres are utilised.
- The ATP-PC system provides energy to produce ATP at a very rapid rate for approximately 10 seconds. It is limited by the amount of PC stored in the muscles.
- The lactic acid system provides energy to produce ATP at a rapid rate for approximately 60–75 seconds. It is limited by muscular fatigue, which coincides with the accumulation of lactate.
- The aerobic system provides energy to produce ATP at a slow rate, but can continue producing energy indefinitely.
- The ATP-PC system and the lactic acid system are anaerobic, which means they do not require oxygen in order to produce energy, whereas the aerobic system requires oxygen.
- The aerobic system uses predominantly glycogen in the initial stages of an endurance activity, but as supplies run low, fat becomes the major fuel source.
- The energy requirements of a physical activity depend on how intense the activity is, how long it will continue and the periods of rest time available.
- Efficient oxygen transportation and utilisation by the body prolong energy supplies for physical activity.
- Oxygen deficit describes the imbalance of oxygen available to that required by the body at the commencement of physical activity and during higher intensity activity requiring anaerobic energy.
- A steady state occurs when oxygen supply meets oxygen demand. This occurs at rest and at exercise levels below an individual's VO_2 max.
- EPOC occurs to replenish energy systems in working muscles back to a resting state.
- Pulmonary and cellular respiration affect the delivery and transportation of oxygen to the working muscle cells.
- Oxygen demand is determined by both the exercise intensity level and the efficiency of our bodies to utilise oxygen.
- Various factors contribute to the maximum amount of oxygen that can be consumed by our bodies.

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- The initial component of EPOC is involved predominantly in the replenishment of ATP and PC stores.
- The latter component of EPOC works to replenish the lactic acid.
- As the intensity of exercise increases, there will come a point where not all the required energy (ATP) can be produced anaerobically, and a proportion of the energy required will be produced aerobically. This is known as the lactate threshold.
- When the lactate threshold is reached, lactate levels in the working muscles (and the blood) rise sharply, as does the rate of ventilation.
- Percentage of maximum heart rate can be used as an indicator of exercise intensity.
- The aerobic training threshold represents a level of exercise intensity where a training effect will begin to occur.
- The aerobic training zone represents a band of exercise intensity where improvements in aerobic endurance will occur with prolonged training.
- The anaerobic training zone represents a band of exercise intensity above the lactic threshold where improvements in anaerobic endurance will occur with prolonged training.
- Coaches and athletes can plan to train in particular training zones according to the specific requirements of their activity and specific role requirements.
- Movement requirements for physical activity are classified as components of fitness. They include aerobic capacity, muscular endurance, speed, strength, power, flexibility and agility.
- Aerobic capacity is important for all physical activities.
- For sustained physical activities, repeated muscular contraction without the development of high levels of fatigue signals developed anaerobic or muscular endurance.
- Isotonic strength involves the lengthening and shortening of muscle fibres.
- Isokinetic strength involves the lengthening and shortening of muscle fibres but at a constant level of exertion of muscular force.
- Isometric strength involves no change in the length of muscle fibres, and therefore no joint movement.
- Dynamic flexibility contributes to the body's ability to make quick, repeated movements.
- Static flexibility illustrates the range of motion possible about a specific joint of our body.
- Power is a combination of muscular strength and speed.
- Speed of muscular contraction and reaction time contribute to the overall time taken to move from one position to another.
- Agility incorporates the ability to accelerate quickly, dodge, weave and turn in an efficient manner.
- Dynamic balance is used when moving the body from one position to another.
- Static balance requires the maintenance of the body in a stationary position.
- Coordination involves the linking of the senses to a movement response in a smooth, quick and efficiently controlled manner.
- Reaction time is the time taken to respond to a stimulus and then initiate a movement response.
- A range of fitness tests can be used to determine the fitness training priorities of individuals and teams.
- Coaches need to analyse the physical fitness and energy demands of physical activity in order to plan specific training activities.
- Training needs to get progressively harder to produce continued adaptations.
- Effective training is specific to the requirements of the physical activity.
- Effective training targets the individual needs and goals of each athlete.
- Training intensity can be manipulated in a variety of ways.
- The Karnoven method of calculating % HRM accounts for individual difference.
- It is recommended that resistance training intensities be linked to percentage 1RM.
- Continuous, fartlek and interval training can target different training zones.

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- Training at or above the anaerobic threshold will produce the greatest aerobic gains.
- Adequate recovery time is required between very high-intensity efforts.
- Circuit training and resistance training are both effective in conditioning muscles for physical activities.
- Muscle contractions can be categorised based on the movement of the muscles when contracting.
- Plyometric training uses the stretch shorting cycle to generate great muscular force.
- The RAMP protocol is an effective guide to follow when designing warm-ups.
- High-intensity conditioning exercises should be placed prior to fatigue at the start of a session.
- Low-intensity continuous activity during the cool down is essential for clearing lactic acid from the working muscles.
- A training season is broken down into smaller periods, each with a specific focus.
- Tapering before progressing to a new period of training allows the body to be repaired and replenished.
- An effective training session should synthesise a range of training considerations.

Chapter review

Multiple-choice questions

1 Carbohydrates are stored in the body as:

A glucose.
B glycogen.
C fatty acids.
D amino acids.

2 At rest, the body's preferred fuel source is:

A fat.
B protein.
C carbohydrate.
D vitamin A.

3 Phosphate creatine is a high-energy substance used to produce ATP while using the:

A aerobic system.
B oxygen system.
C lactic acid system.
D ATP-PC system.

4 The ATP-PC energy system can supply high amounts of energy for approximately:

A 35 seconds.
B 70 seconds.
C 10 seconds.
D 120 seconds.

5 Running a competitive 400 m race would predominately involve energy from:

A the aerobic system only.
B all three systems in equal amounts.
C both the ATP-PC and lactic acid systems.
D the ATP-PC system only.

6 A level of exercise intensity where the body is capable of supplying enough oxygen so that all energy can be supplied aerobically is known as:

A oxygen deficit.
B EPOC.
C steady state.
D maximal.

7 EPOC occurs to:

A replenish energy systems in working muscles back to a resting state.
B remove excess PC from non-working muscles.
C increase recovery times.
D move lactic acid to non-working muscles.

8 The lactate threshold describes:

A the level of exercise intensity where oxygen demand increases.
B the level of exercise intensity where the athlete must stop or slow down.
C the level of exercise intensity where stores of PC are exhausted.
D the level of exercise intensity where lactate begins to accumulate in the blood.

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9 An average athlete will begin working above their lactate threshold when exercising at:

A 10–20% of their VO_2 max.

B 20–40% of their VO_2 max.

C 50–60% of their VO_2 max.

D VO_2 max.

10 A suitable test to determine an athlete's level of aerobic endurance would be:

A the 40 m sprint test.

B the 12-minute run test.

C the sprint fatigue test.

D the Illinois agility test.

11 Training that focuses on the energy systems, fitness components and movement patterns required to successfully complete a physical activity is known as:

A individuality.

B specificity.

C overtraining.

D variety.

12 Gradually increasing the intensity, duration or volume of exercise over time is known as:

A the Karnoven method.

B specificity.

C progressive overload.

D tempo training.

13 Which training zone would an athlete be in if they were working at 85% of their maximum intensity?

A Anaerobic zone

B Aerobic zone

C Endurance zone

D Threshold zone

14 What would the approximate target heart rate be for an athlete who wants to train at 85% intensity if they had an MHR of 205 bpm and a RHR of 70 bpm? (Use the Karnoven method.)

A 185

B 171

C 192

D 178

15 Tempo training can be characterised as:

A training at or just below the aerobic threshold.

B training at a minimum of 95% intensity.

C training at or just below the lactate threshold.

D all of the above.

16 Which energy system would incorporate a W:R ratio or 1:1?

A ATP-PC system

B Lactic acid system

C Aerobic system

D All of the above

17 Which of the following is not a direct benefit of flexibility training?

A Improved posture and muscle balance

B Reduced chance of injury

C Increased speed

D Improved mobility and movement capacity

18 A static stretch should be held for a period of:

A 1–2 minutes.

B 5–10 seconds.

C 30 seconds to 1 minute.

D 15–30 seconds.

19 Which of the following is NOT a benefit of using bodyweight exercises for resistance training?

A No cost

B Ability to train at high intensity

C Range of movements

D Minimal or no equipment required

20 Which of the following demonstrates the correct order of exercises for a warm-up?

A Mobilise joints, activate muscles, raise heart rate, prepare to perform

B Mobilise joints, raise heart rate, prepare to perform, activate muscles

C Raise heart rate, prepare to perform, mobilise joints, activate muscles

D Raise heart rate, activate muscles, mobilise joints, prepare to perform

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Short-answer questions

1 Outline the factors that limit energy supply in each of the three energy systems.

2 Explain why a person finishing a 100 m sprint continues to maintain a higher breathing and heart rate during recovery even though most of the energy for this event was produced by the ATP-PC system.

3 Explain why the body works in oxygen deficit during the initial stages of increased exercise intensity demand.

4 Explain the factors that will force a person to have to slow down or stop when exercising above their lactate threshold.

5 What types of training activities could be used to allow athletes to train in their anaerobic training zone? How can heart rate be used as a guide to training zones?

6 What is the difference between specificity and individuality?

7 Explain the different methods that could be used in circuit training to progress an athlete from one station to the next.

8 Explain the relationship between heart rate, RPE and the ability to talk.

9 Justify the essential methods of training that would support your development of the essential fitness components and energy systems.

10 Justify why it is important to incorporate tapering periods into a training plan.

Extended-response questions

1 Consider the energy requirements of touch football players in a competitive game. Outline your recommendations for a subbing system (given that unlimited substitutions are allowed in touch football) based on your understanding of energy systems and recovery times.

2 Develop a fitness profile that could be used for you personally that is suitable to track your training progress in a particular sport. Justify your inclusion of fitness tests targeted to measure physical capacities required by the sport. Include personal targets for improvement over time.

3 Provide detailed examples of how progressive overload would be used throughout the preparation phase of training for your chosen physical activity.

4 Use primary and secondary data to justify the selection of any three training activities that would be useful to include during the competitive phase of training in your chosen physical activity.

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Chapter 8

Evaluations, evidence and assessment support

This resource is available in the digital version of the textbook.

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Glossary

abduction the movement of a part of the body away from the central part of the body or away from another body part

acceleration the increase or decrease in an object's velocity

adaptability ability or willingness to change

adaptation physiological changes due to the stress of exercise

adduction the movement of a part of the body towards the middle of the body or towards another body part

aerobic capacity the ability to exercise for extended periods using energy produced by the aerobic energy system

aerobic interval training interval training performed with longer durations and shorter rests, with intensities close to the anaerobic threshold

aerobic training threshold the level of intensity sufficient to cause a training effect

aerobic training zone the intensity at which your body is using its aerobic metabolism system to produce energy from fat and glycogen

affirmation a positive statement about you, your abilities or goals that is true or reasonable enough to be valid in the future

affordances environmental characteristics that offer opportunity for action

agent of socialisation an element or section of a society through which learning occurs as part of the socialisation process

agility a rapid whole-body movement with change in velocity or direction in response to a stimulus

anaerobic training zone the heart rate above which you gain anaerobic fitness; you cross your anaerobic threshold at 80 per cent of your MHR

angular motion movement around a fixed point or axis of rotation

annual plan a year-long macrocycle that varies training in response to competition and non-competition phases, as well as targeting times when peak performance is required

anxiety an uncomfortable feeling of nervousness or worry about something that is happening or might happen in the future

arousal a state of physical excitement or attentiveness

attention the act or state of applying the mind to something

autonomy the ability to make your own decisions without being controlled by anyone else

balance the ability to remain in a stable position, whether moving or stationary

barrier a factor that restricts or prevents access to physical activity

Bernoulli's principle the trajectory of an object moving through a fluid may be influenced by lift or Magnus forces

cellular relating to the cells in the body

circuit training training that involves progressing through a number of exercise stations

circumduction the movement of a joint in a circular motion

closed motor skills occur in highly predictable environments

cognitive anxiety the specific thought processes that occur during anxiety

cognitive systems approach acquisition of information-processing abilities

commodification the process of transforming a product, person or service to increase its value and potential to make a profit

commodity a product that has value and thus can be bought, sold or traded

competence the ability to do something well

concentration the ability to think carefully about something you are doing and nothing else

concentric contractions the muscles are developing force while shortening to cause movement

confidence the quality of being certain of your abilities or of having trust in people, plans or the future

consistency the degree to which the performance varies

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constraints boundaries that shape a learner's self-organising movement patterns, cognitions and decision-making processes

contact force a force applied through direct contact with objects, fluids or surfaces

continuous motor skills do not have a defined end, but are repetitive in nature and may continue for an unspecified length of time

continuous training sub-maximal training completed over a long period without pause

coordination the ability to link the messages received by the brain from the senses to our body parts to produce smooth, quick and efficiently controlled movements

culture the values, beliefs, customs and behavioural norms of a group or population

decision-making (information processing) selecting a motor program in response to the current situation

degrees of freedom factors affecting the directions in which independent motion can occur

deliberate practice a special type of practice that is purposeful and systematic

detraining reduction in fitness gains due to extended rest periods

discrete motor skills have a distinct start and finish

diversity the visible and invisible differences that exist between people, such as gender, culture, race, ethnic origin, physical and mental ability, sexual orientation, age, economic class, language, religion, nationality, education and family/marital status

dominant versions of gender the most common and socially accepted ideas associated with being either male or female

dorsiflexion the action of flexing the ankle joint upwards, raising the toes

duration length of the training session

dynamic balance the ability to maintain balance while moving

dynamic flexibility the range of joint movement possible while moving and contributes to the body's ability to make rapid or quick, repeated movements

dynamic stretching the use of momentum and active muscle contractions to increase a joint's range of motion

dynamic systems approach the theory that movement behaviour is the result of complex interactions between many different factors, such as the environment and the task at hand

eccentric contractions the muscles lengthen in a controlled way under tension to absorb force

ecological psychology how the body's systems coordinate actions with the environment, objects and surfaces

enabler a factor that facilitates access and equity in physical activity

environmental constraints the social or situational factors that limit the decision-making and movement patterns that can be displayed by an individual during performance

equity concerned with giving value to and celebrating personal, social and cultural differences in society

ethical standards a set of principles or guidelines that outline expected conduct reflecting underlying morals, such as trust, equality and kindness

ethical strategy a method or plan of action devised to bring about ethical behaviours and encourage individuals to act with integrity; typically involves the creation of ethical standards, guidelines, frameworks or codes

ethics a system of moral principles and values by which actions and proposals may be judged good or bad, or right or wrong

eversion occurs when the ankle turns laterally so the sole of the foot faces outwards

extension occurs when the angle of the joint increases

extrinsic motivation participating in an activity for reasons other than the enjoyment

fairness where competitors have a relatively equal chance of success as all involved are undertaking the activity in accordance with the rules, ethics or logic

fartlek training a series of high-intensity bursts followed by low-intensity recovery periods

