Although sport is played with the body, it is won in the mind. Inspired by this idea, the second edition of this successful textbook provides a comprehensive critical introduction to sport and exercise psychology – a discipline that is concerned with the theory and practice of helping athletes to do their best when it matters the most.

The book is organized into four parts: Part one investigates the nature, foundations and current status of the discipline. Part two reviews the latest research findings on motivation, anxiety, concentration, mental imagery and expertise in athletes. Part three examines group processes and team dynamics. Part four explores exercise behaviour and the psychology of injury rehabilitation. Each chapter contains specially designed critical thinking exercises to encourage students to explore the deeper issues, and also features an invaluable list of suggestions for independent research projects by students. The text has been extensively rewritten and updated with new material to take account of hot topics such as neuroscience and motor imagery, as well as issues such as “grunting” in tennis, the psychology of penalty shootouts, mindfulness training as a concentration technique, the effects of music on physical activity, and “exergaming” – the use of computer games to increase physical activity/exercise.

Written in a lively, accessible style, the book is brimful of vivid contemporary examples and insights from the world’s leading athletes, to provide a compelling bridge between theory and practice for undergraduate and postgraduate students of sport psychology, health psychology, sport science, physical education, kinesiology and leisure management.

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Sport and Exercise Psychology
A Critical Introduction
Second Edition

Aidan P. Moran

To my wife, Angela, and my son, Kevin, with all my love
Contents

Foreword ix
Preface xi
Acknowledgements xv
List of figures xvii

Part one
Introducing sport and exercise psychology 1

1 Introducing sport and exercise psychology: discipline and profession 3

Part two
Exploring athletic performance: key constructs 41

2 Motivation and goal-setting in sport 43
3 “Psyching up” and calming down: anxiety in sport 81
4 Staying focused in sport: concentration in sport performers 127
5 Using imagination in sport: mental imagery and mental practice in athletes 165
6 What lies beneath the surface? Investigating expertise in sport 201
CONTENTS

Part three
Team cohesion 241

7 Exploring team cohesion in sport: a critical perspective 243

Part four
Exploring health, exercise and injury 277

8 Does a healthy body always lead to a healthy mind? Exploring exercise psychology 279

9 Helping athletes to cope with injury: from theory to practice 315

Glossary 345
References 355
Author index 413
Subject index 427
I have had a lifelong love affair with books and it is always a special thrill to open the pages of a new one. The pleasure is all the greater when the book is one I have been eagerly awaiting, the second edition of Aidan Moran’s excellent textbook, *Sport and Exercise Psychology: A Critical Introduction*. And the delight is beyond compare when I know that I am one of the very first to read the words within. It has been a special thrill to preview this book and write this Foreword.

I teach sport psychology at Western Connecticut State University and it is a popular class, filling up weeks in advance. I like to think that the students are keen to receive my words of wisdom every year but I know that a lot of the credit for the good reputation of the course goes to Aidan Moran. I have been using this book as my course textbook since the first edition appeared and it is well liked by all the students, many of whom are competitive athletes at the college or local level. The book appeals to students because it is a pleasure to read – written in clear, straightforward language and organized with the needs of student learners in mind. Perhaps because his own special area of expertise is attention, Aidan Moran captures your attention immediately in each chapter with the fascinating quotes he finds from the world of sports. Hearing about psychological issues from the star athletes and coaches themselves gets students engaged in sport psychology from the get-go, and that attention is sustained with numerous interesting real-life examples throughout each chapter. What could be more relevant to student readers than watching the heart-stopping penalty shootouts in the 2011 Women’s World Cup games between the United States and Brazil and Japan and then reading the compelling analysis *Why do top players miss penalty kicks?* in Box 3.5? Or, after watching a grunt-filled grand slam final between Maria Sharapova and Petra Kvitova, reading and discussing Box 3.3 on *Thinking critically about … grunting in tennis: what a racket!* I love using these creative examples as the basis for informed debates in our classes, and the students learn much more when they can relate to examples they have seen and experienced.

Student learning is front and centre in the organization and presentation of each chapter. Even the subheadings within chapters get students thinking, asking
“What is?”, “How do?”, and “Why?” questions throughout. Each chapter contains Thinking critically about exercises that provide descriptions of relevant research and theory for the learner and then ask a series of questions that compel thoughtful analysis – perfect for in-class discussions or take-home writing assignments! My personal favourites are the ideas for research projects at the end of every chapter. They are detailed yet explained very simply and in my experience students can use them for their own research projects, helping them learn the basics of the scientific approach to sport psychology, including hypothesis generation, experimental design and analysis. All these features combine to create a peerless learning experience and they make this textbook perfect for undergraduate courses in sport and exercise psychology.

The content of the textbook is thoughtfully chosen, with nine chapters comprising a comprehensive overview of our fascinating field. I am glad that the chapter topics have remained constant, as the topic coverage of this text is a major strength. Professor Moran covers all the main areas of sport and performance psychology, from motivation and concentration, to teamwork, health, exercise and injury. I find that the chapter topics fit comfortably into a one semester format and still allow me to add one or two topics of my own choosing to my course. Because he is a true expert in sport psychology himself, he is not content to merely rehash the ideas of others, but he critically presents and assesses the theories and research he discusses. This sets the tone for the reader and encourages us to critically analyse the research. I have never read more thoughtful presentations of the complicated neuroscientific research on concentration and imagery that can be found in Chapters 4 and 5. Student learners are lucky to have such a competent and engaging guide to the mysteries of the interactions between brain and body that lie at the heart of sport psychology.

There is so much that is new in this second edition, I will leave it to you to discover its many delights for yourself. But I must mention the inclusion of a couple of updated sections that especially enchanted me. My daily exercise routine contains an aerobic walk while listening to my trusty iPod (a beloved gift from my children on my fiftieth birthday), so I was delighted to read Box 8.4 on The effects of music on physical activity: exercise for the iPod generation and I am sure students will enjoy it, too. In the same chapter is the provocative Box 8.7 on Thinking critically about … exergaming: is it even better than the real thing?, which as a sport psychology researcher who happens to study video games and their effects I found especially interesting. Just two examples, of many, that indicate how contemporary and in tune with today’s students this textbook is.

I anticipated a special treat when I received the advance copy of this second edition and I was not disappointed. This book is hands-on, down-to-earth, contemporary, engaging, provocative, thoughtful, informative and accessible. I suspect that you are as eager as I was to open its pages and commence the journey of discovery. Let me facilitate the start of that adventure by ending the Foreword and handing you over to Aidan Moran. Enjoy – I know you will.

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Preface to the second edition: what’s new?

Sport and exercise psychology is flourishing both as an academic discipline and as a profession. For example, since 2007, at least five new scholarly journals have been published, and many new graduate training courses developed, in this field. To keep you abreast of such exciting developments, I have made a lot of changes to the second edition of Sport and Exercise Psychology: A Critical Introduction. These changes can be summarized as follows. First, and perhaps most obviously, I have included over 500 new references, thereby updating greatly the topical coverage (especially in the neuroscientific foundations of athletic performance) provided by the book. Second, as a consequence of the inclusion of this new material, I have extensively rewritten the text and lengthened it from about 120,000 words to about 157,000 words. Among the new topics that I have focused on are what sport psychologists do at the Olympic Games (Chapter 1), goal-setting in a team environment (Chapter 2), why players “grunt” in tennis (Chapter 3), attentional control theory (Chapter 3), the psychology of penalty shootouts (Chapter 3), mindfulness training as a concentration technique (Chapter 4), motor imagery (Chapter 5), the neuroscience of expertise (Chapter 6), the question of whether or not team cohesion can ever be harmful (Chapter 7), the effects of music on physical activity (Chapter 8), self-determination theory (Chapter 8), the increasingly popular activity of exergaming (or the use of computer games like Wii Fit to increase physical activity/exercise: see Chapter 8), and some rather unusual causes of sports injuries (Chapter 9). Third, building on some of the unique features of the first edition, I have devised additional critical thinking exercises (increased from 25 to 30) and have also revised, updated and increased (from 41 to 44) my suggestions for independent research projects throughout the book. Fourth, I have tried to enrich the text and bridge the gap between theory and practice by including a wealth of vivid contemporary examples and compelling insights from the world’s leading athletes (e.g., Roger Federer, Xi
As before, the book is divided into four parts. In Part one, I introduce the field of sport and exercise psychology as both an academic discipline and as a profession. In Chapter 1, I’ve added a new section on confidence, new material on sport psychology at the Olympic Games and revised and updated the coverage of mental toughness, sport psychology as an academic discipline, research methods in sport and exercise psychology, and new journals in the field. In Part two, I investigate the various psychological processes that affect individual athletes in their pursuit of excellence. Included here are chapters on motivation, anxiety, concentration, mental imagery and expertise. In Chapter 2, I’ve updated the coverage of achievement goal theory, attribution theory and goal-setting (and have developed a new critical thinking box on this topic) and I’ve also included some new suggestions for research projects on motivation in athletes. In Part three, I’ve updated my coverage of the topics of anxiety in athletes and the conscious processing hypothesis. I’ve also devised a new critical thinking box on “grunting” in tennis as well as a new section on attentional control theory. I’ve added new material on the issue of why top footballers often miss penalty kicks as well as a new critical thinking box on simulation training. I’ve also developed some new suggestions for research projects on anxiety in athletes. In Chapter 4, I’ve updated the material on the nature and importance of concentration, on why athletes appear to “lose” their concentration so easily, and also on concentration training exercises and techniques. I’ve developed a new critical thinking box on mindfulness training as a concentration technique and offered some new suggestions for research on concentration processes in athletes. In Chapter 5, I’ve updated material on the nature, types and dimensions of mental imagery and also updated the section on mental chronometry in action. I’ve added new boxes on the PETTLEP model of motor imagery, the Vividness of Movement Imagery Questionnaire (Revised) and on motor imagery. I’ve also included new suggestions for research on mental imagery in athletes. In Chapter 6, I’ve updated material on the nature and determinants of expertise in sport and on the research methods used in the study of expertise. I’ve updated material on research findings on expert–novice differences in athletes as well as on Ericsson’s theory of deliberate practice. I’ve also included new boxes on the neuroscience of fast-ball sports and on what experts tell us about the factors that determined their success and also some new suggestions for research on expertise in athletes. In Part three, I address the role of team cohesion in athletic performance. In Chapter 7, I’ve updated material on team dynamics, team cohesion and team-building in sport. I’ve added new boxes on whether or not team cohesion can ever be harmful, on building a successful team, and on team-building exercises in rugby. I’ve also included some new suggestions for research on team cohesion in athletes. In Part four, I explore exercise psychology and the psychology of physical injury. In Chapter 8, I’ve updated material on the nature of exercise psychology, the benefits of physical activity and on some possible adverse effects of exercise on health. I’ve added new boxes on the assessment of physical activity, the effects of music on physical activity, and the emerging phenomenon of “exergaming”. I’ve also included new material on self-determination theory as well as some new suggestions for research on exercise psychology. In Chapter 9, I’ve updated material on the nature of injuries in sport, the causes of
injury among athletes, how athletes react psychologically to injury, and on the rehabilitation of injured athletes. I've added a new box on injury rehabilitation in rugby and included some new suggestions for research on injuries in sport. In conclusion, I hope that this book manages to convey the scope and excitement of contemporary sport and exercise psychology in an accurate and accessible manner.
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This book would not have been possible without the help that I received from a large number of friends and colleagues. To begin with, I would like to acknowledge the wonderful editorial support and encouragement that I received from Lucy Kennedy, Sharla Plant, Erasmis Kidd, Tara Stebnicky and Rebekah Waldron of Routledge and Psychology Press. Next, I wish to thank my friend and colleague Shane Murphy (Western Connecticut State University) for agreeing to write the Foreword to the second edition of this book and also for sharing with me his many novel insights into mental imagery processes in athletes. I'm extremely grateful to Aymeric Guillot (Université Claude Bernard Lyon 1, France) and Rich Masters (University of Hong Kong) for their generous endorsements of this book. I also wish to thank three former PhD students and now research collaborators – James Matthews, Peter Slattery and John Toner – for their enthusiasm, meticulous research assistance and reference suggestions. In addition, I’m very grateful to James Matthews and Tadhg MacIntyre for their contributions to Chapter 8. Next, I wish to acknowledge the help that I received from Suzanne Bailey and Georgina Dwyer (University College Dublin, Sport), Norman McCloskey (Inpho Photography), Seán O’Dólmhnaill (University College Dublin, Media Services), Mark McDermott (Irish Rugby Football Union) and Colin Burke and Andrew Flood (both of University College Dublin, School of Psychology) with regard to the photographs and other illustrations used in the book. I would like to acknowledge the generous assistance of Martha Gullo (Human Kinetics, Inc., USA) in relation to copyright clearance for certain figures in the book. Furthermore, I wish to express my gratitude to a number of academic colleagues who influenced the content and structure of this book. In particular, I am extremely grateful to John Kremer (Queen’s University of Belfast) for his friendship, encouragement and insights over the many fruitful years of our collaboration. Similarly, the advice and support of David Lavallee (University of Stirling) and Mark Williams (Liverpool John Moores University and University of Sydney) are deeply appreciated. Two key reviewers whose constructive comments and suggestions contributed greatly to the book are Simon Hartley (Be World Class)
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Figures