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feedback (in motor learning) any information received during or after a performance about the movement itself or the level of success achieved by the movement in that situation

fine motor skills small movements that use the small muscles

flexibility the ability of a joint to move through its full range of motion

flexion occurs when the angle of the joint decreases

force a push or pull in a given direction

force summation the total force produced by the coordinated actions of a group of muscles contracting in sequence

frequency the number of times training occurs in a given period

gender-neutral refers to characteristics, roles and behavioural norms that either equally share characteristics of being both male and female, or display characteristics of neither

globalisation the process by which the world is becoming increasingly interconnected

glucose a type of sugar that is found in plants – especially fruit; supplies an important part of the energy that animals need

glycogen a substance found in the liver and muscles that stores glucose and is important in controlling sugar levels in the blood

green space an area of grass, trees or other vegetation set apart for recreational or aesthetic purposes in an otherwise urban environment

gross motor skills bigger movements that use the large muscles

heart rate reserve the difference between an athlete's maximum and resting heart rates

high-intensity interval training (HIIT) interval training that includes periods of very high or maximal effort and longer rest periods

hyperextension occurs when the joint extends beyond anatomical position

hypertrophy an increase in muscle size

individual constraints the unique mental and physical abilities of the individual that affect their decision-making and movement patterns, and that can be displayed during performance

individuality training that considers the personal needs, goals, fitness levels, motivation and skills of an athlete

institution a body or group that establishes rules and procedures for how the group should behave or operate, and actively promotes these regulations

integrity the application of generally accepted values and norms in daily practice

intelligent performance manipulation of rules, time, score, principles of play, affordances – technical and tactical, individual + team; limitations – technical and tactical, individual + team

intensity the magnitude of exertion required

intrinsic motivation participating in an activity purely for the enjoyment of the experience

invasion game a game where the aim is to attack an opponent's territory and score a goal or point

inversion occurs when the ankle turns medially so the sole of the foot is facing inwards

isokinetic contractions a type of muscular contraction where the muscles remain in motion

isometric contractions when a muscle contracts but its length does not change

isotonic contractions when the length of a muscle changes when contracting

linear motion movement of an object from one place to another

long slow distance training a form of continuous training of moderate intensity, performed over an extended duration

macrocycle a complete training cycle from start to finish

maximum heart rate the highest safe heart rate at maximal exercise; MHR = 220 – your age

megatrend represents an important pattern of social, economic or environmental change

mesocycle a training block that lasts for four to eight weeks and has a specific training focus

microcosm of society a sub-section of society (such as sport, education or politics) that reflects the values, beliefs and behavioural norms of the broader society

microcycle the smallest block of training – usually one week in length, with a specific focus

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morals an individual's sense of right or wrong developed through their own unique socialisation process

motivation enthusiasm for doing something; the direction and intensity of effort

motor learning the study of the processes involved in acquiring and refining skills; the field of study concerned with understanding changes in motor control

muscle fibre recruitment the increased use of muscle fibres as a result of resistance training

muscular endurance the ability of specific muscle groups to sustain activity at high intensity using energy produced by anaerobic energy systems

nationalism devotion and loyalty to your own country and the desire for national advancement

non-contact force a force that acts on an object without physical contact such as the force of gravity

non-linear not in a continuous straight line, which may involve peaks and lows of performance

normalised to cause something to be accepted as normal or expected

open motor skills occur in environments that are highly unpredictable

outcome goals goals that focus on a desired outcome, like winning

over-aroused a level of physiological alert that is detrimental to performance

over-confident high level of confidence that is detrimental to performance

overtraining impaired physical, emotional and psychological responses due to the training intensities exceeding recovery

performance goals goals related to a measured performance

periodisation process of using blocks of training to systematically develop an athlete's fitness and skill levels

persistence lasting for a long time, the act of being persistent

plantar flexion the action of extending the ankle joint downwards, pointing the toes

plyometric training a form of training that involves jumping and bounding

population density a measure of the number of people who make up a population in a defined area

positive self-talk making positive comments to oneself, either silently or out loud

power the ability of muscles to generate force and apply it quickly

principles of play similar characteristics or tactical components in the game; include setting up attack, defending against attack, creating, defending and exploiting space, attacking opposition space and scoring

process goals goals associated with improving essential processes that will lead to performance enhancement

progressive overload the planned, gradual increase in training load to ensure that fitness continues to be optimised

pronation rotation of the palm of the hand so the palm faces down

proprioceptive neuromuscular facilitation advanced flexibility training that involves both stretching and contracting the muscle

psychology the study of how thought influences behaviour

pulmonary relating to the lungs

qualitative analysis examination of events by recording observations that cannot be measured using numeric values

quantitative analysis examination of events through measurement and assigning numeric values

rate limiter constraint that holds back or slows the emergence of a motor skill

rate of perceived exertion the level of intensity an athlete believes they are experiencing

reaction time the time it takes to respond to a stimulus

relatedness situations where social acceptance reinforces the motivation for participation

repetition maximum the maximum weight an athlete can lift over a prescribed number of repetitions

repetitions the number of times an exercise is completed

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response execution occurs when the decision is passed to the relevant body parts and the selected motor plan is enacted

resting heart rate (RHR) the number of times the heart beats per minute when at rest

reward the benefit that can be gained from a situation

risk the probability of a negative outcome occurring

rotation the turning of a limb or the spine along its axis

self-belief trust in your own abilities

self-concept the mental self-image a person has; it includes physical attributes and abilities as well as personality and intellectual ability

self-efficacy a person's belief that they can be successful when carrying out a particular task

self-esteem the way an individual feels about their own abilities, as demonstrated through their self-worth and self-respect

self-fulfilling prophecy something you cause to happen by saying and expecting that it will happen

serial skills those where a number of discrete motor skills are linked together

social cohesion refers to how much individual team members like each other and enjoy each other's company

socialisation the process by which an individual acquires knowledge, language, social skills and values from their surroundings

somatic anxiety the physical symptoms of anxiety

specificity training that is relevant to the energy systems, position-specific movements and fitness requirements of an activity

speed the ability of muscles to contract quickly and repeatedly, resulting in fast body motion

sport psychology the study of the human mind and how it relates specifically to physical performance

sprint interval training a form of HIIT that involves bursts of sprinting interspersed with rest

stability the state of being stable and resistant to change

stakeholders any person or group affected by the way something is organised or managed

static balance the ability to maintain a stationary balanced position

strength the ability of muscles to exert a force against a resistance in one maximal effort

supination the act of turning the palms of the hands upwards

tactical awareness knowing what is happening around you and what options are available (affordances), then selecting (and appropriately adapting) a motor sequence that will be successful

task cohesion the team's ability to work towards a specific goal

task constraints the rules, equipment and goal or purpose of an activity that limit the decision-making and movement patterns that can be displayed by an individual during performance

team dynamics the unconscious, psychological forces that influence the direction of a team's behaviour and performance

technical ability the level to which a specialised movement sequence has been refined in order to produce consistently successful outcomes

tempo training a type of aerobic training at or just below the anaerobic threshold

training zone specific intensity range that identifies the dominant energy system use

under-aroused when arousal levels are less than those desired by the athlete to produce optimal performance

under-confident low level of confidence that is detrimental to performance

vicarious experiences knowledge or information about a skill or behaviour derived from viewing the performance

visualisation creating and focusing on a range of positive mental images and experiences

volume the number of repetitions or sets completed

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Chapter 8

Evaluations, evidence and assessment support

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8.1 Making justified evaluations

This section contains useful information that will help you to make critical evaluations and discerning justifications using both primary and secondary data.

Syllabus requirements

The current version of the Physical Education General Senior Syllabus (Queensland) includes four summative assessment tasks. Three of the tasks are internal assessment (set by your school) and one is external assessment (set by the QCAA). The same external assessment task will be completed by all students studying Physical Education in Queensland.

Each of these tasks require students to make critical evaluations and discerning justifications. Table 8.1 includes the QCAA syllabus objectives relating to the evaluating and justifying criterion in Units 3 and 4, which include the summative assessment tasks.

Structuring an evaluative response

When writing an essay, report or commentary, a number of factors can contribute to the quality of your work. Well-structured writing allows you to communicate your conclusions, evaluations and recommendations with discerning justification and authority. The BAM and PEEL structure for paragraph writing can be used as a framework to help construct evaluative responses.

BAM and PEEL are acronyms to help you to structure your writing. BAM should be used in the introductory paragraph, while PEEL is best used for the following paragraphs that form the body of your writing. Before beginning to write, be clear about your main argument, hypothesis or conclusion, then divide your supporting arguments into a set of main ideas. These will form the basis of each paragraph in the body of your writing.

BAM: Background, argument, main points

- **B:** Background or lead in sentence/s. This statement grabs attention and orients your reader to the topic. This could be an opinion statement, a quote, a statistic or a fact.
- **A:** Argument/hypothesis/thesis. This sets a clear direction for your work, including a statement outlining the purpose of the writing. The findings of your evaluation are briefly outlined to the reader, as is the methodology and/or justification that you will use to support your conclusion.
- **M:** Main points – overview the main points discussed in your writing.

PEEL: Point, evidence, explanation and link

PEEL is used to structure the body of your writing to order to construct clear and cohesive paragraphs.

- **P:** Point – make your main point in the first sentence of the paragraph. This is the topic sentence. In writing for Physical Education, this typically will be your evaluative statement. For example, 'Goal-setting has proven to be an extremely effective psychological strategy in developing motivation towards archery throughout this learning period.'
- **E:** Evidence – support your point with facts, evidence and examples. This evidence may be primary and/or secondary data. You will always be expected to support your point with research from experts in the field of study. Ensure that you have acknowledged the authors of research that you have used with in-text citations and corresponding inclusion on a list of references.
- **E:** Explanation – your justification of how the evidence supports your point. It is through explaining coherently the links between your evidence and your point that you demonstrate your understanding of the underpinning concepts that form the subject-matter of a Physical Education course. Therefore, ensure your explanation draws on and refers to relevant concepts in relation to the task, and that these are articulated clearly and applied correctly.
- **L:** Link – link your point back to your central argument, hypothesis or thesis presented in the introduction – that is, how did the information in this paragraph specifically support the overall contention for your writing? If possible, also provide a logical link to the next paragraph.

Writing tips

Your written and spoken work needs to be completed using appropriate academic English. Good academic writing has a degree of formality, uses appropriate vocabulary and applies correct grammar, spelling and punctuation. You need to avoid using colloquial

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Unit	Topic	Objectives relating to the evaluating and justifying criterion
Unit 3 Tactical awareness, ethics and integrity and physical activity	Topic 1 Tactical awareness integrated with one selected ‘invasion’ or ‘net and court’ physical activity	• Evaluate a tactical strategy and movement strategies relevant to the selected physical activity • Justify a tactical strategy and movement strategies relevant to the selected physical activity.
	Topic 2 Ethics and integrity	• Evaluate an ethics strategy relevant to a class, school or community physical activity context • Justify an ethics strategy relevant to a class, school or community physical activity context.
Unit 4 Energy, fitness and training and physical activity	Topic 1 Energy fitness and training integrated with one selected ‘invasion’, ‘net and court’ or ‘performance’ physical activity	• Evaluate a training strategy and movement strategies relevant to the selected physical activity • Justify a training strategy and movement strategies relevant to the selected physical activity • Evaluate training strategies about movement • Justify training strategies about movement.

Source: Physical Education 2019 v1.1 General Senior Syllabus © Queensland Curriculum & Assessment Authority.

Table 8.1 Physical Education General Senior Syllabus (Queensland) objectives relating to the evaluating and justifying criteria in Units 3 and 4

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language and slang terms. For example, a phrase such as 'the feedback provided to him by his coach allowed him to reconsider his strategy' would be better than 'after his coach talked to him, he sat down and took a long hard look at himself'.

Writing in the first person (using I, me, my, mine, we, us, our or ours) is not usually considered good practice in academic writing. The more formal nature of academic writing is best served by communicating in the third person. The exception to this convention is when *you* are the subject of the investigation. For example, if you were writing a report about *your* tactical understanding of and application in a particular sport, it would be acceptable for the report to be written in the first person. Try to avoid sentence starters such as 'I think …' or 'It is my opinion that …' Instead, merely begin the sentence with your idea or opinion. If the idea or opinion does not have an in-text citation to another author, it is obvious to the reader that the idea is yours.

Primary and secondary data

The use of primary and secondary data plays a crucial role in conducting critical evaluations and providing discerning justifications. All summative assessment tasks in Physical Education require the use of both primary and secondary data.

Primary data are collected by the researcher conducting the inquiry. For example, you could be involved in collecting the heart rate responses of the students in your class to a particular exercise regime. These data could then be used to evaluate the suitability of students to playing in a particular position or taking a particular role in a physical activity, or justifying a particular training activity in preparation to play. Primary data may be *quantitative* (involving numeric measurements from sources such as experiments) or *qualitative* (usually involving ideas and opinions from sources such as surveys, questionnaires or interviews).

Secondary data are data that have been already collected, and in many cases analysed by another researcher. For example, you may use secondary data to justify your recommendation for a training drill suitable for beginners to practise a basic skill. Secondary data are usually found by researching websites, books, journal articles or other published sources. They can also be used to verify primary data as well as to evaluate and recommend strategies and justify decisions. Table 8.2 compares primary and secondary data.

Referencing secondary data sources

Referencing is the process of acknowledging the contributions of other researchers in your work. By referencing the sources of the secondary research data that you have used in your work, you give credit to the authors whose ideas and findings you have borrowed. As well as acknowledging the intellectual property rights of the original author, referencing also assists your writing by:

- providing evidence to support your claims and ideas
- using experts in the field of study to add credibility to your work

Characteristic	Primary data	Secondary data
Definition	Data collected by the researcher themselves	Data collected and analysed by another researcher
Currency	Real time – up to date	Past data
Difficulty	Time-consuming and complex – need to check for validity and reliability	Time effective and easy
Cost	Potentially expensive	Relatively cheap
Suitability	Designed specifically to suit the needs of the inquiry	May or may not specifically suit the needs of the inquiry
Usability	Raw data analysis needs to be completed	Analysis and discussion may be completed

Table 8.2 Comparison between primary and secondary data

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- allowing your readers to find and read the research you have used
- making your writing more persuasive.

What information requires a reference?

The following require a reference:

- books
- journal articles
- newspapers and magazines
- films, documentaries, TV shows
- advertising in any media
- online video
- websites and other electronic sources
- emails, blogs, forums, discussions
- personal interviews
- any diagrams, graphs, pictures, drawings reprinted in your work.

What information does not require a reference?

The following do not require a reference:

- personal observations or results from primary data collection
- your personal experiences
- your personal opinions, thoughts or conclusions
- your analysis or evaluation of data
- original plans, ideas or strategies
- generally accepted facts in the field of study
- facts that are considered to be 'common knowledge' and likely to be known by many people.

In-text citations

In-text citations are designed to acknowledge in the text where another person's ideas are being used. Whether you are using a direct quote from someone else's work (which must be enclosed in quotation marks) or paraphrasing someone else's work, you must include an in-text citation. In-text citations link to a full reference entry on a reference list placed at the end of the work. The following rules apply to the use of in-text citations using APA style (note that this can vary according to the style required):

- The in-text citation consists of:
  - the author surname(s) in the order they appear on the publication
  - the year of publication
  - the page or paragraph number for direct quotes – for example, (Patel, 2017, p. 45)
  - just the date for paraphrasing – for example, (Brown, 2015).
- The citation is placed immediately after the information being cited.
- If your citation occurs at the end of a sentence, place the full stop after the citation.
- If quoting or paraphrasing a source that is cited in another source, you must cite the original source and the source were you found the information e.g. (Zhou, 2014, cited in Redmond, 2015).
- If there are two or more authors, the symbol '&' can be used in the citation. If the authors' names are used to as part of a sentence then 'and' must be used e.g. (Mwangi & Jones, 2018) or 'According to Mwangi and Jones (2018), many people …'

Placement of in-text citations

When quoting or paraphrasing a secondary data source, the placement of the citation depends on whether you want to emphasise the information or emphasise the author.

If you want to emphasise the information, use an 'information prominent' citation – for example, 'as demonstrated in a study of Australian high school aged students (Karlsson, 2009) …' The citation is inserted at the end of the information.

If you want to emphasise the author, use an 'author prominent' citation – for example, 'Nguyen (2016) argues that …' The author's name is used as part of the sentence.

Examples of in-text citations variations

Table 8.3 on the following page is a guide to creating in-text citations for common variations in the numbers of authors and publishing conditions (again according to APA style).

Reference lists

Any research that is cited in the text must be included on a reference list at the end of the work. Conversely, any sources included in a reference list must have a corresponding in-text citation. References included in a reference list generally include the following information:

- author
- year of publication

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Condition	Citation example
One author	This trend has been identified in various studies (Fisher, 2013) OR Fisher (2013) identified … OR In 2013, Fisher identified …
Two authors	… (Petran & Ivanov, 2008) OR Petran & Ivanov (2008) conclude that …
Three to five authors	First time cited in the work: … (Alexiou, Fourie & Mahmoud, 1999) thereafter: … (Alexiou et al., 1999) OR As observed by Alexiou et al. (1999) …
Six or more authors	… (Brodie et al., 2010). OR Brodie et al. (2010) contend that …
Anonymous author	Only use an 'information prominent' citation: … (Anonymous, 2000).
Corporate author	First time cited in the work: … (Australian Sports Commission [ASC], 2012). Thereafter: … (ASC, 2012). OR if the abbreviation could be confused or is uncommon give the full name every time. … (National Rowing League, 2003).
A number of authors who support the same idea.	… (Nathan, 2001; Bianchi, 2005; Ricci, 2007).
Direct quotation	Bisset (2014, p.213) claims that 'many Australians are now …' OR 'Many Australians are now …' (Bisset, 2014, p.213).
Direct quotation from an electronic source without page numbers	If page numbers are not used, use paragraph number: 'Distributed practice tends to be more effective …' (Abumohor & Berkowitz, 2008, para. 2) OR Abumohor & Berkowitz (2008, para. 2) note that 'distributed practice tends to be more effective …'

Table 8.3 Examples of various in-text citations

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- title of book, article or web page (in italics)
- website address (URL) if web based
- publisher
- city/country of publication.

Examples of reference list entries

Rules for reference list entries vary for the many different types of published works. The fictitious examples below show the format for some of the most common sources used in Senior Physical Education assessment tasks.

- **Book:** Jewel, G. (2009). *Integrity in Sport*. Melbourne: Cambridge University Press.
- **Website:** Harrison, M. & Garret, J.G. (2011). Exercise done right. Available at: http://www.exercisedoneright.com.uk.
- **Journal:** Ferguson, G., Stepford, J. & Jones, B. (2010). Getting the best from your team in Australia. *Coaching Journal*, 23(4), 21–34.
- **Newspaper:** Norris, T. (2013). Players unite to stamp out doping. *The Australian*, 23 February, 26.

Note

If you are using a source that is different from those listed, there are many online referencing generators that will help you construct you reference list entries for a large range of published sources.

Helpful hint

When researching and collecting secondary data, create a reference table to store the sources of your information. This will save considerable time in creating your reference list, particularly if you are sourcing web-based research.

A better way to say …

Table 8.4 includes examples of linking words and phrases to improve the linking, readability and authority of your writing.

Purpose	Link words and phrases		
Alternate words for 'is' OR 'makes'	allows becomes causes contributes to creates culminates in engenders exemplifies	expresses indicates influences leads to manifests mirrors produce	provokes reflects represents reveals shapes shows symbolises
Alternate words for 'says that'	admits that argues that asserts that claims that concludes that condemns the view that contends that explains that	expresses the view that is critical of maintains that observes that points out that refutes the evidence/view	reinforces the view that rejects the point that stresses the point that submits that
Presenting evidence	this is/can be illustrated by it is seen through this can be demonstrated by/through this is shown when this is exemplified by/when this illustrates that	this shows that this can be observed through it clearly points out it can therefore be perceived that it is most notable when	it is most marked when this is seen clearly through this is evident when this is apparent this is most obvious when

Table 8.4 Link words and phrases

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Purpose	Link words and phrases		
Elaborating – providing further evidence	a number of additionally also and another as well as	besides both firstly furthermore in addition	in conjunction with lastly moreover to illustrate secondly
Analysis – comparing and contrasting	alike also alternatively although both but compared with contrasts with conversely despite differs from equally even though	have in common however in the same way in spite of this instead like likewise neither nevertheless on the contrary on the other hand rather	similar to similarly subsequently the dissimilarity the features they have in common the opposite the reverse unlike whereas while yet
Justifying an argument, conclusion or evaluation	although as can see seen as evidenced by as indicated by but but also consequently despite this due to even if findings indicate that further to	furthermore given that however if in order that in order to in spite of this it is clear that nevertheless not only rather than regardless of since	the reason is that then this extends the idea that this finding is supported by this is significant because this seems to imply whether or not while yet
Concluding	accordingly as a result as shown consequently finally for this/that reason	having examined the evidence hence in conclusion in other words	in summary in view of that on the whole ultimately we come to realise

Table 8.4 *(continued)*

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8.2 Multimodal projects

The Physical Education General Senior Syllabus (Queensland) requires the collection of evidence to complete multimodal assessment tasks and to highlight the demonstration and application of technical and tactical elements of performance.

Capturing quality video evidence

In order to gather appropriate digital evidence, it is important to consider a range of factors that will not only benefit the final multimodal product, but will also allow effective analysis of performance to occur.

- **Ensure picture quality.** High-definition picture quality is essential, and may require a camcorder or camera that captures high-quality video footage. HD quality video also allows high-quality stills to be generated if required. While phones or other devices may be convenient, and can provide additional footage if required, in many cases they may not allow the smooth zooming or cropping required in production to highlight that essential moment of play when footage is captured from a distance.
- **Ensure that the captured footage is steady.** The best way to do this is to always use a tripod; having the device held in the hand and following play from the sideline is not effective. Fittings are available to allow all devices – even phones – to attach to standard tripods.
- **Avoid filming into light.** A bright background makes it difficult to identify characteristics in the performance of those performing in the foreground as they appear 'in shadow'. If the sun is low in the sky when outside, ensure that that it is behind the camera. If inside, avoid filming directly into windows and blinds if possible.

- **Avoid background disturbances.** Try to ensure that footage is taken from an angle where sideline players or spectators are not in shot or their conversations cannot be heard; this may detract from the performance if used as part of an assessment response.
- **Reduce background noise.** For some assessment, it may be helpful to use the sound from the footage collected. For example, the tactical talk in defence or attack may be useful for demonstrating the application of strategic knowledge. Consider limiting background player chat or the effect of wind. Alternatively, it may be relevant to talk through 'thinking' before, after or in between performances, particularly in activities like archery, golf, or track and field. Consider auxiliary microphones that can be attached to digital devices to enhance the quality and volume of this captured audio.

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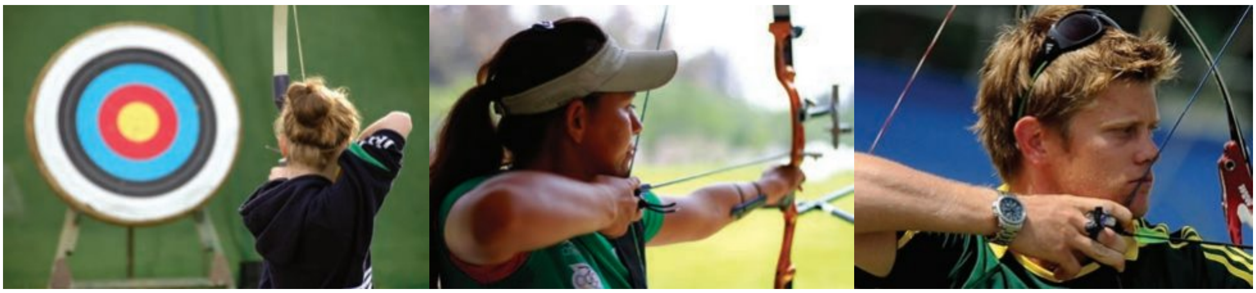
- **Carefully consider the angle of the shots required.** The correct angle can be one of the most important factors in producing creditable evidence in assessment tasks. For example, shooting side on and focusing on one end in a tennis match may be counter-productive, as it shows very little of the important aspects of the game. An 'over the shoulder' shot showing serves and gameplay from behind will not only demonstrate technique, but also the application of the skills, as the opponent's movement and outcome of the rally can be seen.



The key is to identify early in the unit the type of footage required to successfully complete the assessment task, and then frequently collect a wide variety of shots through the learning period.

- **Consider the height, depth and width of shots.** Invasion and striking and fielding activities may require footage captured from behind the goals or score-line to see the movements of all players on and off the ball when setting up attacking or defending strategies. Where a defence line is required, in activities such as touch football, then some side-on shots may also be helpful, with the camera panning and zooming as required.

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In activities played on a small court, such as badminton, volleyball or tennis, it may be advantageous to gain shots from an elevated position behind the court, rather than tracking the ball from end to end from the side of court.

- **Use the zoom function.** When taking long shots of an entire game (e.g. from behind the line in a touch game), zoom should be used to gain a closer perspective, focusing on fewer players at some stages. However, do not zoom to a close shot of a single player, as this does not allow the interplay between players and opponents to be viewed. With these types of activities, this interplay (and the associated decision-making and skill modification) may be essential to the assessment task.