1.1 Sport is played with the body but won in the mind 4
1.2 Four aspects of athletic performance 9
1.3 It is a myth that sport psychologists are “shrinks” 36
2.1 Arsène Wenger believes that footballers perform best when they are relaxed 45
2.2 Managers of losing teams tend to make excuses 59
3.1 According to Pádraig Harrington, playing in the Ryder Cup can be a nerve-racking experience 82
3.2 Rafael Nadal believes that he plays best when he is calm 83
3.3 José Mourinho believes that emotional control is essential for success in sport 84
3.4 Overanalysis can unravel people’s sport skills 106
3.5 Rory McIlroy displayed remarkable mental strength to win the 2011 US Open golf championship 110
4.1 According to Alex Ferguson, concentration is vital for success in sport 128
4.2 Novak Djokovic discovered that a lapse in concentration can prove costly in tennis 130
4.3 Concentration principles 146
4.4 Internal distractions can upset athletes’ concentration in competitive situations 149
4.5 Concentration techniques 154
4.6 Pre-performance routines help players to concentrate 155
4.7 Paula Radcliffe counts silently to herself in order to maintain her concentration in a race 160
5.1 Michael Phelps uses kinaesthetic imagery to “feel” the water 167
5.2 Tiger Woods uses kinaesthetic imagery to “feel” his shots before he plays them 172
5.3 It is dangerous to listen to a football match while driving a car 180
6.1 Phil “The Power” Taylor – the greatest darts player of all time? 206
6.2 Usain Bolt has a wonderful physique that facilitates his prodigious speed 212
6.3a A meaningful “three-man defence” pattern in rugby 218
6.3b A meaningless “three-man defence” pattern in rugby 219
6.4 Eye-tracking technology allows psychologists to study visual search behaviour in athletes 222
7.1 Barcelona FC, winners of the 2011 Champions’ League, displayed remarkable team cohesion 244
7.2 Team spirit helped the European team to victory over the United States in the 2011 Ryder Cup 248
7.3 Carron’s model of group cohesion 252
7.4 Jumping for joy … University College Dublin women’s rowing team celebrate victory 272
8.1 Theories of reasoned action and planned behaviour 302
8.2 The transtheoretical model of behaviour change applied to physical activity 308
9.1 Injury is almost inevitable in sport 316
9.2 Diagram of cognitive appraisal model of injury reaction 334
Using imagination in sport: mental imagery and mental practice in athletes

You have to see the shots and feel them through your hands.

(Tiger Woods, quoted in Pitt, 1998b)
Introduction

Many top athletes have discovered that “mental imagery”, or the ability to simulate in the mind information that is not currently being perceived by the sense organs, is helpful for the learning and performance of sport skills. For example, “seeing” and “feeling” oneself performing one’s skills in one’s mind’s eye is widely evident among world-class performers in rugby, athletics and swimming. When Ronan O’Gara, the Ireland and Lions’ rugby out-half, had scored a last-minute drop goal against Wales to help Ireland to win the 2009 Six Nations’ championship, he revealed how he had simulated the kick in his mind:

I picked out three numbers in the stand behind the posts. I can still picture them perfectly. That was my target. I visualized the ball going through and kept that image. I played it in my mind a few times … this is what it comes down to now. One chance.

(cited in Walsh, 2009)

When British athlete Paula Radcliffe (a world record holder for the marathon event) trained for the 2012 Olympic Games, she visualized herself running up the final stretch of the race venue in London. As she said at the time, “I try to imagine that I’m in the closing stages of the marathon in London … I just visualize myself running up The Mall” (cited in Hart, 2011). Just like Tiger Woods (see quotation above), Michael Phelps, fourteen times Olympic gold medallist in swimming, highlighted the importance of kinaesthetic or “feeling oriented” imagery (see Figure 5.1). He said:

swimmers like to say they can “feel” the water. Even early on, I felt it. I didn’t have to fight the water. Instead, I could feel how I moved in it. How to be balanced. What might make me go faster or slower.

(Phelps, 2008a)

Not surprisingly, the value of using mental imagery to rehearse actions and movements is also recognized in other fields of skilled performance. Imagery has been shown to enhance performance in musicians (Meister et al., 2004) and surgeons (Arora et al., 2010, 2011) and can even be used to augment the physical rehabilitation of people who have suffered neurological damage (e.g., see review of the use of imagery with stroke patients: Braun et al., 2006; McEwen et al., 2009). Perhaps not surprisingly, mental imagery techniques are used extensively by athletes, coaches and sport psychologists to improve motor learning and skilled performance (see review by Weinberg 2008) and, as a result, are widely recommended by sport psychologists (e.g., see Cumming and Ramsey, 2009; Vealey and Greenleaf, 2010). To illustrate Caliari (2008) found that table tennis players who used imagery to mentally rehearse a stroke (the forehand drive) improved significantly relative to a control group. Furthermore, Mellalieu et al. (2009) found that imagery can improve psychological skills such as self-confidence in rugby players. Arising from such research, imagery has become such a common component of sport psychological
interventions (e.g., see P. Holmes and Collins, 2002) that it has been acclaimed as a “central pillar of applied sport psychology” (T. Morris et al., 2004, p. 344). Nevertheless, athletes who practise imagery may be regarded as rather eccentric. For example, when the England goalkeeper David James rehearses his skills imaginatively during traffic delays, he often receives puzzled glances from other drivers. As he says, “I have had a few strange looks when people see my head nodding from side to side but I firmly believe that it is part of the repetitive process that every sportsman requires” (D. James, 2003). In summary, athletes, dancers and sport psychologists endorse the value of imagery as a cognitive tool for giving performers a winning edge in their chosen field. But is this belief in the power of imagery supported by empirical evidence in psychology? Or does it merely reflect some “New Age”, pseudo-scientific mysticism?

In attempting to answer these challenging questions, this chapter explores a variety of intriguing issues at three different levels: practical, methodological and theoretical. For example, if mental imagery does improve athletic performance, is it possible that athletes could practise their skills in their heads without leaving their armchairs? Or are the alleged benefits of systematic mental rehearsal too small to be of any practical significance to sport performers? Turning to methodological issues,
how can we measure people’s mental images? After all, they are among the most private and ephemeral of all our psychological experiences. At a theoretical level, many fascinating questions have emerged in this field. For example, what happens in our brains when we imagine something? Also, what psychological mechanisms could account for the effects of mental rehearsal on skilled performance? More generally, can research on imagery processes in athletes provide us with any valuable insights into how the mind works? For example, could it be that imagery is not something that we “have” in our minds but something that we “do” with our brains? Perhaps the best way to address these questions is to explore the main psychological theories, findings and issues in research on mental imagery in sport performers. In order to achieve this objective, I have organized this chapter as follows.

In the next section, I investigate the nature and types of mental imagery and also explain what the term “mental practice” means in sport psychology. The third section reviews the main findings, theories and issues arising from research on mental practice in sport. The fourth section considers briefly the measurement of mental imagery skills in sport. The fifth section describes what researchers have learned about the ways in which athletes use mental imagery in various athletic situations. In the sixth section, I sketch some new directions for research on imagery in athletes, with a special emphasis on motor imagery or a dynamic mental state during which the representation of a given motor act or movement is rehearsed in working memory without any overt motor output (Moran et al., in press). Finally, a few ideas for possible research projects in this field are provided.

What is mental imagery?

Historically, the term “mental imagery” has been used in two ways (Wraga and Kosslyn, 2002). First, it designates the content of one’s imagination such as the subjective experience of “seeing with the mind’s eye” or “hearing with the mind’s ear”, for example. Second, imagery refers to “an internal representation that gives rise to the experience of perception in the absence of the appropriate sensory input” (Wraga and Kosslyn, 2002, p. 466). It is this latter understanding of the term that guides this chapter.

One of the most remarkable features of the mind is its capacity to mimic or simulate experiences. Psychologists use the term mental imagery to describe this cognitive (or knowledge-seeking) process which we use every day in order to represent things (e.g., people, places, experiences, situations) in working memory in the absence of appropriate sensory input (Moran, 2002a). For example, if you close your eyes, you should be able to imagine a set of traffic lights changing from green to red (a visual image), the sound of an ambulance siren (an auditory image) or maybe even the muscular feelings evoked by running up steep stairs (a kinaesthetic image). Theoretically, imagery involves perception without sensation. Specifically, whereas perception occurs when we interpret sensory input, imagery arises from our interpretation of stored, memory-based information. Thus the process of generating a mental image may be understood crudely as running perception backwards (Behrmann, 2000). As we shall see later, the term “mental practice” refers to a
particular application of mental imagery in which performers “practise” in their heads, or rehearse their skills symbolically, before actually executing them.

If imagery resembles perception, there should be similarities between the measurable cortical activity involved in these psychological processes. Put simply, similar parts of the brain should “light up” when we imagine things as when we actually perceive them. For example, visual imagery should be associated with neural activity in the cortical areas that are specialized for visual perception. Until the 1990s, this hypothesis remained untested simply because no technology was available to allow researchers to peer into the brain in order to measure the neural substrates of “real time” or ongoing cognitive activities. Since about 2000, however, a variety of neuroimaging techniques have been developed to allow brain activation to be measured objectively. What are these dynamic brain techniques and how do they work?