✓ Long shots are fine to use when players can easily be identified.

✓ Zooming can be used to highlight specific skills or tactics.

✗ Zooming too close restricts what the footage can demonstrate.

- **Film frequently.** It can be difficult to find the best clips to represent exactly what is required for an assessment task. Knowing the task and what is required assists in identifying the type of footage that might be helpful. However, collecting footage frequently right from the beginning of a unit will make finding the required shot more likely.
- **Be familiar with the video editing software that will be used for putting the evidence together.** Having to change the file format of footage can be a long and confusing task before editing even begins. It is essential to ensure that the captured video footage is compatible with the editing software to be used.

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Tips for editing

To make a multimodal project from raw footage typically requires elements such as trimming clips, voiceovers, titles, creating stills and the ability to draw diagrams and titles over footage to highlight features. At times, a completed multimodal project may require the use of three or four different programs in its construction, from video editing to Excel graphs or screen capturing; knowing these programs is vital to maximising assessment results. During construction, consider the following:

- **Clearly label and identify the footage through the use of titles.** Appropriate titles may:
  - include an initial title highlighting the purpose of the task
  - include additional titles to introduce sub-sections if appropriate
  - be overlaid on footage to highlight specific points for the audience
  - pose inquiry questions which are answered through the pictures or voiceovers.
- **Use meaningful 'chunks' of footage.** When showcasing the ability to demonstrate and apply technical and tactical elements for physical performance, use clips that are at least 15–20 seconds long. Cutting together 20 different five-second clips may be an indication that the performance lacks consistency. Bigger chunks also mean less time spent editing.
- **Only use quality footage that supports the assessment task.** Cut out irrelevant footage from performances to reduce the length of evidence. Be selective in what is presented. No matter what the task, ability and knowledge you are showing may be, taking 15 seconds to set up an activity or retrieve a dropped ball does not help to demonstrate ability, nor will it support the quality of an activity.
- **Use slow motion for emphasis.** It may be beneficial to slow down elements or even 'freeze' performances to showcase technical or tactical aspects and allow time for commentary to explain the evidence. The section slowed might then be replayed in real time to demonstrate performance.
- **Speed up footage to reduce time.** Consider the relevance of the footage being displayed in relation to the task. When completing some activities,

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it may be vital to show the entire performance (such as a timed 800 m race or a complete sport aerobic routine) or to show successive performances (for example, consecutive shots to complete a golf hole or shooting four consecutive arrows). However, it may be beneficial to speed up much of the performance so relevant aspects can be highlighted in more detail as they appear.

- **Use the sound of performance.** If the sound from the footage is simply the irritating sound of wind blowing across the device's microphone, then turning the volume down or muting it altogether may be entirely appropriate. However, the sounds of 'play' (calls and player communication) may be beneficial to the task. Consider lowering the volume while speaking a voiceover, but then enhancing the audio from the footage when there is no commentary if relevant.
- **Use footage from different times if appropriate to the task.** Placing moving footage of two cricket shots – one from early in the unit and the other from later in the unit – may assist in highlighting performance gains over time. Side-by-side still shots of techniques can produce the same effect.
- **Ensure the final product is in a format that can be viewed.** When submitting a completed multimodal project, ensure the files are exported correctly from the software and can be played independently from the device on which they were created.

8.3 Assessment support

In this section, advice will be given on responding to multiple-choice and short-response questions.

Within Physical Education, an external exam will be set. This will include both multiple-choice and short-response questions, and an extended writing task. This section will deal with strategies for supporting students to complete assessment in multiple-choice and short-response questions.

Multiple-choice questions

Multiple-choice items are designed to assess your knowledge retrieval and comprehension, and when stimulus is provided, your ability to analyse.

Multiple-choice questions are made up of the following components:

- **Stem.** This is the question, which may be in the form of a question, problem, incomplete statement or situation.
- **Option.** Usually there will be four possible options.
- **Key.** The correct answer in the list of options.
- **Distractors.** The incorrect answers in the list of options.

To be successful at completing multiple-choice questions, besides knowing the content matter and developing your cognitive processes, a number of strategies can be used, as shown in Table 8.5 on the following page.

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Active reading	Question	Stimulus material
Annotating – as the external exam is online, use of paper to clarify your thoughts is essential.	Clear identification of what is being asked is crucial.	If stimulus material is included, it is there for a reason. Use the information in the material.
Dual strategy	Positive identification – look for evidence to support choice.	Elimination – look for distractors that are incorrect.
Avoid projection	If it seems too easy, it most probably is. Ensure you are not misunderstanding what has been asked and that your processes are accurate.	Use information in the stimulus material.
Dangerous questions	Answer based on evidence that you know.	Be alert to classic errors – use of some information as a distractor, an opposite response, etc.
Taking uncertain questions in your stride	Level of difficulty is not always sequential, do not get stuck or flustered.	Perseverance and good management are rewarded.
Never leave any question 'unguessed'	Revert to concrete working.	Ensure that you continue to refer back to the stimulus to ensure your understanding.
Ensure time-management is effective	Use of perusal time – read over stimulus, be aware of number of questions and time available.	During the test, reflect on the number of questions answered and the time remaining.

Table 8.5 Strategies for responding to multiple-choice questions

Short-response questions

You must have an open mind to find ways to improve your application of cognitive skills in new problem-solving situations. You possess a range of cognitions learned and refined in Physical Education and other subjects over the past five years, and these questions are about ensuring that you can demonstrate these skills to the best of your ability.

You must accept that skills can be improved and that there is room for improvement. Do not undersell yourself. If you have the capacity to acquire basic skills, you also have the capacity to continually refine their application. Do not believe you already 'know it all': learning is a lifelong process, and new skills and higher level refinements can always be acquired.

The difficulty of achieving very high marks on all questions of the short-response question test should not put you off, but rather give you confidence and challenge you. You can be confident that, by having a go and getting on the board in those items that are most difficult, you will be much better placed than those students who do not attempt difficult tasks.

Short-response questions assess retrieval, comprehension, analysis and knowledge utilisation.

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Students apply their knowledge and demonstrate skills or processes. Depending on the type of short-response question, expected responses are likely to be up to 250 words in length. Short-response questions may involve:

- **simple short-response items** – simple familiar procedures, labelling diagrams, sentences, short paragraphs, response to stimulus single word or sentence response or simple familiar calculations
- **practical short-response items** – drawing maps, graphs or diagrams, calculations, modelling, illustrations, data responses, complex familiar operations in an unfamiliar context
- **interpretive short-response items** – interpreting graphs, tables and diagrams, analysing stimulus and information, paragraph responses to stimulus or complex unfamiliar operations.

Before attempting a short-response question, you should consider the following three steps. These represent a strategic approach to answering short-response questions that can reduce the likelihood of you making costly errors and not achieving grades that reflect your ability:

1 Consider all the information.
2 Ask yourself the question: What do I have to do?
3 Ask yourself the question: What will be valued?

Consider all the information

Before attempting to answer a question, make sure you have considered all the materials associated with the question. Some material relates to more than one question, so be careful. Even minor detail such as the border around a page may give some hint as to what is required.

Short-response questions come in many forms. They may be in colour or black and white, and they may present information in a table, a painting, a poem or any combination of these and many other forms. You can be certain, as the examinee, that every piece of material is important and must be considered. For example, if colour is used, it is there to make or emphasise an important feature or point. It will be useful when considering all the information in a question for you to know, understand and be able to identify the essential features present in all short-response questions:

- **stimulus** – information provided with the question, which will be data of some sort; this may be a paragraph of text, a diagram or a graph
- **stem** – the question, which may be a direct question, problem, incomplete statement or situation
- **cue** – essential further instructions on how you are to respond. In your consideration of all the information, you should consciously try to identify the essential features listed.

For the question as a whole and for each of these items (as applicable), ensure that you are able to identify the stimulus material, stem and cue.

There is no accepted preference for students to first read the stimulus material then the questions, or vice versa. The best approach to a short-response question is probably to skim the entire question to begin with, get some sense of the stimulus and the question, then go back and read the stimulus material carefully and critically (highlighter in hand).

What do I have to do?

The answer to this question is generally found in the stem. Typically, you are looking for key words that instruct you with regard to the task to be completed. Such key words are shown in Table 8.6.

Before answering each question, identify key words (usually in the stem) that answer the question

account for	approximate	comment on	compare	contrast	demonstrate	derive	describe
determine	discuss	draw	estimate	evaluate	explain	expound	express
find	generalise	identify	illustrate	indicate	justify	list	outline
present	prove	quote	rank	refer	show	sketch	state
substitute	suggest	summarise	transcribe	verify			

Table 8.6 Key words in short-answer questions

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Objectives	Activity icons
1 Students **recognise** and explain tactical awareness and ethics and integrity concepts and principles about selected physical activities.	
2 Students **demonstrate** specialised movement sequences and movement strategies in the selected physical activity.	
3 Students **apply** concepts to specialised movement sequences and movement strategies in the selected physical activity.	
4 Students **analyse and synthesise** data to devise strategies about tactical awareness and ethics and integrity.	
5 Students **evaluate** tactical, ethics and movement strategies.	
6 Students **justify** tactical, ethics and movement strategies.	
7 Students **make decisions** about and use language, conventions and mode-appropriate features for particular purposes and contexts.	

Table 8.7 Objectives and activity icons

'What do I have to do?' For example, you are required to 'find a sentence' in the 'second paragraph' that 'summarises the idea' …

The words used in the stem will be linked to the cognitions undertaken during the course of study. Throughout this book, the cognitions have been highlighted and practised while completing Engage-in and Check-in activities, and Active Investigations. Similarly, the cognitions are listed within the objectives and activity icons at the start of each chapter (see Table 8.7).

What will be valued?

Before answering each question, identify key words (usually in the cue as well as in the stem) that answer the question 'What will be valued?' For example, the words 'transcribe' and 'exact' make it quite clear how the answer should be presented.

Having established the task, the next step is to establish how to complete the task. Clues to what will be valued by the marker may be explicit or implicit, and they are usually found in the cue, the stem or both. For example:

a Use information in Extract 1.
b Show all intermediate steps.
c Round your answer to the nearest million.

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Evaluation and reflection

At the completion of the practice questions at the end of each chapter, you should evaluate your performance and reflect on the following:

- How easily were you able to identify the relevant sections of the text?
- Could you explain to another person the steps you went through to arrive at your answer once you had identified the relevant section of the text?
- Are the cues clear? What circumstances might lead to responses that do not follow the cues?
- Calling on the experience and insights you have gained, list some strategies that could be used to avoid errors and improve grades on similar items in the future.
- Finally, a very useful conclusion to this activity may be for you to summarise your learning in the form of a plan of approach (game plan) for similar units, or perhaps any unit that complements or expands upon the 'three-step approach'.

8.4 Taxonomy, cognitive processes and cognitive verbs

The current version of the Physical Education General Senior Syllabus (Queensland) is underpinned by an educational taxonomy based on the work of Marzano and Kendall (2006). Through the syllabus objectives, students are required to engage in a range of cognitive processes deemed relevant to Physical Education. It is through the use of these cognitive processes that students demonstrate thinking, learning and understanding in relation to the required Physical Education subject-matter. Students are guided towards cognitive processes through the use of cognitive verbs instructing them how to interact with the subject-matter. It is therefore essential that cognitive verbs are clearly defined and understood by students if they are to interact with subject-matter in the required ways. Table 8.8 (on pp. 498–514) helps to outline cognitive processes and cognitive verbs surrounding the current version of the Physical Education General Senior Syllabus (Queensland).

Cognitive process categories and cognitive verbs

Cognitive processes, verbs and definitions

Rows in green in Table 8.8 highlight the cognitive verbs specific to the current version of the Physical Education General Senior Syllabus (Queensland). Additional cognitive verbs that exist within the syllabus of all Queensland subjects are also defined here to assist in the development of all thinking skills.

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Term	Explanation	Process	Graphic organisers to clarify thinking
Analyse	• Dissect to ascertain and examine constituent parts and/or their relationships; break down or examine in order to identify the essential elements, features, components or structure; determine the logic and reasonableness of information. • Examine or consider something in order to explain and interpret it, for the purpose of finding meaning or relationships and identifying patterns, similarities and differences.	1 **Establish the purpose.** Know exactly what is to be analysed; what is the focus and who is the audience for the analysis. 2 **What are the constituent parts?** Identify each element that is the focus of the analysis. 3 **Examine each part and its place.** For each part, explain its purpose or function within the item or concept being analysed. If required, detail how it relates to other parts. 4 **Present the analysis.** Using logical development, present the item being analysed and in a procedural way break down and explain each part that must be examined. Provide the relationship with other parts if required to create links and allow the response to flow.	• Cluster map • Flow chart • Relationship flower • Relationship web • SWOT analysis
Apply	Use knowledge and understanding in response to a given situation or circumstance; carry out or use a procedure in a given or particular situation.		
Appraise	Evaluate the worth, significance or status of something; judge or consider a text or piece of work.	1 **What are the criteria?** Establish or identify the criteria by which worth, significance or status will be determined. 2 **What is the scale?** Establish or identify a scale to be used for the criteria (i.e. how will the levels of worth, significance or status be described?). 3 **Make an appraisal.** Reflect on the focus for the appraisal and use the criteria and scale to make a judgment on the worth, significance or status. 4 **Support your appraisal** *(if required)*. Defend your appraisal by identifying the links between each criterion and the merit assigned in the appraisal.	• Evaluating scales • PMI chart • Star review • SWOT analysis • Y-chart

Table 8.8 Cognitive verbs

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Term	Explanation	Process	Graphic organisers to clarify thinking
Appreciate	Recognise or make a judgment about the value or worth of something; understand fully; grasp the full implications of.		
Argue	Give reasons for or against something; challenge or debate an issue or idea; persuade, prove or try to prove by giving reasons.		
Assess	Measure, determine, evaluate, estimate or make a judgment about the value, quality, outcomes, results, size, significance, nature or extent of something.		
Calculate	Determine or find (e.g. a number, answer) by using mathematical processes; obtain a numerical answer showing the relevant stages in the working; ascertain/determine from given facts, figures or information.		
Categorise	Place in or assign to a particular class or group; arrange or order by classes or categories; classify, sort out, sort, separate.	1 **What are the categories?** Establish or identify the category or categories to be used. 2 **Category criteria.** Establish exactly what is meant by each category by defining it or setting some criteria. 3 **Classify and present.** Place the elements to be classified into the relevant category and present appropriately. Consider formal paragraphs, lists, dot points, tables, graphs or diagrams.	• Classification table • Classification web • T-chart • Tree map
Clarify	Make clear or intelligible; explain; make a statement or situation less confused and more comprehensible.		

Table 8.8 *(continued)*

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Term	Explanation	Process	Graphic organisers to clarify thinking
Classify	Arrange, distribute or order in classes or categories according to shared qualities or characteristics.		
Comment	Express an opinion, observation or reaction in speech or writing; give a judgment based on a given statement or result of a calculation.		
Communicate	Convey knowledge and/or understandings to others; make known; transmit.		
Compare	Display recognition of similarities and differences and recognise the significance of these similarities and differences.	1 **Identify features.** List all the features associated with one area of focus, then all those associated with the other. 2 **Categorise.** Identify features that are common to both areas of focus (similarities), ensure the features left over for each area of focus are actually 'unique' to each (differences). 3 **Display.** Construct a piece of writing that fluently gathers and explains the key similarities and then highlights the unique features of each area of focus; or display using an appropriate diagram.	• Similarities and Differences (S&D) bubble map • Relationship web • T-chart • Venn diagram
Comprehend	Understand the meaning or nature of; grasp mentally.		
Conduct	Direct in action or course; manage; organise; carry out.		

Table 8.8 *(continued)*

ISBN 978-1-108-59096-9

Term	Explanation	Process	Graphic organisers to clarify thinking
Consider	Think deliberately or carefully about something, typically before making a decision; take something into account when making a judgment; view attentively or scrutinise; reflect on.	1 **Identify what is to be considered.** What exactly is the focus, concept or dilemma? 2 **Identify the purpose for the consideration.** To make judgment, a decision, view alternatively, scrutinise or reflect on. 3 **Identify all relevant aspects.** Considering the purpose, what are the essential elements or features that need to be thought through? 4 **Research each relevant element.** For each element, ensure enough factual knowledge is gained. 5 **Address the purpose.** Appropriately present the consideration, ensuring the purpose is addressed clearly.	• Cause-and-effect map • Cluster map • Flow chart • Relationship web • SWOT analysis • T-chart
Construct	Create or put together (e.g. an argument) by arranging ideas or items; display information in a diagrammatic or logical form; make; build.		
Contrast	Display recognition of differences by deliberate juxtaposition of contrary elements; show how things are different or opposite; give an account of the differences between two or more items or situations, referring to both or all of them throughout. Use juxtaposition: placing side by side for examination or comparison.	1 **Identify features.** List all the features associated with each area of focus 2 **Categorise.** Identify features that are common to both areas of focus (similarities); ensure the features left over for each area of focus are actually 'unique' to each (differences). 3 **Display.** Construct a piece of writing that fluently highlights the key features unique to each area of focus. Use terms such as 'while', 'whereas', 'however', 'but' and 'although' to form complex sentences relating differences and creating the juxtaposition. Alternatively, use an appropriate diagram highlighting differences.	• S&D bubble map • Relationship web • T-chart • Venn diagram

Table 8.8 *(continued)*

ISBN 978-1-108-59096-9

Term	Explanation	Process	Graphic organisers to clarify thinking
Create	Bring something into being or existence; produce or evolve from one's own thought or imagination; reorganise or put elements together into a new pattern or structure or to form a coherent or functional whole.	1 **What are the constraints and criteria?** Identify any guidelines to which your creation may need to adhere and, if relevant, the criteria by which your creation will be judged. 2 **Research.** Find as many examples as possible of the creation already in existence and identify components from each that are relevant or that could be utilised. 3 **Construct and critically review.** Drawing on your research, construct your creation. Ensure that, throughout construction, ideas are workshopped to make a unique composition and ensure any requirements or criteria are being met. 4 **Journal the creative process.** Ensure thoughts and ideas are tracked – those that helped to form the creation and those that were dismissed. Many tasks of this nature require written documentation of the creative process.	• Concept board • Concept map • Flow chart • Mind map • Storyboard
Critique	Review (e.g. a theory, practice, performance) in a detailed, analytical and critical way.	1 **Establish the focus for the critique.** What exactly are you required to comment on or about? 2 **Establish the judgments to be made.** What scale or adjectives could be used to comment on the consistency, authenticity or merit? 3 **Make judgments.** Decide on the level of consistency, authenticity or merit in the focus for your critique. Write these comments in clear statements and provide support for your statements by referring specifically to elements in the text or focus of the critique.	• Evaluating scales • PMI chart • Star review • SWOT analysis • Y-chart

Table 8.8 *(continued)*

ISBN 978-1-108-59096-9

Term	Explanation	Process	Graphic organisers to clarify thinking
Decide	Reach a resolution as a result of consideration; make a choice from a number of alternatives.	1 **Identify solutions or alternatives.** Research a range of possible alternatives. 2 **Evaluate each alternative.** Evaluate each alternative, investigating their effectiveness in other similar situations and the ability to transfer to the current issue. 3 **Decide on an option.** Select an option that is most likely to produce a suitable resolution. 4 **Justify** *(if required)*. Present the decision and, in a logical manner, outline the process undertaken to reach the selected option.	• Evaluating scales • PMI chart • Recommendation table • Star review • SWOT analysis
Deduce	Reach a conclusion that is necessarily true, provided a given set of assumptions is true; arrive at, reach or draw a logical conclusion from reasoning and the information given.		
Define	Give the meaning of a word, phrase, concept or physical quantity; state meaning and identify or describe qualities.		
Demonstrate	Prove or make clear by argument, reasoning or evidence, illustrating with practical example; show by example; give a practical exhibition.		
Derive	Arrive at by reasoning; manipulate a mathematical relationship to give a new equation or relationship; in mathematics, obtain the derivative of a function.		
Describe	Give an account (written or spoken) of a situation, event, pattern or process, or of the characteristics or features of something.		

Table 8.8 *(continued)*

ISBN 978-1-108-59096-9

Term	Explanation	Process	Graphic organisers to clarify thinking
Design	Produce a plan, simulation, model or similar; plan, form or conceive in the mind; in English, select, organise and use particular elements in the process of text construction for particular purposes; these elements may be linguistic (words), visual (images), audio (sounds), gestural (body language), spatial (arrangement on the page or screen) and multimodal (a combination of more than one).	1 **What are the constraints and criteria?** Identify any guidelines to which your design may need to adhere and, if relevant, the criteria by which your design will be judged. 2 **Research.** Find as many examples as possible of products already in existence and identify components of each that are relevant or that can be utilised. 3 **Construct and critically review.** Drawing on your research, construct your design. Ensure that throughout construction you trial ideas and workshop unique composition to ensure you meet requirements or maximise how criteria are being met. 4 **Journal the creative process.** As you design, ensure you track your thoughts and ideas – those that helped form your product and those with which you did not follow through. Many tasks of this nature require you to document the design process with a written accompaniment.	• Concept board • Concept map • Flow chart • Mind map • Storyboard
Determine	Establish, conclude or ascertain after consideration, observation, investigation or calculation; decide or come to a resolution.		
Develop	Elaborate, expand or enlarge in detail; add detail and fullness to; cause to become more complex or intricate.		
Devise	Think out; plan; contrive; invent.		

Table 8.8 *(continued)*

ISBN 978-1-108-59096-9

Term	Explanation	Process	Graphic organisers to clarify thinking
Differentiate	Identify the difference/s in or between two or more things; distinguish, discriminate; recognise or ascertain what makes something distinct from similar things; in mathematics, obtain the derivative of a function.		
Discriminate	Note, observe or recognise a difference; make or constitute a distinction in or between; differentiate; note or distinguish as different.		
Discuss	Examine by argument; sift the considerations for and against; debate; talk or write about a topic, including a range of arguments, factors or hypotheses; consider, taking into account different issues and ideas, points for and/or against, and supporting opinions or conclusions with evidence.		
Distinguish	Recognise as distinct or different; note points of difference between; discriminate; discern; make clear a difference/s between two or more concepts or items.		
Document	Support (e.g. an assertion, claim, statement) with evidence (e.g. decisive information, written references, citations).		
Evaluate	Make an appraisal by weighing up or assessing strengths, implications and limitations; make judgments about ideas, works, solutions or methods in relation to selected criteria; examine and determine the merit, value or significance of something, based on criteria.	1 **What are the criteria?** Establish or identify the criteria by which judgments, merit, value or significance will be determined. 2 **What is the scale?** Establish or identify the scale to be used for each criterion – how many levels there are and what standards are associated with each level.	• Evaluating scales • PMI chart • Star review • SWOT analysis • Y-chart

Table 8.8 *(continued)*

ISBN 978-1-108-59096-9

Term	Explanation	Process	Graphic organisers to clarify thinking
		3 **Analyse and categorise.** Analyse the topic and categorise the relevant features using the scale for each criteria – that is, make the appraisal. 4 **Support your evaluation.** Defend your evaluation by identifying the links between each criteria and the merit assigned in the appraisal.	
Examine	Investigate, inspect or scrutinise; inquire or search into; consider or discuss an argument or concept in a way that uncovers the assumptions and interrelationships of the issue.	1 **Establish the purpose.** Know exactly what is to be examined; know the focus and audience for the examination. 2 **Identify all relevant features.** Considering the purpose, what are the essential features that need to be investigated? 3 **Research each relevant feature.** For each feature, ensure enough factual knowledge is gained for examination. 4 **Address the purpose.** Using logical development, present the item being examined and, in a procedural way, explain each feature in relation to the purpose of the examination.	• Cause-and-effect map • Cluster map • Flow chart • PMI chart • Relationship web • SWOT analysis • T-chart
Execute	Apply a procedure to a familiar task; perform a procedure without significant error, but not necessarily understanding how and why the procedure works; produce in accordance with a plan or design; put into effect – a plan, order or course of action.		

Table 8.8 *(continued)*

ISBN 978-1-108-59096-9

Term	Explanation	Process	Graphic organisers to clarify thinking
Experiment	Try out or test new ideas or methods, especially in order to discover or prove something; undertake or perform a scientific procedure to test a hypothesis, make a discovery or demonstrate a known fact.		
Explain	Make an idea or situation plain or clear by describing it in more detail or revealing relevant facts; give an account; provide additional information.	1 **Identify all relevant features.** What are the essential features or facts about the subject that need to be explained? 2 **Research each relevant feature.** Ensure enough factual knowledge is gained to adequately explain each feature or fact. 3 **Present** the explanation. Using logical development, present the item being explained and, in a procedural way, systematically clarify each feature.	• Cause-and-effect map • Fishbone diagram • Flow chart • PMI chart • Relationship web • T-chart
Explore	Look into, both closely and broadly; scrutinise; inquire into or discuss something in detail.		
Express	Convey, show or communicate (e.g. a thought, opinion, feeling, emotion, idea or viewpoint); (in words, art, music or movement) convey or suggest a representation of; depict.		
Extrapolate	Infer or estimate by extending or projecting known information; conjecture; infer from what is known; extend the application of something (e.g. a method or conclusion) to an unknown situation by assuming that existing trends will continue or similar methods will be applicable.		
Generate	Produce; create; bring into existence.		

Table 8.8 *(continued)*

ISBN 978-1-108-59096-9

Term	Explanation	Process	Graphic organisers to clarify thinking
Hypothesise	Formulate a supposition to account for known facts or observed occurrences; conjecture, theorise, speculate; especially on uncertain or tentative grounds. The supposition is often the subject of a validation process. *Note:* Supposition – a belief held without proof or certain knowledge; an assumption.	1 **What are the current facts?** Identify the data or information about which a hypothesis is to be made. 2 **Form a hypothesis.** From the information to hand, make a plausible assumption that explains how the data, information or results came about – what 'caused' this. 3 **Validate the hypothesis** *(if required).* Undertake further research to find evidence to prove or disprove the supposition and/or undertake a process to gather primary evidence that tests your hypothesis. 4 **Present finding (if required).** Use an appropriate genre to present the evidence gathered about the hypothesis. Clearly state the hypothesis early on, provide evidence gathered then conclude by stating whether the evidence has proved or disproved the hypothesis.	• Cause-and-effect map • Fishbone diagram • Flow chart • Relationship web
Identify	Distinguish; locate, recognise and name; establish or indicate who or what someone or something is; provide an answer from a number of possibilities; recognise and state a distinguishing factor or feature.		
Implement	Put something into effect – e.g. a plan or proposal.		
Infer	Derive or conclude something from evidence and reasoning, rather than from explicit statements; listen or read beyond what has been literally expressed; imply or hint at.		