According to Kolb and Whishaw (2009), the modern era of brain imaging began in the early 1970s with the development of an X-ray procedure called “computerised tomography” (derived from the word “tomo” meaning “cut”) or the CT scan. The logic of this approach is that a computer may be used to draw a three-dimensional map of the brain from information yielded by multiple X-rays directed through it. With the advent of more sophisticated computational strategies to reconstruct images, three other brain imaging procedures emerged: positron emission tomography (PET scanning), functional magnetic resonance imaging (fMRI) and transcranial magnetic stimulation (TMS). These procedures are designed to detect changes in metabolism or blood flow in the brain as people are engaged in cognitive tasks. Such changes are correlated with neural activity. Briefly, in the PET scan, people are given radioactively labelled compounds such as glucose which are metabolized by the brain. This radioactivity is subsequently recorded by special detectors. For reasons of convenience, however, PET scan measurement of metabolism was replaced by the measurement of blood flow. Magnetic resonance imaging is a less invasive technique and is based on two key principles. First, blood oxygenation levels tend to change as a result of neural activity. Second, oxygenated blood differs from non-oxygenated blood in its magnetic properties. When combined, these principles allow researchers to detect changes in brain activity using special magnets. TMS is a procedure in which a magnetic coil is placed over the skull either to stimulate or to inhibit selectively certain areas of the cortical surface.

Using these neuroimaging techniques, research shows that the occipital cortex or visual centre of the brain (which is located at the back of our heads) is activated when people are asked to imagine things (Kosslyn et al., 2001). In addition, these brain-imaging studies have also shown that, contrary to what most people believe, mental imagery is not a single undifferentiated ability but, instead, a collection of different cognitive capacities localized in different brain regions. To illustrate, brain imaging studies show that when we “rotate” images in our mind (as happens, for example, when we try to imagine what an object would look like if it were turned upside down), neural activity is detected in the parietal lobes (which are located behind the frontal lobe and above the temporal lobe). By contrast, visualizing previously memorized patterns tends to elicit neural activity in the occipital lobes at the back of our heads where vision is coordinated (Kosslyn et al., 2001). Similarly, research on brain-damaged patients shows that if the ventral pathways from the
occipital lobes are impaired, people often lose their ability to recognize and/or imagine shapes. But if damage occurs in the dorsal system, the person may suffer deficits in his or her ability to visualize the locations of objects.

Before concluding this section, it is important to mention a conceptual issue that has been debated vigorously by imagery researchers since the late 1970s. Briefly, this debate concerns the nature of the mental representations that underlie imagery experiences. Specifically, does visual mental imagery rely on mental representations that depict things or on ones that describe things? Championing the former position, Kosslyn and his colleagues (e.g., see Kosslyn, 1994; Kosslyn et al., 2006) argue that images are visuo-spatial brain representations or depictions (“pictures in the head”) and that visual mental images are structurally analogous to visual perceptual representations. Supporting this position is evidence that mental imagery activates significant fronto-parietal and occipito-temporal neural networks in the brain (e.g., Sack et al., 2008). Opposing this view is Pylyshyn (1973, 1981), who argues that visual mental imagery relies on representations that are largely propositional or language-like and that any structural or phenomenal similarities between imagery and perception are illusory. Another point of disagreement between these rival theorists is whether or not mental imagery plays a functional role in cognitive processing. Whereas Kosslyn and his colleagues use neuroscientific evidence to support their argument that visuo-spatial depictions play a crucial role in human cognition, Pylyshyn (1973, 1981) argues that imagery is epiphenomenal – an accidental byproduct of abstract cognitive processing but not a central part of it – like the pilot light of a CD player.

**Types and dimensions of mental imagery**

At the outset, at least four general points can be made about mental imagery types and dimensions. First, depending on the sensory modality and cognitive systems involved, different types of mental imagery have been identified. Second, research suggests that imagery is a multisensory experience. In other words, we have the capacity to imagine “seeing”, “hearing”, “tasting”, “smelling” and “feeling” various stimuli and/or sensations. Third, the greater the number of sensory modalities that we use to create our mental representation of the non-present information, the more vivid is the resulting mental imagery experience. Fourth, images differ from each other in dimensions such as vividness and controllability (Callow and Hardy, 2005; Moran, 1993). Let us now explore each of these points briefly.

First, whereas sport psychology researchers tend to differentiate between different types of imagery based on their predominant sensory modality (e.g., visual, auditory, gustatory) cognitive neuroscientists tend to use more theoretically based distinctions – such as those between visual, spatial and motor imagery processes. To explain, researchers have discovered two distinct cognitive systems that encode and process visual information in different ways (Blajenkova et al., 2006). Whereas object-based imagery represents the shape and colour information of objects, spatial imagery represents location information. More precisely, “visual object imagery” involves mental representations of “the literal appearances of individual objects in terms of their precise form, size, shape, colour and brightness”
(Blajenkova et al., 2006, p. 239) and “spatial imagery” involves the mental representations of “the spatial relations amongst objects, parts of objects, locations of objects in space, movements of objects and object parts and other complex spatial transformations” (Blajenkova et al., 2006, pp. 239–240). Cognitive researchers have identified “motor imagery” as “a mental/neuronal simulation of an overt movement without muscle contraction” (Hohlefeld et al., 2011, p. 186). This largely proprioceptive or kinaesthetic process is used whenever people imagine actions without engaging in the actual physical movements involved (see also Box 5.2, later in the chapter).

As I mentioned, imagery is a multisensory experience. Thus L. Hardy et al., (1996, p. 28) defined it as “a symbolic sensory experience that may occur in any sensory mode”. Of the various senses contributing to imagery experiences in daily life, vision is the most popular. Thus diary studies (Kosslyn et al., 1990) showed that about two-thirds of people’s mental images in everyday life are visual in nature. For example, have you ever had the experience of trying to remember where you parked your car as you wandered around a large, congested carpark? If so, then the chances are that you tried to form a mental map of the location of your vehicle. Interestingly, some neuroscientific studies corroborate the primacy of the visual modality over other types of imagery. To explain, Kosslyn et al. (2001) reported that visual images rely on about two-thirds of the same brain areas that are used in visual perception. Specifically, the areas that appear to be most active during visual imagery lie in the occipital lobe (especially areas 17 and 18 or “V1” and “V2”). Evidence to support this conclusion comes from the fact that when people visualize things with their eyes closed, the “V1” and “V2” areas of the brain become active. Also, if these areas are temporarily impaired by the effects of strong magnetic pulses, the person’s visual imagery abilities are disrupted (Kosslyn et al., 2001). Despite this phenomenological and neurological evidence that most of our images are visual in nature, our imagination is not confined solely to the visual sense. To illustrate, if you pause for a moment and close your eyes, you should also be able to imagine the sensations evoked by feeling the fur of a cat (a tactile image), hearing the sound of your favourite band or song (an auditory image) or experiencing the unpleasant grating sensation of a nail being scraped across a blackboard (a combination of tactile and auditory images).

Visual and auditory sensations are easily imagined in sport (e.g., can you “see” yourself taking a penalty and then “hear” the crowd roar as your shot hits the net?), but the type of feeling-oriented imagery that Tiger Woods referred to earlier in the chapter is more difficult both to conceptualize and to investigate empirically (see Figure 5.2).

Although few studies have been conducted on feeling-oriented imagery in sport, Moran and MacIntyre (1998) and Callow and Hardy (2005) have investigated kinaesthetic imagery processes in elite athletes (see Box 5.1).

To summarize, we have learned that although mental imagery is a multisensory construct, most studies of imagery processes in athletes have been confined to the visual sensory modality.

Turning to the third and fourth points – how images differ from each other – as explained earlier, it is clear that images vary in controllability as well as vividness. “Controllability” refers to the ease with which mental images can be manipulated by the person who creates them. To illustrate, can you imagine a feather falling down
from the ceiling of your room, slowly wafting this way and that before gently landing on your desk? Now, see if you can imagine this feather reversing its path – floating back up towards the ceiling like a balloon, as if carried higher by a sudden current of air. If you found these mental pictures easy to create, then you probably have reasonably good control over your imagery. As another example of this skill, try to imagine yourself standing in front of where you live. How many windows can you see? Count them. Now, using your imagination as a camera with a zoom lens, try to get a close-up picture of one of the windows. What material are the frames made of? What colour are the frames? Can you see them in a different colour? If you can “see” these details of your windows accurately, then you have good imagery control skills.

Box 5.1 Exploring “feel”: investigating kinaesthetic imagery in athletes

As research on mental imagery in athletes has focused almost exclusively on the visual sensory modality, other types of imagery experiences in sport have been relatively neglected. This oversight is unfortunate because elite performers in sports such as golf (e.g., Tiger Woods), swimming (e.g., Michael Phelps), canoe slalom and horse-racing rely greatly on “touch” and “feel” when rehearsing their skills and movements in their minds before they actually execute them. Such kinaesthetic imagery processes involve feelings of force and motion or the mental simulation of sensations associated with bodily movements. More precisely, kinaesthetic imagery denotes “the sensations of how it feels to perform an action, including the force and effort involved in movement...
and balance, and spatial location (either of a body part or piece of sports equipment) (Callow and Waters, 2005, pp. 444–445). Since the late 1990s, some progress has been made in understanding and using this type of imagery in athletes (e.g., see Callow and Hardy, 2005; Moran and MacIntyre, 1998). Moran and MacIntyre (1998) used a combination of qualitative and quantitative methods to investigate the kinaesthetic imagery experiences of a sample (n = 12) of elite canoe slalomists participating in World Cup competitions. These athletes were first interviewed about their understanding and use of feeling-oriented imagery in their sport. Then they were assessed using a battery of measures which included specially devised Likert rating scales and the Movement Imagery Questionnaire-Revised (C. Hall and Martin, 1997). Next, in an effort to validate the athletes’ subjective reports on their imagery experiences (see later in the chapter for a discussion of this problem), the canoe slalom competitors were timed as they engaged in a “mental travel” procedure during which they had to visualize a recent race in their imagination and execute it as if they were paddling physically. The time taken to complete these mental races was then compared with actual race times. As expected, there was a significant positive correlation between mental and physical race times (r = 0.78, p < 0.05). Callow and Waters (2005) investigated the efficacy of a kinaesthetic imagery intervention on the confidence of three flat-race jockeys. Using a single-case, multiple-baseline design (for a comprehensive account of single-case research in sport and exercise psychology, see Barker et al., 2011), Callow and Waters (2005) found that the kinaesthetic imagery intervention was associated with a significant increase in confidence for two of the three jockeys involved. An interesting implication of this latter finding is that a delay is likely to occur between athletes’ use of imagery and any subsequent benefits that may accrue from it. Presumably, this time lag occurs simply because athletes need to learn to use imagery properly before any of its advantages become evident. Unfortunately, as Shane Murphy et al. (2008, p. 321) noted, “the expected duration of this time lag is unknown”.

Mental imagery representations have three important characteristics. First, they are multisensory constructs that enable us to bring to mind experiences of absent objects, events and/or experiences. Second, they are believed to be functionally equivalent to percepts in the sense that they share a great deal of the same brain machinery or neural substrates with perception. Third, mental images vary in their vividness and controllability – two dimensions which facilitate their measurement (see the fourth section of this chapter). Having explained the nature and types of imagery, let us now consider the topic of mental practice.

**Mental practice**

As I explained earlier, MP refers to a systematic form of covert rehearsal in which people imagine themselves performing an action without engaging in
the actual physical movements involved (Driskell et al., 1994). Because it relies on simulated movements (see Decety and Ingvar, 1990), MP is sometimes known as visuo-motor behavioural rehearsal (VMBR: Suinn, 1994). It has also been called: symbolic rehearsal, imaginary practice, implicit practice, mental rehearsal, covert rehearsal, mental training and cognitive practice (see Shane Murphy and Jowdy, 1992) as well as motor imagery (Decety and Michel, 1989).

Psychological interest in mental practice is as old as the discipline of psychology itself. W. James (1890) suggested rather counter-intuitively that by anticipating experiences imaginatively, people actually learn to skate in the summer and to swim in the winter! Interestingly, the 1890s witnessed various expressions of an idea called the ideo-motor principle which suggested that all thoughts have muscular concomitants. For example, in 1899 Henri-Etienne Beaunis (cited in Washburn, 1916, p. 138) proposed that “it is well known that the idea of a movement suffices to produce the movement or make it tend to be produced”. Similarly, Carpenter (1894) claimed that low-level neural impulses are similar in imagined movement. Furthermore, he argued that these impulses are similar in nature, but lower in amplitude, to those emitted during actual movement. I shall return to this ideo-motor hypothesis later in the chapter when evaluating theories of mental practice.

Although research on MP was vibrant in the wake of Galton’s (1883) research on imagery vividness, it declined in popularity shortly afterwards as a result of the Behaviourist manifesto (Watson, 1913) which attacked “mentalistic” constructs such as imagery because they were too subjective to be amenable to empirical investigation. Fortunately, a resurgence of research on mental practice occurred in the 1930s with the work of Jacobson (1932), H. Perry (1939) and Sackett (1934). These studies continued in a rather sporadic, atheoretical manner until the 1960s, when the first comprehensive reviews of mental practice were published by A. Richardson (1967a, 1967b). Unfortunately, despite (or maybe, because of!) more than a century of research on imagery, criticisms have been levelled at both the definition of MP and at the typical research designs used to study it. Shane Murphy and Martin (2002) identified a contradiction at the heart of this construct. Specifically, the term mental practice conveys an implicit, dualistic distinction between physical and mental practice that is at variance with current neuroscientific understanding of how the brain works. Thus the fact that visualizing something in the mind’s eye usually elicits measurable brain activity in the visual cortical areas (Kosslyn et al., 2001) suggests that mind and body are not really separate processes but function as an integrated unit. Murphy and Martin (2002) also criticized the assumption that mental practice is a standardized, homogeneous intervention. It is not. To illustrate, visualizing a perfect tennis serve could mean either seeing yourself playing this stroke or perhaps seeing someone else (e.g., Rafael Nadal) performing this action. It seems likely that there will be many differences between these two types of MP. Further criticism of MP research will be considered in the next section of the chapter. Now that we have examined the nature of mental imagery and mental practice, let us explore research methods and findings on MP. Research on athletes’ use of mental imagery will be examined in the fifth section of the chapter.
Research on mental practice in sport

For over a century, the effects of MP on skilled performance have attracted research attention from psychologists. Reviews of this large research literature (amounting to several hundred studies) have been conducted, in chronological order, by A. Richardson (1967a, 1967b), Feltz and Landers (1983), Grouios (1992), Shane Murphy and Jowdy (1992), Driskell et al. (1994), Shane Murphy and Martin (2002), van Meer and Theunissen (2009) and Schuster et al. (2011). Before I summarize the general findings of these reviews, here is a brief explanation of the typical research paradigm used in studies of MP.

Typical research design and findings

In general, the experimental paradigm in MP research involves a comparison of the pre- and post-intervention performance of the following groups of participants: those who have been engaged only in physical practice of the skill in question (the physical practice group, PP); those who have mentally practised it (the mental practice group, MP); those who have alternated between physical and mental practice (PP/MP); and, finally, people who have been involved in a control condition. Historically, the target skills investigated in MP research have largely been relatively simple laboratory tasks (e.g., dart-throwing or maze-learning) rather than complex sports skills. After a pre-treatment baseline test has been conducted on the specific skill involved, participants are randomly assigned to one of these conditions (PP, MP, PP/MP, or control). Normally, the cognitive rehearsal in the MP treatment condition involves a scripted sequence of relaxing physically, closing one’s eyes, and then trying to see and feel oneself repeatedly performing a target skill (e.g., a golf putt) successfully in one’s imagination. After this MP intervention has been applied, the participants’ performance on this skill is tested again. Then, if the performance of the MP group exceeds that of the control group, a positive effect of mental practice is reported.

Based on this experimental paradigm, a number of general conclusions about mental practice have emerged. First, relative to not practising at all, MP appears to improve skilled performance. However, MP is less effective than is physical practice. More precisely, a meta-analytic review by Driskell et al. (1994) showed that physical practice (PP) treatment conditions produced greater statistical effect sizes than was evident in mental rehearsal conditions (recall from Chapter 2 that meta-analysis is a statistical technique which combines the results of a large number of studies in order to determine the overall size of a statistical effect). Statistically, the relative effect sizes of physical practice and mental practice were estimated by these researchers as 0.382 and 0.261 (both Fisher’s Z), respectively. These figures can be interpreted with reference to J. Cohen’s (1992) suggestion that values of 0.20, 0.50 and 0.80 represent effect sizes that are small, medium and large, respectively. The second general finding from the research literature is that MP, when combined and alternated with physical practice, seems to produce superior skill-learning to that resulting from either mental or physical practice conducted alone. Third, research suggests that mental practice improves the performance of cognitive skills (i.e., those that
involve sequential processing activities; e.g., mirror drawing tasks) more than it does for motor skills (e.g., as balancing on a stabilometer). Fourth, there seems to be an interaction between the level of expertise of the performer and the type of task which yields the best improvement from mental rehearsal (Driskell et al., 1994). Specifically, expert athletes tend to benefit more from MP than do novices, regardless of the type of skill being practised (either cognitive or physical). Fifth, the positive effects of MP on task performance tend to decline sharply over time. Indeed, according to Driskell et al. (1994), the beneficial effects of visualization are reduced to half of their original value after approximately two weeks of time has elapsed. A practical implication of this finding is that in order to gain optimal benefits from mental practice, “refresher” training should be implemented after this critical two-week period. Finally, there is evidence that imagery ability mediates the relationship between MP and motor skill performance. More precisely, athletes who display special skills in generating and controlling vivid images tend to benefit more from visualization than do counterparts who lack such abilities. In summary, there is now considerable evidence (much of it experimental) to support the efficacy of mental practice as a technique for improving the performance of a variety of sport skills. These skills include not only “closed” actions (i.e., ones which are self-paced and performed in a relatively static environment) such as golf putting or placekicking in rugby but also “open” or reactive skills. For example, the rugby tackle (McKenzie and Howe, 1991) and the counter-attacking forehand in table tennis (Lejeune et al., 1994) have shown improvements under mental rehearsal training.

Critical evaluation of research on mental practice

At first glance, the preceding evidence on the efficacy of mental practice conveys the impression of a vibrant and well-established research field in cognitive sport psychology. But closer inspection reveals a less satisfactory picture. Specifically, as I mentioned in the previous section, MP research has encountered many conceptual and methodological criticisms over its century-long history (Shane Murphy and Martin, 2002). Of these criticisms, perhaps the two most persistent concerns have been the “validation” problem and an issue stemming from a lack of field research in the area. The validation problem can be conveyed by a simple question. How do we know that people who claim to be visualizing a target skill are actually using mental imagery? In other words, how can we validate people’s subjective reports about their imagery processes? The problem stemming from the neglect of field research concerns the fact that few published studies of MP have been conducted on athletes engaged in learning and performing sport skills in real life settings. Let us now sketch these problems in more detail.

The validation problem: how do we know that athletes are actually using imagery?

At the beginning of this chapter, we encountered a quotation from Tiger Woods, which provided an anecdotal testimonial to the value of mental
imagery. As critical psychologists, however, should we accept at face
value what athletes and performers tell us about their imagery experiences?
After all, cognitive researchers (e.g., Nisbett and Wilson, 1977) and sport
psychologists (e.g., Brewer et al., 1991) have warned us that people’s retro-
spective reports on their own mental processes are susceptible to a variety of
memory biases and other distortions (e.g., “response sets” whereby people may
wish to convey the impression that they have a good or vivid imagination).
Unfortunately, few researchers over the past century have attempted either to
keep precise records of the imagery scripts used by participants in MP studies
or otherwise to validate athletes’ reports of their alleged imagery experiences.
This neglect is probably attributable to the fact that in order to validate these
latter reports, sport psychology researchers require either objective methods
(e.g., functional brain imaging techniques to find out if the imagery centres in
the brain are activated when the person claims to be visualizing; see Kosslyn
et al., 2001) or experimental procedures (e.g., manipulation checks such as
asking people detailed questions about their images; see Shane Murphy and
Martin, 2002).

Although the use of brain imaging technology with athletes is prohibited by
cost and inconvenience at present, progress has been made in devising theoretically
based procedures to check if athletes are really using imagery when they claim to be
doing so. For example, Moran and MacIntyre (1998) checked the veracity of canoe
slalomists’ imagery reports (see Box 5.1) by using a theoretical principle derived
from Decety et al. (1989) and MacIntyre (1996). Specifically, this proposition sug-
gests that the greater the congruence between the imagined time and “real” time to
complete a mental journey, the more likely it is that imagery is involved. This mental
chronometric paradigm offers an intriguing way to check whether or not athletes
are actually using imagery when claiming to do so. To explore what can be learned
from comparing the time it takes to complete actual and imaginary tasks, try the
exercise in Box 5.2.

Box 5.2 Mental chronometry in action: experiencing your imagination

What is the relationship between imagining an action and actually doing it?
Using the mental chronometric paradigm (see Guillot and Collet, 2005, 2010), it
is now possible to investigate motor imagery objectively by comparing the
duration required to execute real and imagined actions. The logic here is as
follows. If imagined and executed actions rely on similar motor representations
and activate certain common brain areas (e.g., the parietal and prefrontal
cortices, the pre-motor and primary cortices; see Gueugneau et al., 2008), the
temporal organization of imagined and actual actions should also be similar. If
that is so, there should be a close correspondence between the time required to
mentally perform a given action and that required for its actual execution. Using
this logic, Calmels et al. (2006) examined the temporal congruence between
actual and imagined movements in gymnastics. They found that the overall
times required to perform and imagine a complex gymnastic vault were
broadly similar, regardless of the imagery perspective used (i.e., imagining oneself from a first person perspective or from a third person perspective). However, the temporal congruence between actual and imagined actions is mediated by a number of factors. Guillot and Collet (2005) concluded that when the skills to be performed are largely automatic (e.g., reaching, grasping) or occur in cyclical movements (e.g., walking, rowing), there is usually a high degree of temporal congruence between actual and imagined performance. But when the skills in question involve complex, attention-demanding movements (e.g., golf putting, tennis serving), people tend to overestimate their imagined duration. Although this use of mental chronometry has proved very helpful in motor imagery research, it needs to be augmented by other techniques in order to identify the cognitive mechanisms mediating the relationship between imagined and actual skilled performance. One possible solution to this problem is to use eye-tracking technology (see Chapter 6) as an objective method for investigating online cognitive processing during “eyes open” motor imagery. By comparing the eye movements of people engaged in mental and physical practice, we may be able to investigate the cognitive processes (especially those concerned with attention) that are activated by imaginary action (see Heremans et al., 2008).

To experience the mental chronometry in action, try this exercise (adapted from Robertson, 2002) at home. Imagine that you are about to write down your name, address and phone number on a sheet of paper. Before you begin this mental task, make sure the second hand of your watch is at the zero position. Then, make a note of how long it took you to write the three pieces of information in your mind’s eye. Next, find another piece of paper and repeat the writing exercise. Now, compare the two times that you recorded. If you were to repeat this exercise several times, you would find that the time it takes to write down your name, address and phone number is about the same as it takes to complete this task mentally.