Table 8.8 *(continued)*

ISBN 978-1-108-59096-9

Term	Explanation	Process	Graphic organisers to clarify thinking
Interpret	Use knowledge and understanding to recognise trends and draw conclusions from given information; make clear or explicit; elucidate or understand in a particular way. Bring out the meaning of, for example, a dramatic or musical work, by performance or execution; bring out the meaning of an artwork by artistic representation or performance; give one's own interpretation of. Identify or draw meaning from, or give meaning to, information presented in various forms, such as words, symbols, pictures or graphs.		
Investigate	Carry out an examination or formal inquiry in order to establish or obtain facts and reach new conclusions; search, inquire into, interpret and draw conclusions about data and information.	1 **Establish the purpose.** Know exactly what is to be investigated; what is the focus and who is the audience; identify all relevant data or information. 2 **Research data and information.** Considering the purpose, what is the essential data and information that is required? Gather and interpret enough data and information to establish facts; and draw conclusions if required. 3 **Present the investigation.** Using logical development, present the item being investigated and in a procedural way interpret relevant information and data; finish by drawing the logical conclusion.	• Cause-and-effect map • Cluster map • Flow chart • PMI chart • Relationship web • SWOT analysis • T-chart

Table 8.8 *(continued)*

ISBN 978-1-108-59096-9

Term	Explanation	Process	Graphic organisers to clarify thinking
Judge	Form an opinion or conclusion about; apply both procedural and deliberative operations to make a determination.	1 **What is the judgment about?** Identify the topic for the judgment and exactly what features are to be judged. 2 **Research the features.** Investigate each relevant feature of the topic. 3 **Evaluate the research.** For each element of research, consider the importance of or influence on the topic and on the individual making the judgment. 4 **Form an opinion or conclusion.** From the evaluation of research, present an opinion or conclusion about the topic; if required, support with the research that led to the opinion or conclusion being formed.	• Cause-and-effect map • Evaluating scales • PMI chart • Star review • SWOT analysis • Y-chart
Justify	Give reasons or evidence to support an answer, response or conclusion; show or prove how an argument, statement or conclusion is right or reasonable.	1 **Identify.** Identify the statement and the exact manner in which it is to be supported. 2 **Gather.** Gather a range of creditable evidence that supports the statement in the manner that is required. 3 **Evaluate and rank.** Assess the quality of the evidence and rank from best to worst. 4 **Formulate a response.** In a logical manner, provide the relevant evidence to support the statement, generally beginning with the best evidence identified.	• Cause-and-effect map • Flow chart • Relationships flower • SWOT analysis • Writing scaffold

Table 8.8 *(continued)*

ISBN 978-1-108-59096-9

Term	Explanation	Process	Graphic organisers to clarify thinking
Make decisions	Select from available options; weigh up the positives and negatives of each option and consider all the alternatives to arrive at a position.	1 **Identify the issue.** Clearly identify the issue and any factors that may be influencing the outcome. 2 **Identify solution or alternatives.** Research a range of possible alternatives. 3 **Evaluate each alternative.** Evaluate each alternative, investigating its effectiveness in other similar situations and the ability to transfer to the current issue. 4 **Decide on an option.** For the evaluation, decide on the best option. 5 **Justify** *(if required).* Present the decision and, in a logical manner, outline the process undertaken in reaching the selected option.	• Cause-and-effect map • Evaluating scales • PMI chart • Recommendation table • Star review • SWOT analysis • Synthesis bring down
Manipulate	Adapt or change to suit one's purpose.		
Modify	Change the form or qualities of; make partial or minor changes to something.	1 **Understand** the purpose for the modification. 2 **Identify why a modification is required** – what is trying to be achieved? 3 **Identify the deficiencies.** 4 **Find** exactly how the item to be modified is currently not meeting the desired purpose and the causes of these deficiencies. 5 **Find solutions.** Research other items that achieve a similar purpose and/ or trial potential options. 6 **Synthesise and evaluate**. Incorporate the best modification for achieving the purpose and continue to evaluate its effectiveness.	• Concept board • Concept map • Flow chart • Mind map • SWOT analysis • Synthesis bring down

Table 8.8 *(continued)*

ISBN 978-1-108-59096-9

Term	Explanation	Process	Graphic organisers to clarify thinking
		7 **Journal the modification process.** Ensure thoughts and ideas are tracked – those that helped with the modification and those that were dismissed. Many tasks of this nature require written documentation of the modification process.	
Organise	Arrange, order; form as or into a whole consisting of interdependent or coordinated parts, especially for harmonious or united action.		
Predict	Give an expected result of an upcoming action or event; suggest what may happen based on available information.		
Propose	Put forward (e.g. a point of view, idea, argument, suggestion) for consideration or action.		
Prove	Use a sequence of steps to obtain the required result in a formal way.		
Realise	Create or make (e.g. a musical, artistic or dramatic work); actualise; make real or concrete; give reality or substance to.		
Recall	Remember; present remembered ideas, facts or experiences; bring something back into thought, attention or into one's mind.		
Recognise	Identify or recall particular features of information from knowledge; identify that an item, characteristic or quality exists; perceive as existing or true; be aware of or acknowledge.		
Reflect on	Think about deeply and carefully.		

Table 8.8 *(continued)*

ISBN 978-1-108-59096-9

Term	Explanation	Process	Graphic organisers to clarify thinking
Resolve	(In the arts) consolidate and communicate intent through a synthesis of ideas and application of media to express meaning.		
Select	Choose in preference to another or others; pick out.		
Sequence	Place in a continuous or connected series; arrange in a particular order.		
Sketch	Execute a drawing or painting in simple form, giving essential features but not necessarily with detail or accuracy; in mathematics, represent by means of a diagram or graph; the sketch should give a general idea of the required shape or relationship and should include features.		
Solve	Find an answer to, explanation for, or means of dealing with (e.g. a problem). Work out the answer or solution to (e.g. a mathematical problem). Obtain the answer/s using algebraic, numerical and/or graphical methods.	1 **Find.** Identify the issue to be solved, and where this problem may have been seen or solved previously. 2 **Plan.** Explore possible solutions and select the most appropriate or logical. 3 **Do.** Implement the solution (if required). 4 **Review.** Review the implemented solution to check the problem has been solved.	• Problem–solution table • Recommendation table • SWOT analysis • Synthesis bring down
Structure	Give a pattern, organisation or arrangement to; construct or arrange according to a plan.		
Summarise	Give a brief statement of a general theme or major point/s; present ideas and information in fewer words and in sequence.		

Table 8.8 *(continued)*

ISBN 978-1-108-59096-9

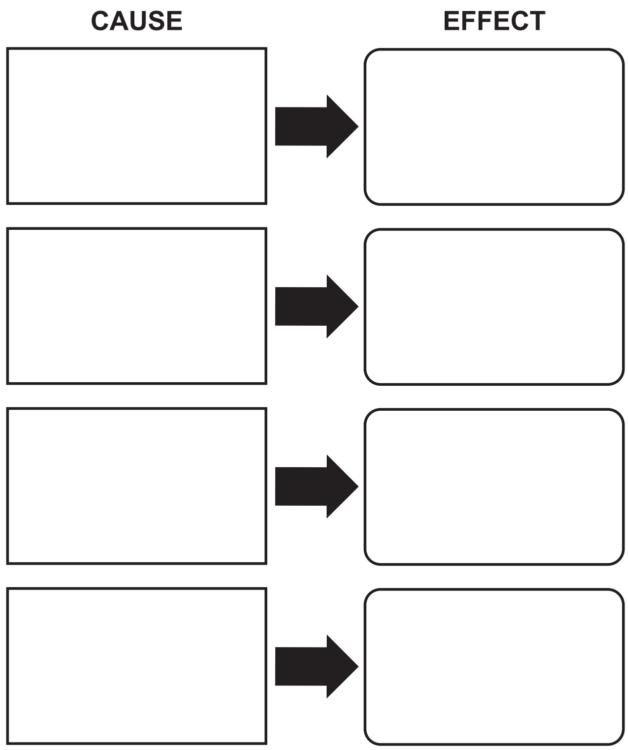
Term	Explanation	Process	Graphic organisers to clarify thinking
Symbolise	Represent or identify by a symbol or symbols.		
Synthesise	Combine different parts or elements (e.g. information, ideas, components) into a whole, in order to create new understanding.	1 **Know** the final product. 2 **Identify** what is to be produced through the synthesis, knowing that the final purpose will assist in knowing what is relevant to incorporate. 3 **Gather** the elements required. 4 **Identify** what elements have to be synthesised. Have all elements been given? Is research beyond the given elements required? If so, ensure the quality and relevance of the elements gathered. 5 **Examine** and understand each element or component individually. 6 **Look** for the links and assemble. 7 **Present** the relationships between the elements in a coherent and logical manner.	• Concept board • Concept map • Fishbone diagram • Frayer model diagram • Flow chart • Information vortex • Mind map • Synthesis bring down
Test	Take measures to check the quality, performance or reliability of something.		
Understand	Perceive what is meant by something; grasp; be familiar with (e.g. an idea); construct meaning from messages, including oral, written and graphic communication.		
Use	Operate or put into effect; apply knowledge or rules to put theory into practice.		