Perhaps not surprisingly, the temporal congruence between actual and imagined movements seems to be affected by intervening variables such as the nature of the skill being performed and the level of expertise of the performers. Reed (2002) compared physical execution times for springboard dives with the time taken to execute this skill mentally. Three groups of divers were used: experts, intermediate performers and novices. Results revealed that, in general, visualization time increased with the complexity of the dives. Also, by contrast with the experts and novices, visualized dive execution time was slower than physical dive execution time. A further complication within this field of mental chronometry emerged from a study by Orliaguet and Coello (1998). Briefly, these researchers found little or no similarity between the timing of actual and imagined putting movements in golfers. Until recently, most research on the congruence between actual and imagined movement execution used skilled tasks
(e.g., canoe slalom, diving) in which there were no environmental constraints imposed on the motor system of the performer. However, Papaxanthis et al. (2003) conducted a remarkable study in which cosmonauts were tested on actual and imagined motor skills (e.g., climbing stairs, jumping and walking) before and after a six-month space flight. The specific issue of interest to these researchers was the degree to which a long exposure to microgravity conditions could affect the duration of actual and imagined movements. Results showed that, in general, the cosmonauts performed the actual and imagined movements with similar durations before and after the space flight. Papaxanthis et al. (2003) interpreted this finding to indicate that motor imagery and actual movement execution are affected by similar adaptation processes and share common neural pathways. In summary, the fact that the timing of mentally simulated lengthy actions tends to resemble closely the actual movement times involved suggests that motor imagery is functionally equivalent to motor production. Let us now return to the issue of how to assess the veracity of athletes’ imagery reports. Another possibility in this regard is to validate such experiences through functional equivalence theory. To explain, until the 1980s, the mechanisms underlying mental imagery were largely unknown. However, important theoretical progress on this issue occurred with the discovery that imagery shares some neural pathways and mechanisms with like-modality perception (Farah, 1984; Kosslyn, 1994) and with the preparation and production of motor movements (Jeannerod, 2001). This postulated overlap of neural representations between imagery, perception and motor execution is known as the functional equivalence hypothesis (e.g., Finke, 1979; Jeannerod, 1994). To illustrate, P. Johnson (1982) investigated the effects of imagined movements on the recall of a learned motor task and concluded that “imagery of movements has some functional effects on motor behaviour that are in some way equivalent to actual movements” (P. Johnson, 1982, p. 363; italics mine). Other studies (e.g., Roland and Friberg, 1985) suggested a functional equivalence between imagery and perception because “most of the neural processes that underlie like-modality perception are also used in imagery” (Kosslyn et al., 2001, p. 641). According to the functional equivalence hypothesis, mental imagery and perception are functionally equivalent in the sense that they are mediated by similar neuropsychological pathways in the brain. Accordingly, interference should occur when athletes are required to activate perceptual and imagery processes concurrently in the same sensory modality. This interference should manifest itself in errors and longer response times when athletes face this dual-task situation. Interestingly, as Figure 5.3 shows, interference can also occur between mental imagery and perception in other situations in everyday life such as driving a car while listening to the radio. Why is it so difficult to use perception and imagination in the same sensory modality? See Box 5.3.

The idea of using cognitive interference to validate imagery reports has certain obvious limitations, however. For example, apart from being modality-specific, it is rather unwieldy if not impractical as it depends on finding a suitable pair of perceptual and imagery tasks. Let us now turn to the second problem afflicting MP research. Why have there been so few imagery studies conducted on elite athletes who have to learn and perform sport skills in field settings?
Why you should not listen to football commentaries while driving: interference between imagery and action

It has long been known that people have great difficulty in perceiving and imagining information presented in the same sensory modality. Indeed, research by the British Transport Research Laboratory showed that listening to sport on the radio can affect drivers more than being drunk at the wheel (Massey, 2010). Furthermore, during simulated driving scenarios, there were nearly 50 per cent more incidents involving hard braking while motorists were listening to sport commentaries on the radio than when drivers were driving without the presence of distractions. To experience this difficulty of trying to engage in perception while imagining, try to form a mental image of a friend’s face while reading this page. If you are like most people, you should find this task rather difficult because the cognitive activities of forming a visual image and reading text on a page draw upon the same neural pathways. Another example of this “like-modality” interference problem occurs if you try to imagine your favourite song in your “mind’s ear” while listening to music on the radio. Just as before, auditory perception and auditory imagery interfere with each other because both tasks compete for the same processing pathways on the brain. An interesting practical implication of this interference phenomenon is that you should not listen to football matches while driving your car because both tasks require visual processing. This time, unfortunately, cognitive interference could result in a nasty accident (see Figure 5.3). Similar interference could occur if you try to visualize an action while driving.

Figure 5.3 It is dangerous to listen to a football match while driving a car
Lack of field research problem in MP research

Earlier in this chapter, I indicated that most research on mental practice has been carried out in laboratories rather than in real-life settings. Unfortunately, this trend has led to a situation in which few studies on MP have used “subjects who learned actual sport skills, under the same conditions and time periods in which sport activities are typically taught” (Isaac, 1992, p. 192). This neglect of field research is probably attributable to the fact that studies of this type are very time-consuming to conduct – which is a major drawback for elite athletes whose training and travel schedules are usually very busy. In addition, laboratory studies offer a combination of convenience and experimental control which is not easily rivalled in research methodology (see Chapter 1 for a brief summary of research methods in sport and exercise psychology). Since about 2000, there has been an upsurge of interest in “single-case” multiple-baseline research designs (for a comprehensive review of these designs, see Barker et al., 2011). In this paradigm, all participants not only receive the treatment but also act as their own controls because they are required to spend some time earlier in a baseline condition. A major advantage of these research designs is that they cater for individual differences because the intervention in question is administered at different times for each of the different participants in the study. As yet, however, only a handful of imagery studies in sport (e.g., Casby and Moran, 1998) have used single-case research designs.

Despite the conceptual and methodological criticisms discussed above, few researchers deny that MP is effective in improving certain sport skills in certain situations. So, what theoretical mechanisms could account for this MP effect?

Theories of mental practice: overview

Although many theories have been proposed since the 1930s to explain MP effects (see review by Moran, 1996), the precise psychological mechanisms underlying symbolic rehearsal remain unclear. One reason for this equivocal state of affairs is that most MP studies are “one-shot” variations of a standard experimental paradigm (described in the previous section) rather than explicit hypothesis-testing investigations. In spite of this problem, three main conceptual approaches have been postulated to explain MP effects: the neuromuscular theory of mental practice (e.g., Jacobson, 1932), the cognitive or symbolic theory of mental practice (e.g., Denis, 1985) and the bio-informational theory of imagery (e.g., Lang, 1979). As we shall see, the neuromuscular perspective proposes that mental practice effects are mediated mainly by faint activity in the peripheral musculature whereas the cognitive model attributes causal mechanisms to a centrally stored representation in the brain. The bio-informational theory postulates that MP effects reflect an interaction of three different factors: the environment in which the movement in question is performed (stimulus information), what is felt as the movement occurs (response information) and the perceived importance of this skill to the performer (meaning information). Let us now outline and evaluate each of these theories briefly (but for a more detailed review see Murphy and Martin, 2002) before proposing a possible compromise between these rival models of mental practice.
Neuromuscular theories of mental practice

The earliest theories of mental rehearsal (e.g., ideo-motor principle: Carpenter 1894; Washburn, 1916) contained two key propositions. First, they suggested that imagination of any physical action tends to elicit a pattern of faint and localized muscle movements. Second, they claimed that such muscular activity can provide kinesthetic feedback to the performer which enables him or her to make adjustments to this skill in future trials. This version of neuromuscular theory was supported by Jacobson (1932) who suggested that visualization causes tiny innervations to occur in the muscles that are actually used in the physical performance of the skill being rehearsed covertly. Such minute subliminal muscular activity was held to be similar to, but of a lower magnitude than, that produced by actual physical execution of the movements involved. A subsequent term for this theory is the inflow explanation approach (Kohl and Roenker, 1983) whereby the covert efferent activity patterns elicited by imagery are held to “facilitate appropriate conceptualizing for future imagery trials” (Kohl and Roenker, 1983, p. 180).

In order to corroborate neuromuscular theories of MP, evidence would have to be found which shows that there is a strong positive relationship between the muscular activity elicited by imagery of a given skill and that detected during the actual performance of this skill. Unfortunately, there is very little empirical support for neuromuscular theories of mental practice. For example, there is no convincing evidence that the faint muscular activity which occurs during imagery of a given skill is similar to that recorded during its overt performance. W. Shaw (1938) found that increased electromyographic (EMG) activity during motor imagery was distributed across a variety of muscle groups in the body – including some which were not directly related to the imagined action. In other words, the muscular innervations elicited by imagery may merely reflect generalized arousal processes. Doubts have surfaced about the type of muscular activity elicited by imagery. Despite using nuclear magnetic resonance (NMR) spectroscopy to monitor what happens in people’s muscles during imaginary performance of a specific skill, Decety et al. (1993) could not detect any change in relevant muscular metabolic indices. Finally, in a test of some predictions from neuromuscular theory, Slade et al. (2002) reported that the EMG pattern of activation in biceps and triceps for two types of imagined movements (namely, dumbbell and “manipulandum” curls) did not match the EMG pattern detected during actual movement. The authors of this study concluded that it added to “the mounting research evidence against the psychoneuromuscular theory” (Slade et al., 2002, p. 164). On the basis of the preceding evidence, Shane Murphy and Martin (2002) concluded that there is little or no empirical support for a relationship between the muscular activity elicited by MP and subsequent performance of sport skills. This conclusion was supported by Lutz (2003). Briefly, this investigator used a sample of novice darts players to test the relationship between covert muscle excitation elicited during motor imagery and subsequent performance in dart-throwing. Results showed that although motor imagery led to elevations in covert muscle excitation (as predicted by neuromuscular theory), the pattern of activation did not match that shown by the participants during actual dart-throwing. Also, this covert muscle excitation did not predict
motor skill acquisition or retention errors. Therefore, Lutz (2003) concluded that covert muscle excitation is an outflow from the central generation of motor imagery rather than an inflow from peripheral structures.

Cognitive theories of mental practice

Cognitive (or symbolic) accounts of visualization propose that mental practice facilitates both the coding and rehearsal of key elements of the task. One of the earliest proponents of this approach was Sackett (1934), who discovered that people’s performance on a finger-maze task improved following mental rehearsal of the movement patterns involved. This finding was held to indicate that imagery facilitates the symbolic coding of the mental representation of the movements involved. For example, if you are a keen tennis player you could use imagery to practise a top-spin serve in your mind. This might involve seeing yourself in your mind’s eye standing at the service line, feeling yourself bouncing the ball a few times before tossing it upwards and then feeling the strings of your racket brushing up behind it as you hit the ball and move onto the court.

By contrast with neuromuscular accounts of MP, cognitive models attach little importance to what happens in the peripheral musculature of the performer. Instead, they focus on the possibility that mental rehearsal strengthens the brain’s central representation or cognitive blueprint of the skill or movement being visualized. In general, two types of evidence have been cited in support of cognitive theories of MP (Murphy and Martin, 2002). First, central representation theories may explain why visualization is especially suitable for mastering tasks (e.g., mirror drawing) which contain many cognitive or symbolic elements such as planning sequential movements (see research findings on MP discussed previously). Interestingly, some anecdotal evidence complementing this finding comes from athletes who use mental imagery to anticipate what might happen in a forthcoming competitive situation (see the quote from Ronan O’Gara in Chapter 4). Second, a cognitive explanation of MP is corroborated by certain research findings on the transfer of learned skills. Specifically, Kohl and Roenker (1980) investigated the role of mental imagery in the bilateral transfer of rotary pursuit skill from participants’ right hands to their left hands. Results showed that such transfer of learning occurred even when the training task (involving the contralateral limb) was imagined.

Despite receiving some empirical support, symbolic theories of mental practice have been criticized on at least four grounds. First, they cannot easily explain why MP sometimes enhances motor or strength tasks (see Budney et al., 1994) which, by definition, contain few cognitive components. Remarkably, since the early 1990s, evidence has emerged that imagery training can lead to enhanced muscular strength. Yue and Cole (1992) used a variation of the mental practice research design to show that imagery training could increase finger strength. Subsequently, Yue and his colleagues extended this paradigm to other types of strength training. Uhlig (2001) reported that Yue and his research team required ten volunteers to take part in an imagery-training exercise involving a mental work-out five times a week. This “mental gym” exercise, which consisted of the imaginary lifting of heavy weights
with their arms, increased the bicep strength of the participants by 13.5 per cent! Control participants, who missed such mental work-outs, did not show any significant gains in muscle strength. Second, in contrast to these studies, Herbert et al. (1998) discovered that imagined training produces increases in the strength of the elbow flexor muscles which did not differ significantly from those attained by a control group. Third, another problem for symbolic theories is that they find it difficult to explain how MP enhances the performance of experienced athletes who, presumably, already possess well-established blueprints or motor schemata for the movements involved. Fourth, and perhaps most worryingly, most cognitive theories of MP are surprisingly vague about the theoretical mechanisms which are alleged to underlie imagery effects.

**Bio-informational theory of mental practice**

The bio-informational theory of imagery grew out of Lang’s (1979) attempt to understand how people respond emotionally and psychophysiological to feared objects. It was subsequently applied to research on MP in motor skills by Bakker et al. (1996).

Influenced by the ideas of Pylyshyn (1973), Lang (1979) began with the claim that mental images are not “pictures in the head” but propositional representations in long-term memory. These propositional representations are abstract, language-like cognitive codes that do not physically resemble the stimuli to which they refer. Three types of information about the imagined object or situation are coded in these propositional representations. First, stimulus propositions are statements that describe the content of the scene or situation being imagined. For example, if one were to visualize a penalty kick in football, stimulus information might include the sight of the opposing goalkeeper, the sound of the crowd, and the feel of the ball in one’s hands as one places it on the penalty spot. Second, response propositions are statements that describe how and what the person feels as he or she responds to the scenario imagined. For example, stepping up to take a penalty kick is likely to cause some degree of tension and physiological arousal in the player. Images that are composed of response propositions tend to be more vivid than those containing only stimulus propositions (Bakker et al., 1996). Third, meaning propositions refer to the perceived importance to the person of the skill being imagined. For example, if there were only a few seconds left in the match, and one’s team is a goal down, the hypothetical penalty kick is imbued with great significance. Lang’s (1979) theory postulates that information from these three types of propositions is organized in an associative network in the mind.

Within this network, the response propositions are of special interest to imagery researchers. This is so because these propositions are believed to be coded as bodily responses which are primed by efferent outputs to the muscles of the body. In other words, the propositions regulating imagined responses reflect how a person would actually react in the real-life situation being imagined. Lang (1977, 1979) suggested that response propositions are modifiable. Therefore, based on this theory, it should be possible to influence athletes’ mental practice by using imagery scripts that are heavily laden with response propositions. Unfortunately, with the
exception of studies by researchers such as Bakker et al. (1996) and Hecker and Kaczor (1988), this hypothesis has not been tested systematically in sport psychology. Nevertheless, there is some evidence that imagery scripts emphasizing response propositions elicit greater physiological activation than do those containing stimulus propositions predominantly (Lang et al., 1980). This conclusion was supported by Cremades (2002), who recorded the EEG activity of golfers during imagery of a putting task using different types of visualization scripts. Analysis of alpha activity in these participants revealed that greater arousal and effort were needed during the golfers’ imagery emphasizing response propositions as compared with that apparent during imagery emphasizing stimulus propositions.

In summary, according to bio-informational theory, imagery not only allows people to rehearse what they would do in certain hypothetical situations but also leads to measurable psychophysiological changes associated with the response and meaning propositions triggered by the situation being imagined. Although this theory has not been widely tested in sport and exercise psychology, it has at least three interesting implications for MP research. First, it encourages researchers to regard imagery as more than just a “picture in the head”. To explain, Lang’s (1977, 1979) theories postulate that for MP to be effective, both stimulus and response propositions must be activated by the imagery script used (Gould et al., 2002a). Second, it highlights the value of “individualizing” imagery scripts so that they take account of the personal meaning which people attribute to the skills or movements that they wish to rehearse. For an application of this idea to sport psychology, see the discussion of the PETTLEP model of P. Holmes and Collins (2001, 2002) in Box 5.4. Third, bio-informational theory emphasizes the need to consider emotional factors when designing imagery scripts – an issue which has been largely neglected by advocates of neuromuscular and cognitive theories of mental practice. There is now compelling evidence that visualizing a stimulus has an effect on the body similar to that when actually seeing it. Lang et al. (1993) discovered that people who imagine threatening objects experience the same signs of emotional arousal (e.g., increased heart rate, shallow breathing) as they do when actually looking at them.

**Box 5.4** An applied checklist for mental practice in sport: the PETTLEP model

In an effort to develop a theoretically based checklist for the effective implementation of mental imagery intervention in sport, P. Holmes and Collins (2001) drew upon Lang’s (1977, 1979) bio-informational theory and the functional equivalence hypothesis in neuroscience (described above) to produce the PETTLEP model. PETTLEP is an acronym, with each letter representing a key practical issue to be considered when designing imagery scripts and implementing imagery interventions for optimal efficacy in sport. Specifically, these issues are physical, environmental, task, timing, learning, emotional and perspectival. Thus “P” refers to the athlete’s physical response to the sporting situation, “E” is the environment in which the imagery is
performed, “T” is the imagined task, “T” refers to timing – or the pace at which the imagery is performed, “L” is a learning or memory component of imagery, “E” is the emotions elicited by the imagery and “P” designates the type of visual imagery perspective used by the practitioner (either first person or third person). Overall, the PETTLEP model proposes that in order to produce optimal functional equivalence between imagery and motor production, and thereby to enhance subsequent sport performance, imagery interventions should replicate not only athletes’ sporting situation but also the emotions that they experience when performing their skills. For example, P. Holmes and Collins (2002) proposed various practical ideas to “enhance the physical dimensions of an athlete’s imagery. These include using the correct stance, holding any implements that would usually be held, and wearing the correct clothing” (D. Smith and Wright, 2008, p. 145). Furthermore, in accordance with bio-informational theory, the PETTLEP model recommends that imagery scripts should include stimulus (i.e., the information describing the stimuli in the environment), response (i.e., the cognitive, affective and behavioural responses of the person to a given stimulus), and meaning (i.e., the perceived importance of the behaviour) propositions (Cumming and Ramsey, 2009). Although the predictions of the PETTLEP model have not been tested extensively to date, available empirical results are generally supportive. For example, D. Smith et al. (2007) compared the use of PETTLEP imagery training with traditional mental practice techniques and also with physical practice in developing gymnastics jump skills. Results showed that the PETTLEP group improved its proficiency in these skills whereas the traditional imagery group did not.

A note of caution about PETTLEP

Sometimes, theories in psychology become distorted through a slippage in the meaning of key terms. This problem is evident among some researchers who have attempted to test the PETTLEP model. For example, consider the claim by Ramsey et al. (2008, p. 209) that “the degree of equivalence between the imagery experience and the physical experience is a major determinant of imagery’s effectiveness at modulating behaviour”. This claim can be challenged on at least two grounds. First, it is inaccurate to postulate that functional equivalence occurs at the phenomenological level – between the “experience” of imagining a skill or movement and that of performing it. Early proponents of the concept of functional equivalence (e.g., Finke, 1979; P. Johnson, 1982) were at pains to suggest that the hypothesized equivalence occurred either at the neural or mental representational levels – not experientially. Clearly, imagining running a marathon does not make one feel as tired as if one actually ran this event! Second, there is no agreed index of “degree of equivalence” as it is difficult to measure objectively. This apparent misunderstanding of functional equivalence is also evident in Cumming and Ramsey’s (2009, p. 20) suggestion that “imagery more functionally equivalent to actual performance will
have more pronounced effects on subsequent performance compared to less functionally equivalent imagery”. Again, the problem with this claim is that there is no independent measure of the “amount” of functional equivalence between imagery and motor production. This is a problem for all studies of functional equivalence in psychology.

An integrated model of mental practice: functional equivalence theory

Having considered the strengths and limitations of three traditional theories of mental practice (namely, the neuromuscular, cognitive and bio-informational models), it may be helpful to propose an integrated, compromise position that takes account of neuropsychological research on mental imagery namely, functional equivalence theory. Briefly, two key propositions underlying this integrated position may be expressed as follows. First, neuroimaging studies suggest that imagery is functionally equivalent to perception because these two types of cognitive activity share similar neural pathways in the brain (Kosslyn et al., 2001). Second, research indicates that mental practice is functionally equivalent to physical practice in the sense that imagery is guided by the same kinds of central mental representations as are motor movements (C. Hall, 2001). Evidence to support this proposition comes from several sources. For example, neuroscientific studies show that there is a great deal of overlap between the neural substrates of physical and imagined movement execution (see Moran et al., in press). Specifically, motor imagery and movement execution activate such neural regions as the premotor cortex, primary motor cortex, basal ganglia and cerebellum (Jeannerod, 2001). This overlap of neural substrates is not complete, though. Thus Carrillo-de-la-Peña et al. (2008) found that there were significant differences between the event-related potentials elicited during motor imagery and motor execution. Indeed, Dietrich (2008) claimed that there are a number of brain areas that show increased activation while participants are engaged in imagery of a skill but not during its actual performance. The converse also appears to be true. Thus there are certain brain areas that are activated during physical performance but not during mental imagery. Based on such neuroscientific evidence, it seems plausible that mental practice is best understood, at present, as a centrally mediated cognitive activity that mimics perceptual, motor and certain emotional experiences in the brain. This view integrates the strengths of all three theories of mental practice – the neuromuscular account (because MP has neural substrates even though these are regulated neither centrally nor peripherally), the cognitive model (because MP is believed to be mediated by a central mental representation) and the bio-informational approach (because MP elicits emotional reactions as well as cognitive and neural activity). Influenced by recent developments in neuroscience, Shane Murphy et al. (2008, p. 308) have proposed “a neurocognitive model of imagery for movement disciplines”. This model is based on the functions that imagery serves in regulating action (e.g., motor control, regulation of emotional and motivational processes) and allocates a central role to working memory. Empirical validation of this model is awaited.
Conclusions about research on mental practice in athletes

In summary, research on MP has shown that the systematic covert rehearsal of motor movements and sport skills has a small but significant positive effect on their actual performance. But this conclusion must be tempered by at least three cautionary notes. First, as Box 5.5 shows, mental practice effects are influenced by a number of intervening variables.