Table 8.8 *(continued)*

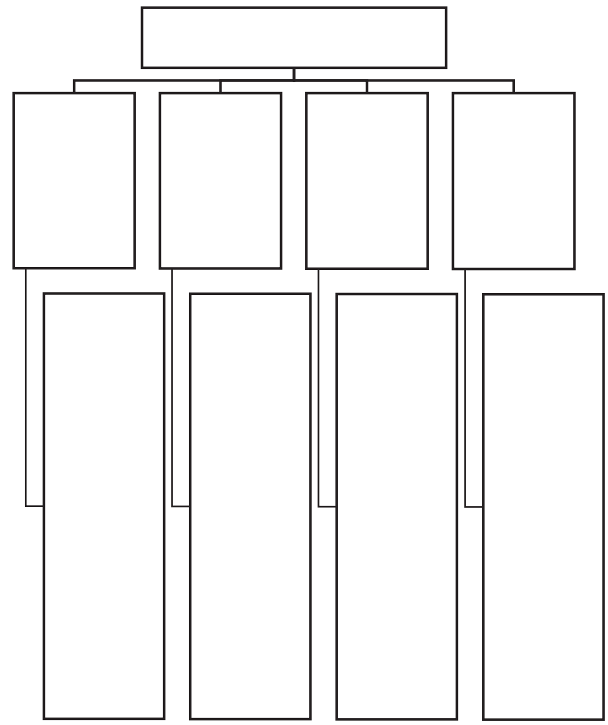
ISBN 978-1-108-59096-9

8.5 Graphic organisers to assist with cognitive verb use

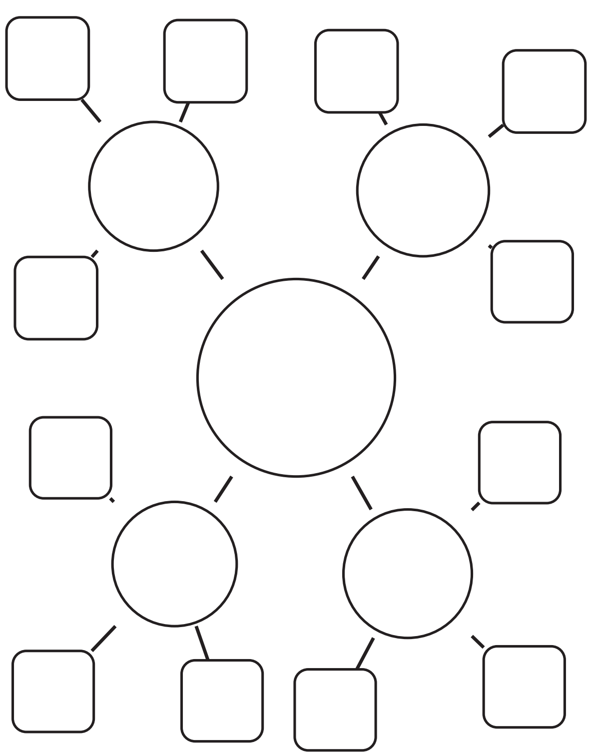
Cause-and-effect map



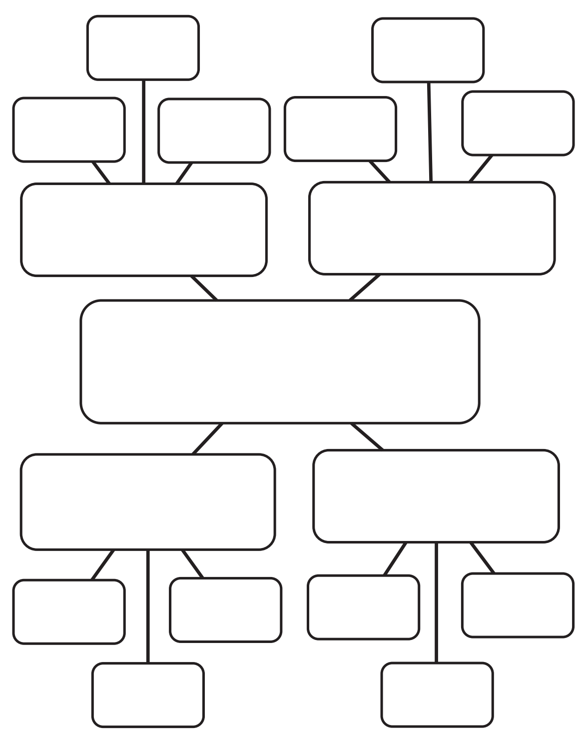
Classification table



Classification web



Cluster map



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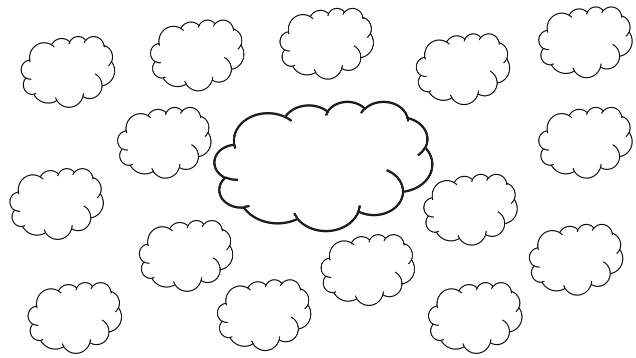
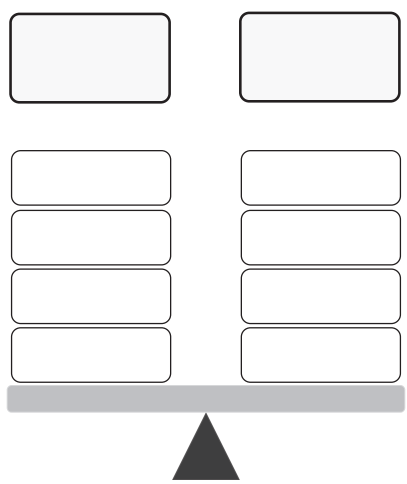
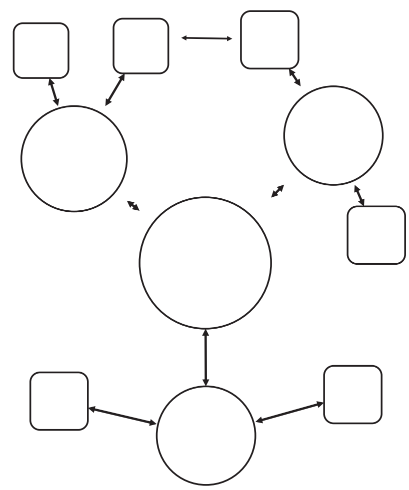
Concept board



Evaluating scales



Concept map



Essay planner

THESIS STATEMENT:

Point 1:This should be an evaluation statement that supports your THESIS STATEMENT

What Evidence Supports this point?

What is your **1st piece of evidence** to support the point of this paragraph?

What Type of Evidence is this?:
How does this evidence supports the Point (**Explanation**)

What is your **2nd piece of evidence** to support the point of this paragraph?

What Type of Evidence is this?:
How does this evidence supports the Point (**Explanation**)

What is your **3rd piece of evidence** to support the point of this paragraph?

What Type of Evidence is this?:
How does this evidence supports the Point (**Explanation**)

Point 2:This should be an evaluation statement that supports your THESIS STATEMENT

What Evidence Supports this point?

What is your **1st piece of evidence** to support the point of this paragraph?

What Type of Evidence is this?:
How does this evidence supports the Point (**Explanation**)

What is your **2nd piece of evidence** to support the point of this paragraph?

What Type of Evidence is this?:
How does this evidence supports the Point (**Explanation**)

What is your **3rd piece of evidence** to support the point of this paragraph?

What Type of Evidence is this?:
How does this evidence supports the Point (**Explanation**)

Point 3:This should be an evaluation statement that supports your THESIS STATEMENT

What Evidence Supports this point?

What is your **1st piece of evidence** to support the point of this paragraph?

What Type of Evidence is this?:
How does this evidence supports the Point (**Explanation**)

What is your **2nd piece of evidence** to support the point of this paragraph?

What Type of Evidence is this?:
How does this evidence supports the Point (**Explanation**)

What is your **3rd piece of evidence** to support the point of this paragraph?

What Type of Evidence is this?:
How does this evidence supports the Point (**Explanation**)

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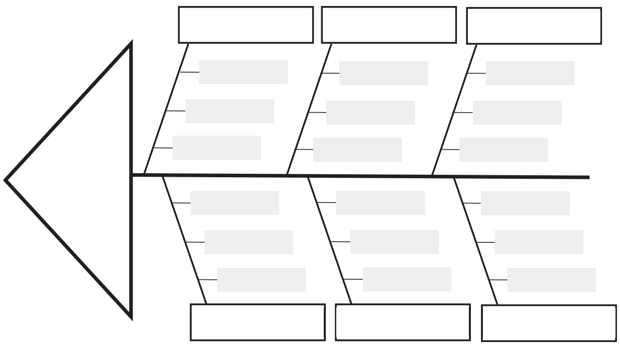
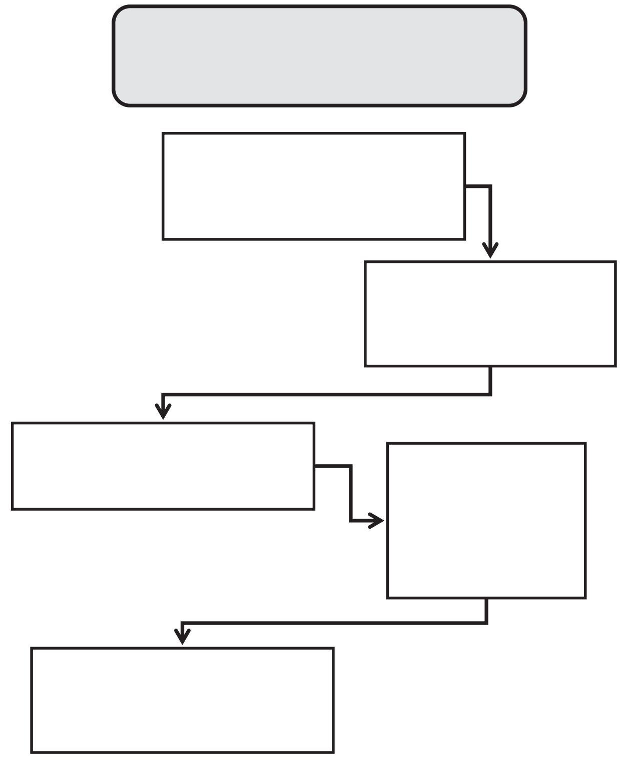
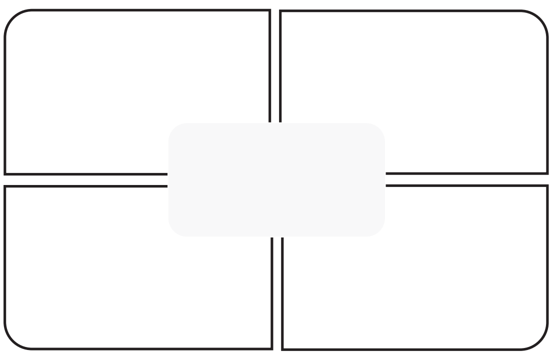
Fishbone diagram



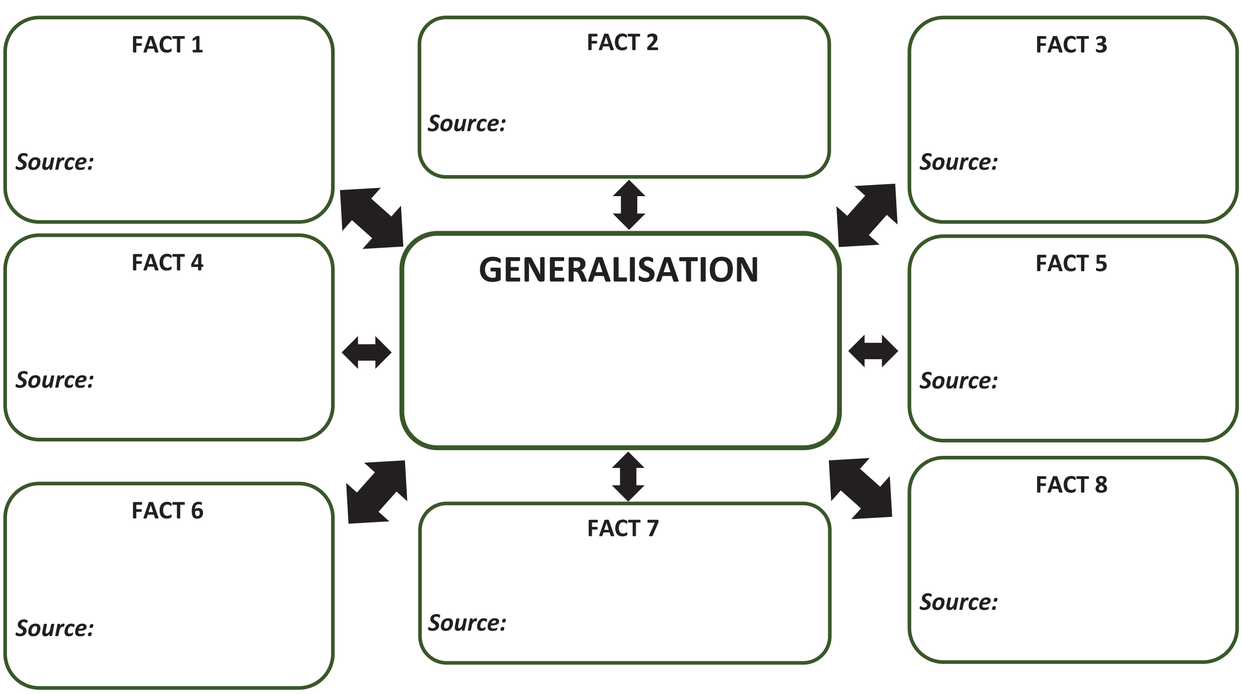
Flow chart



Frayer model diagram



Generalisation template



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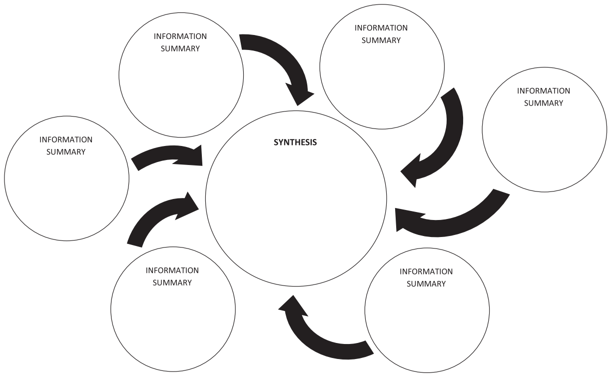
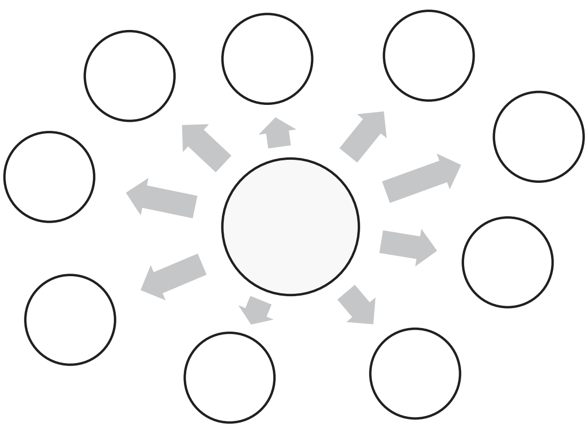
Information vortex



Mind map



PEEL paragraph template (PEEEEEEL)

POINT:

WHAT IS YOUR **FIRST** PIECE OF **EVIDENCE** TO SUPPORT THE POINT OF THIS PARAGRAPH?

HOW DOES THIS EVIDENCE SUPPORT THE POINT OF THIS PARAGRAPH? (**EXPLANATION**)

WHAT IS YOUR **SECOND** PIECE OF **EVIDENCE** TO SUPPORT THE POINT OF THIS PARAGRAPH?

HOW DOES THIS EVIDENCE SUPPORT THE POINT OF THIS PARAGRAPH? (**EXPLANATION**)

WHAT IS YOUR **FIRST** PIECE OF **EVIDENCE** TO SUPPORT THE POINT OF THIS PARAGRAPH?

HOW DOES THIS EVIDENCE SUPPORT THE POINT OF THIS PARAGRAPH? (**EXPLANATION**)

LINK (HOW DID THE EVIDENCE IN THIS PARAGRAPH CONTRIBUTE TO THE OVERALL PURPOSE OR THESIS OF THE ESSAY and/ or HOW DOES THIS LINK TO THE NEXT PARAGRAPH)**:**

PMI chart

PMI focus:			
Sub-categories *(if required)*	**Plus**	**Minus**	**Interesting**

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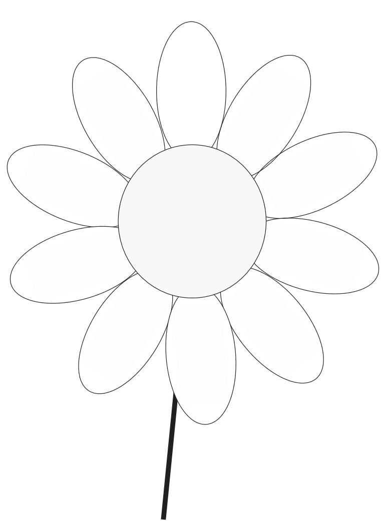
Problem-solution table

THE PROBLEM:							
POSSIBLE SOLUTION 1:		POSSIBLE SOLUTION 2:		POSSIBLE SOLUTION 3:		POSSIBLE SOLUTION 4:	
STRENGTHS	WEAKNESSES	STRENGTHS	WEAKNESSES	STRENGTHS	WEAKNESSES	STRENGTHS	WEAKNESSES
THE SOLUTION:							
REFLECTION:							

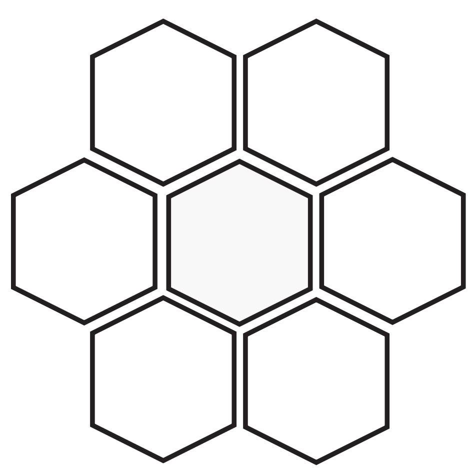
Recommendation table

Recommendation	Reasons and justifications
Hypothesised outcomes	

Relationship flower



Relationship web



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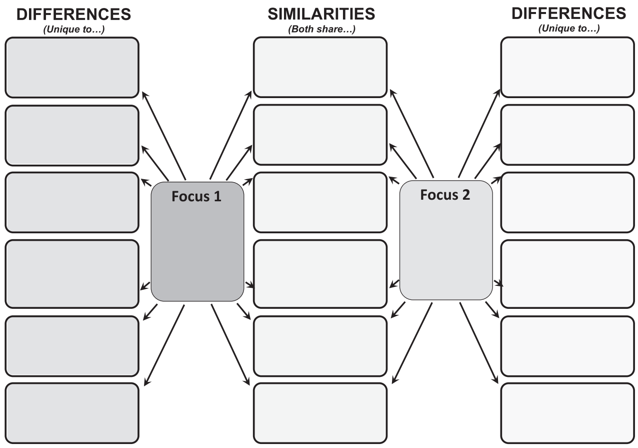
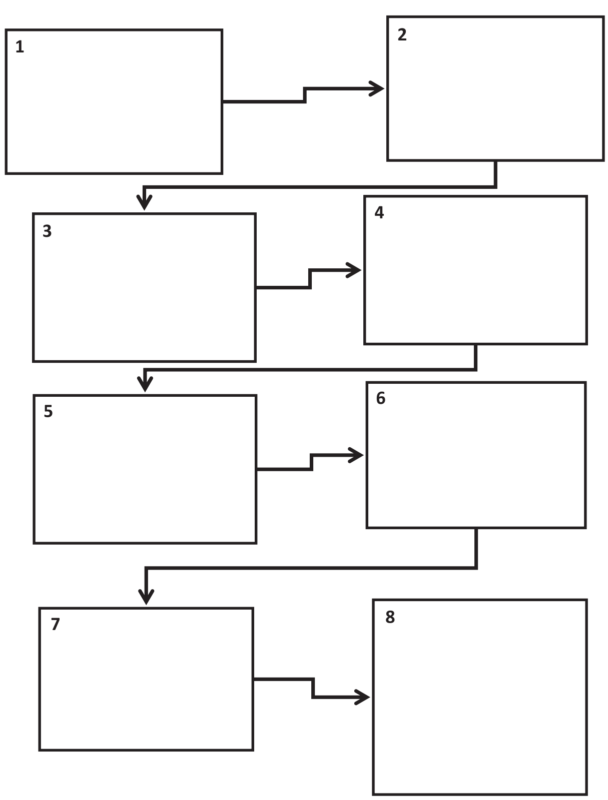
S&D bubble map



Star review

Review Focus	Evaluation	Justification
	☆☆☆☆☆	
	☆☆☆☆☆	
	☆☆☆☆☆	
	☆☆☆☆☆	
	☆☆☆☆☆	

Storyboard



SWOT analysis

TOPIC:

STRENGTHS	WEAKNESSES
OPPORTUNITIES	**THREATS**

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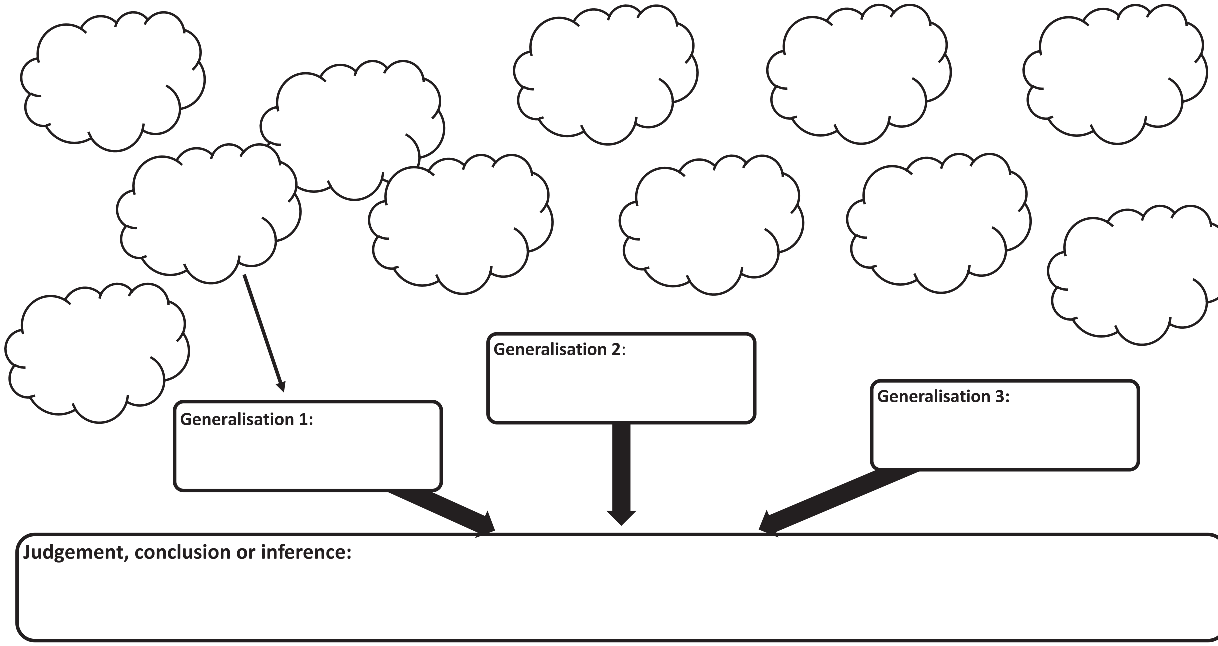
Synthesis bring down

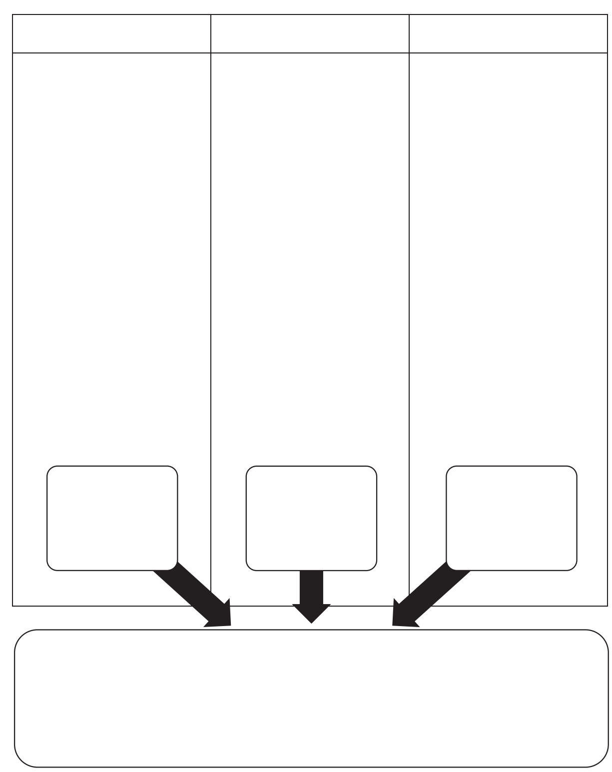


T-chart

Topic: ________________

For	Against

Tree map



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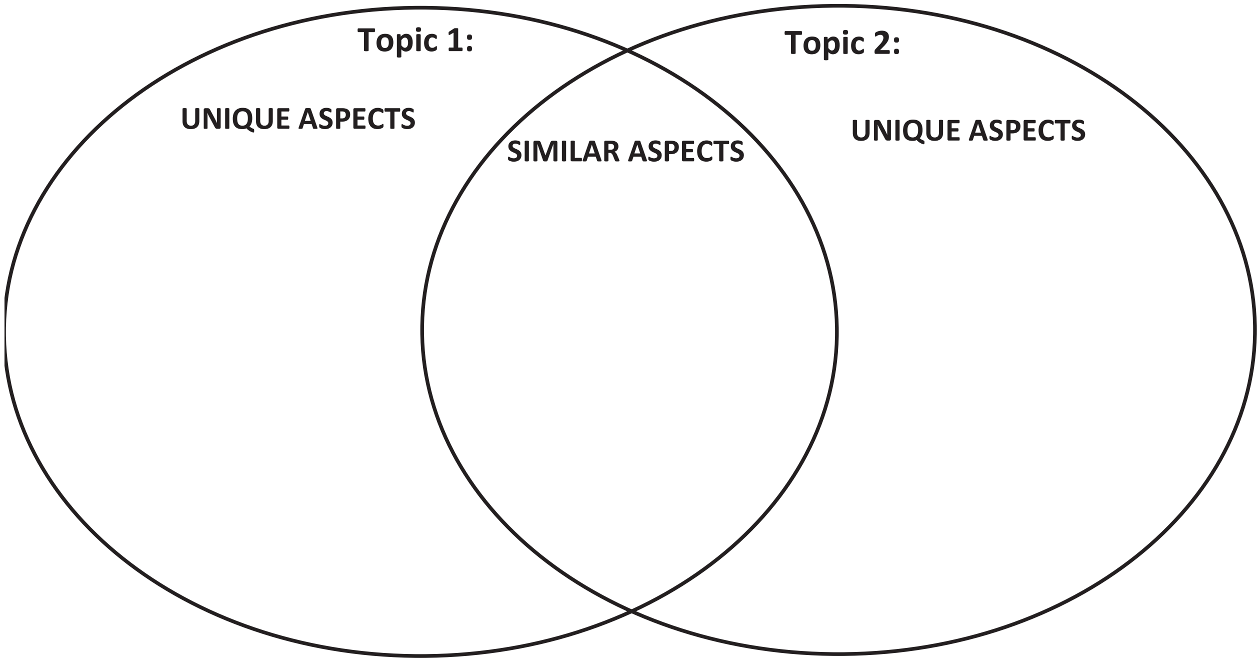
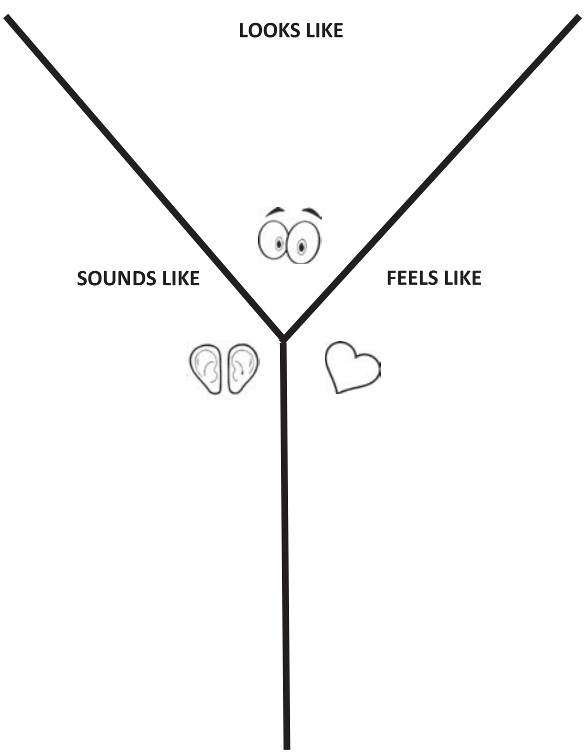
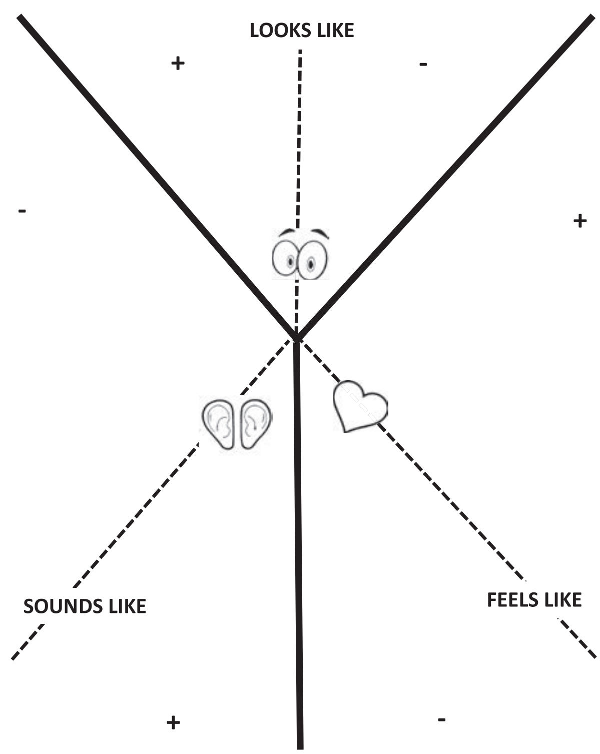
Venn diagram



Y-chart



Y-chart double



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