Box 5.5 Thinking critically about … the effects of mental practice on sport performance

Despite an abundance of research on mental practice since the 1960s, relatively few studies have been conducted on the nature of, and cognitive mechanisms underlying, motor imagery processes in athletes. Therefore, any conclusions about the effects of MP on sporting performance – especially at the elite level – must be regarded as somewhat tentative because they reflect extrapolations from a body of research literature that was developed using rather different tasks and research designs from those employed in sport psychology. For example, for reasons of convenience and control, the criterion tasks employed by most MP researchers tend to be laboratory tasks (e.g., maze-learning) rather than complex sport skills (e.g., the golf drive). In addition, traditional studies of mental practice have adopted “between groups” experimental designs in laboratory settings rather than either single-case studies or field experiments. Clearly, future studies of mental practice in athletes will benefit from the use of more complex and ecologically valid sport skills than those used to date and also from the adoption of a wider range of experimental research designs than has been evident until now. Nevertheless, there is at least one important lesson to be learned by motor imagery researchers in sport psychology from traditional studies of MP. Specifically, investigators in the latter field have evaluated a range of intervening variables that affect the relationship between MP and skilled performance. These intervening variables offer crucial clues to the design of successful motor imagery interventions. Schuster et al. (2011) conducted a systematic review of the research literature on mental practice in an effort to identify the key elements of successful motor imagery interventions reported in 133 studies in five different disciplines – sport (i.e., research using athlete populations), psychology (i.e., research using healthy participants who were not athletes), education, medicine and music. Schuster et al. (2011) discovered that, in general, successful imagery interventions had a number of key training elements. For example, the imagery training was conducted in individual sessions and added after physical practice of the skill being targeted. In addition, the participants received acoustic and detailed imagery instructions and kept their eyes closed while imagining the execution of the skill. The imagery perspective that seemed to work best was an internal/kinaesthetic one.
Critical thinking questions

All too often, studies on mental practice in sport fail to include either an imagery test or a manipulation check on whether or not participants actually adhered to the imagery instructions provided. Why do you think it is important to evaluate the imagery skills of participants in mental practice research? (As a hint, would it be helpful to find out if people’s imagery scores changed over the course of the intervention? If so, why?) Is it possible to evaluate an imagery intervention in the absence of a manipulation check that imagery instructions were followed adequately? Do you think that the duration of a motor imagery intervention affects its efficacy? Give reasons for your answer – and then check your ideas with what Schuster et al. (2011) found in their review.

Second, research on imagery processes in athletes is hampered by inadequate theoretical explanation of the psychological mechanisms underlying MP effects. In this regard, however, the weight of evidence at present tends to favour the functional equivalence model of mental rehearsal. The third cautionary note arises from the possibility that MP research may constrain our understanding of imagery use in athletes. To explain, as Shane Murphy and Martin (2002) observed, research on the symbolic rehearsal of movements and skills may blind us to the many other ways in which athletes use imagery in sport. Put differently, MP research “offers little guidance regarding the many uses of imagery by athletes beyond simple performance rehearsal” (Shane Murphy and Martin, 2002, p. 417). I shall return to this last point in the fifth section of this chapter.

Measuring mental imagery skills in sport

Research on the measurement of mental imagery has a long and somewhat controversial history in psychology. It goes back to the earliest days of experimental psychology when Galton (1883) asked people to describe their images and to rate them for vividness. Not surprisingly, this introspective, self-report strategy proved contentious. In particular, as I explained earlier in the chapter, Behaviourists like Watson (1913) attacked it on the grounds that people’s imagery experiences could neither be verified independently nor linked directly with observable behaviour. Fortunately, theoretical advances in cognitive psychology (see Kosslyn et al., 2006) and the advent of brain imaging techniques in neuroscience (discussed earlier in this chapter) overcame these methodological objections and led to a resurgence of interest in imagery research. Thus imagery is now measured via a combination of techniques that include experimental tasks (e.g., asking people to make decisions and solve problems using imagery processes), timing of behaviour (e.g., comparing imagined with actual time taken to execute an action), neuroscientific procedures (e.g., recording what happens in brain areas activated by imagery tasks) and psychometric tools (e.g., for the assessment of imagery abilities and imagery use in athletes). Arising from these empirical strategies, two questions are especially relevant to this chapter. First, how can psychologists measure people’s private experience of mental imagery? Second, what progress has been made in assessing
imagery processes in athletes? In order to answer these questions, a brief theoretical introduction is necessary.

Earlier in this chapter, we learned that although mental images are ephemeral constructs, they differ from each other along at least two psychological dimensions: vividness and controllability. Over the past century, these two dimensions of imagery have been targeted by psychologists in their attempt to measure this construct. Throughout this period, two different strategies have been used to assess these imagery dimensions. Whereas the subjective approach is based on the idea of asking people about the nature of their images, the objective approach requires people to complete visualization tasks that have right or wrong answers. The logic here is that the better people perform on these tasks, the more imagery skills they are alleged to possess.

These approaches to imagery measurement can be illustrated as follows. The vividness of an image (which refers to its clarity or sharpness) can be assessed using self-report scales in which people are asked to comment on certain experiential aspects of their mental representation. For example, close your eyes and form an image of a friend’s face. On a scale of 1 (meaning “no image at all”) to 5 (meaning “as clear as in normal vision”), how vivid is your mental image of this face? Similarly, the clarity of an auditory image might be evaluated by asking people such questions as: “If you close your eyes, how well can you hear the imaginary sound of an ambulance siren?” Unfortunately, subjective self-report scales of imagery have certain limitations (Moran, 1993). For example, they are subject to contamination from response sets such as social desirability. Put simply, most people are eager to portray themselves as having a good or vivid imagination regardless of their true skills in that area. For this reason, objective tests of imagery have been developed. Thus the controllability dimension of a visual mental image (which refers to the ease and accuracy with which it can be transformed symbolically) can be measured objectively by requesting people to complete tasks which are known to require visualization abilities. In the Group Mental Rotations Test (GMRT: Vandenberg and Kuse, 1978), people have to make judgements about whether or not the spatial orientation of certain three-dimensional target figures matches (i.e., is congruent with) or does not match (i.e., is incompatible with) various alternative shapes. The higher people’s score is on this test, the stronger are their image control skills. For a more comprehensive account of the history of imagery measurement, as well as of the conceptual and methodological issues surrounding it, see J. Richardson (1999).

Let us now turn to the second question guiding this section. What progress has been made in assessing imagery processes in athletes? The most comprehensive account of imagery measurement in sport psychology to date is that provided by T. Morris et al. (2005). In general, two types of instruments have been developed in this field: tests of athletes’ imagery abilities and tests of their imagery use (see T. Morris et al., 2005). Although an exhaustive review of these measures lies beyond the scope of this chapter, some general trends and issues in imagery measurement may be summarized as follows.

First, among the most popular and psychometrically impressive tests of imagery skills in athletes are the Vividness of Movement Imagery Questionnaire (VMIQ: Isaac et al., 1986) and the revised version of the Movement Imagery Questionnaire (MIQ-R: C. Hall and Martin, 1997). The VMIQ is a twenty-four-item
measure of “visual imagery of movement itself and imagery of kinaesthetic sensations” (Isaac et al., 1986, p. 24). Each of the items presents a different movement or action to be imagined (e.g., riding a bicycle). Respondents are required to rate these items in two ways: “watching somebody else” and “doing it yourself”. The ratings are given on a five-point scale where 1 = “perfectly clear and as vivid as normal vision” and 5 = “no image at all”. Although not extensive, available evidence suggests that the VMIQ satisfies conventional standards of psychometric adequacy. Eton et al. (1998) reported that it had high internal consistency coefficients (e.g., 0.97 for the total scale) and a test-retest reliability score of 0.64 (for the “other” subscale) to 0.80 (for the “self” score) over a two-week interval. Lequerica et al. (2002) reported a high internal consistency value of 0.95 for the visual imagery subscale and 0.97 for the kinaesthetic imagery subscale. An amended version of this test called the Vividness of Movement Imagery Questionnaire-2 (VMIQ-2) was published by R. Roberts et al. (2008) (see Box 5.6).

**Box 5.6 A new test of movement imagery in athletes: revising the Vividness of Movement Imagery Questionnaire**

Although the Vividness of Movement Imagery Questionnaire (VMIQ: Isaac et al., 1986) has been one of the most popular and psychometrically sound imagery tests used in sport psychology, it has several limitations that were identified by R. Roberts et al. (2008). First, the VMIQ appears to confound two different imagery modalities – visual and kinaesthetic. Thus it requires respondents to imagine performing movements themselves but does not instruct them to use the kinaesthetic modality rather than the visual one, even though first person visual imagery (IVI) and kinaesthetic imagery are regarded as separate modalities (Fourkas et al., 2006b). Second, as the visual imagery subscale of the VMIQ requests respondents to imagine someone else performing actions (as distinct from watching oneself performing these actions), it fails to measure adequately external self-imagery. Third, the VMIQ has not been subjected to confirmatory factor analysis – a technique commonly used to investigate the construct validity of a psychometric test. To address these problems, R. Roberts et al. (2008) developed the Vividness of Movement Imagery Questionnaire – 2 (VMIQ-2). This test consists of twelve items and assesses the ability to form mental images of a variety of movements visually and kinaesthetically. The visual component is further subdivided into “external” and “internal” visual imagery. Respondents are required to imagine each of the twelve movements and to rate the vividness of each item on a Likert-type scale from 1 (“perfectly clear and vivid”) to 5 (“no image at all”). The VMIQ-2 displays impressive factorial validity and acceptable concurrent and discriminate validity.

Turning to the MIQ-R (C. Hall and Martin, 1997), this test is especially interesting for sport researchers because it was designed to assess individual differences in kinaesthetic as well as visual imagery of movement. Briefly, this test contains eight items which assess people’s ease of imaging specific movements...
either visually or kinaesthetically. In order to complete an item, respondents must execute a movement and rate it on a scale ranging from “1” (meaning “very hard to see/feel”) to 7 (meaning “very easy to see/feel”). Imagery scores are calculated as separate sums of the two subscales of visual and kinaesthetic imagery skills. Available evidence indicates that the MIQ-R displays adequate reliability and validity. Abma et al. (2002) reported an internal consistency value of 0.87 for the visual scale and a value of 0.88 for the kinaesthetic scale.

The second point to note about imagery assessment in sport is that the Sport Imagery Questionnaire (SIQ: C. Hall et al., 1998, 2005) is a popular, theory-based and reliable tool for measuring the frequency with which athletes use imagery for motivational and cognitive purposes. Based on Paivio’s (1985) theory that imagery affects behaviour through motivational and cognitive mechanisms operating at general and specific levels, the SIQ is a thirty-item instrument (with five subscales) that asks respondents to rate on a seven-point scale (where 1 = “rarely” and 7 = “often”) how often they use five specific categories of imagery: motivational general-mastery (e.g., imagining appearing mentally tough, self-confident and in control in front of others), motivational general-arousal (e.g., imagining the anxiety, stress and/or excitement associated with competition), motivational specific (e.g., imagining achieving an individual goal, such as winning a medal), cognitive general (e.g., imagining various strategies, game plans or routines for a competitive event) and cognitive specific (e.g., mentally practising specific sport skills). Sample items from these subscales include “I imagine myself appearing self-confident in front of my opponents” (motivational general-mastery), “I imagine the stress and anxiety associated with competing” (motivational general-arousal), “I imagine myself winning a medal” (motivational specific), “I imagine alternative strategies in case my event/game plan fails” (cognitive general) and “I can mentally make corrections to physical skills” (cognitive specific).

The six items that comprise each subscale are averaged to yield a score that indicates to what extent respondents use each of the five functions of imagery. According to C. Hall et al. (2005), this test has acceptable psychometric characteristics. This claim is supported by Cumming and Ste-Marie (2001), who reported internal consistency values of 0.75 to 0.91 for the various subscales. Beauchamp et al. (2002) reported internal consistency values ranging from 0.72 (for a scale measuring motivational general-arousal) to 0.94 (for a scale assessing motivational general-mastery) for a modified version of the SIQ. Mellalieu et al. (2009) reported internal consistency values for the scale that ranged from 0.77 (for the motivational general-arousal subscale) to 0.83 (for the cognitive specific subscale).

Unfortunately, despite the preceding progress in imagery measurement, a number of conceptual and methodological issues remain in this field (see also T. Morris et al., 2005). First, even though evidence has accumulated from neuroimaging techniques that imagery is a multidimensional construct, most imagery tests in sport and exercise psychology rely on a single imagery scale score. Second, until recently, few imagery tests in sport psychology had either an explicit or an adequate theoretical rationale. This issue prompted Shane Murphy et al. (2008, p. 298) to proclaim that “researchers and theorists need to develop a comprehensive model that will guide imagery investigations”. Third, much of the psychometric evidence cited in support of imagery tests in sport psychology comes from the research teams...
that developed the tests in the first place – which is hardly ideal an ideal scientific development. A brief summary of some other issues in the field is contained in Box 5.7.

**Box 5.7** Thinking critically about … imagery tests in sport psychology

Many tests of imagery abilities and imagery use are available in sport psychology (see T. Morris et al., 2005). Which one should you use? Although the answer to this question depends partly on the degree to which the test matches your specific research requirements (e.g., are you studying visual or kinaesthetic imagery or both?), it also depends on psychometric issues. These issues are expressed below in the critical thinking questions.

**Critical thinking questions**

If the psychometric adequacy of the imagery test is unknown, how would you assess its reliability? What value of a reliability coefficient is conventionally accepted as satisfactory by psychometric researchers? How would you establish the construct validity of an imagery test in sport? Specifically, what other measures of this construct would you use to establish the “convergent validity” of the test? Also, how would you establish the “discriminant validity” of the test (i.e., what measures should your test be unrelated to statistically)? If you were designing an imagery test for athletes from scratch, what precautions would you take to control for response sets (e.g., social desirability) or acquiescence (i.e., the tendency to apply the same rating to all items regardless of the content involved)?

**Athletes’ use of mental imagery**

Having analysed how mental imagery processes have been measured in sport performers, let us now consider how they are used by athletes. People use mental imagery for many purposes in everyday life. Kosslyn et al. (1990) asked a sample of university undergraduates to keep a diary or log of their imagery experiences over the course of a week. Results revealed that imagery was used for such functions as problem solving (e.g., trying to work out in advance whether or not a large suitcase would fit into the boot of a car), giving and receiving directions (e.g., using mental maps to navigate through the physical environment), recall (e.g., trying to remember where they had left a lost object), mental practice (e.g., rehearsing what to say in an important interview on the way to work) and motivation (e.g., using images of desirable scenes for mood enhancement purposes). This type of research raises several interesting questions. How widespread is imagery use among athletes (see review by Munroe et al., 2000)? Do elite athletes use it more frequently than less proficient counterparts? For what specific purposes do athletes employ imagery?
Before we explore empirical data on these questions, let us consider briefly some anecdotal reports and textbook accounts of reports on imagery use in sport. In this regard, many testimonials to the value of imagery have emerged from interviews with, and profiles on, athletes in different sports. For example, current and former world-class performers such as Michael Jordan (basketball), Tiger Woods and Jack Nicklaus (golf), John McEnroe and Andre Agassi (tennis), George Best and David James (football) all claim to have seen and felt themselves performing key actions successfully in their imagination before or during competition (Begley, 2000). As critical thinkers, however, we should be careful not to be too easily influenced by anecdotal testimonials. A critic once remarked acerbically about another psychologist’s work which was heavily based on colourful examples, the plural of anecdote is not data! In other words, examples do not constitute empirical evidence. As I explained in Chapter 1, psychologists are wary of attaching too much importance to people’s accounts of their own mental processes simply because such insights are often tainted by biases in memory and distortions in reporting. Athletes may recall more cases of positive experiences with imagery (i.e., occasions on which their visualization coincided with enhanced performance) than negative experiences with it (where visualization appeared to have no effect).

Turning to the textbooks, many applied sport psychologists have compiled lists of alleged uses of imagery in sport (see Box 5.8).

**Box 5.8 Thinking critically about … athletes’ use of mental imagery**

Many applied sport psychologists provide lists of assumed applications of mental imagery by athletes. Vealey and Greenleaf (2010) suggested that athletes use imagery to enhance three types of skills: physical (e.g., a golf putt), perceptual (e.g., to develop a strategic game plan) and psychological (e.g., to control arousal levels). Within these three categories, imagery is alleged to be used for the following purposes:

- Learning and practising sport skills (e.g., rehearsing a tennis serve mentally before going out to practise it on court)
- Learning strategy (e.g., formulating a game plan before a match)
- Arousal control (e.g., visualizing oneself behaving calmly in an anticipated stressful situation)
- Self-confidence (e.g., “seeing” oneself as confident and successful)
- Attentional focusing/refocusing (e.g., focusing on the “feel” of a gymnastics routine)
- Error correction (e.g., replaying a golf swing slowly in one’s mind in order to rectify any flaws in it)
- Interpersonal skills (e.g., imagining the best way to confront the coach about some issue)
- Recovery from injury or managing pain (e.g., visualizing healing processes).
Critical thinking questions
Sometimes, speculation goes beyond the evidence in sport psychology. To explain, there is a big difference between speculating about what athletes could use imagery for and checking on what they actually use it for in sport situations. For example, few studies have found any evidence that athletes use imagery to enhance either interpersonal skills or recovery from injury. Therefore, despite the unqualified enthusiasm which it commonly receives in applied sport psychology, mental imagery is not a panacea for all ills in sport. Clearly, it is advisable to adopt a sceptical stance when confronted by claims about the alleged use of mental imagery by athletes.

How can we test the claims made in Box 5.8? To answer this question, two main research strategies have been used by sport psychologists: descriptive and theoretical. Whereas the descriptive approach has tried to establish the incidence of general imagery use in athletes, the theoretical approach has examined specific categories of imagery use (e.g., imagery as an aid to motivation and cognition) in these performers. These two approaches to imagery use can be summarized as follows.

Using the descriptive approach, special survey instruments have been designed to assess imagery use in various athletic populations. This approach has led to some interesting findings. For example, successful athletes appear to use imagery more frequently than do less successful athletes (Durand-Bush et al., 2001). We should not be surprised at this discovery because Shane Murphy (1994) reported that 90 per cent of a sample of athletes at the US Olympic Training Centre claimed to use imagery regularly. Ungerleider and Golding (1991) found that 85 per cent of more than 600 prospective Olympic athletes employed imagery techniques while training for competition. Clearly, imagery is used extensively by expert athletes. By contrast, Cumming and Hall (2002b) found that recreational sport performers used imagery less than did more proficient counterparts (namely, provincial and international athletes) and also rated it as being less valuable than did the latter group. This trend was apparent even out of season (Cumming and Hall, 2002a). Moreover, as one might expect, visual and kinaesthetic imagery are more popular than other kinds of imagery in athletes (C. Hall, 2001).

Although this type of descriptive research provides valuable baseline data on imagery use among athletes, it does not elucidate the precise tasks or functions for which athletes employ their visualization skills. To fill this gap, a theoretically derived conceptual model of imagery use in athletes was required. Craig Hall et al. (1998) postulated a taxonomy of imagery use in athletes based on Paivio’s (1985) theory that imagery affects both motivational and cognitive processes. As indicated in the previous section, this taxonomy of C. Hall et al. (1998) proposed five categories of imagery use. First, motivational general-mastery involved the imagination of being mentally tough and focused in a forthcoming competitive situation. Second, motivational general-arousal involved imagining the feelings of excitement that accompany an impending competitive performance. Third, motivational specific was implicated in visualizing the achievement of a goal such as winning a race.
Fourth, cognitive general imagery occurred when athletes imagined a specific strategy or game plan before or during a match. Fifth, cognitive specific imagery involved mentally rehearsing a skill such as a golf putt or a penalty kick in football.

At first glance, this taxonomy is helpful not only because it distinguishes between imagery function and imagery content but also because it allows researchers to explore the relationship between these variables and subsequent athletic performance. Short et al. (2002) discovered that both imagery direction (i.e., whether imagery was positive or negative) and imagery function (motivational general-mastery and cognitive specific) can affect people’s self-efficacy and performance in golf putting. Despite its heuristic value, however, the classification system by C. Hall et al. (1998) has been criticized for conceptual vagueness. To illustrate, Abma et al. (2002) pointed out that athletes who use cognitive specific imagery regularly (e.g., in rehearsing a particular skill) may be classified as using motivational general-mastery if they believe that mental practice is the best way to boost their confidence. Another limitation of this taxonomy is that it offers no explanation of the cognitive mechanisms underlying imagery processes. Despite such criticisms, the theoretically driven taxonomies developed by C. Hall et al. (1998) and K. Martin et al. (1999) offer greater scope for research on imagery use by athletes than do the intuitive classifications promulgated by applied sport psychologists (e.g., Vealey and Greenleaf, 2010).

Let us now summarize some general findings on imagery use in athletes. According to C. Hall (2001), three general trends may be detected in this field. First, athletes tend to use imagery more in pre-competitive than in practice situations – a fact which suggests that they tend to visualize more frequently for the purpose of mental preparation or performance enhancement in competition than for skill acquisition. Second, available evidence suggests that, as predicted by Paivio (1985), imagery is used by athletes for both motivational and cognitive purposes. Although the former category is rather fuzzy and ill-defined, it includes applications like seeing oneself achieving specific goals and feeling oneself being relaxed in competitive situations. It is precisely this latter application that the British Olympic champion shooter, Richard Faulds, pursued in creating the image of an ice-man prior to winning the 2000 Olympic gold medal for trap-shooting: “The image is the ice-man. You walk like an ice-man and think like an ice-man” (quoted in Nichols, 2000, p. 7). With regard to cognitive uses of imagery by athletes, two main applications have been discovered by researchers. First, as is evident from anecdotal and survey evidence, imagery is widely used as a tool for mental rehearsal (a “cognitive specific” application). Second, imagery is often used as a concentration technique. The former England cricket batsman Mike Atherton used to practise in his mind’s eye in an effort to counteract anticipated distractions on the big day. This involved visualizing “What’s going to come, who’s going to bowl, how they are going to bowl, what tactics they will use, what’s going to be said to try and get under my skin so that nothing can come as a surprise” (cited in Selvey, 1998). A third general research finding in this field concerns the content of athletes’ imagery. In this regard, C. Hall (2001, p. 536) claims that athletes tend to use positive imagery (e.g., seeing themselves winning competitive events) and “seldom imagine themselves losing”. But is this really true? After all, everyday experience would suggest
that many club-level golfers are plagued by negative mental images such as hitting bunkers or striking the ball out of bounds. Nevertheless, C. Hall (2001) concluded that athletes’ imagery is generally accurate, vivid and positive in content.

New directions for research on imagery in athletes

Two questions dominate this section of the chapter. First, what new directions can be identified in research on imagery processes in athletes? Second, does this research shed any light on how the mind works?

At least seven new directions may be identified for imagery research on athletes. First, despite its obvious importance for skilled performance (e.g., see the quotes from Tiger Woods and Michael Phelps near the beginning of the chapter), motor imagery has been relatively neglected by imagery researchers in sport psychology and cognitive psychology. Fortunately, this trend has changed and significant interdisciplinary progress has been made in understanding motor imagery processes since 2000 (see Box 5.9).

Box 5.9 Exploring motor imagery: some progress … but still some confusion apparent

As we discovered earlier in the chapter, people have the capacity to mentally simulate actions as well as experiences. The term “motor imagery” refers to people’s imagination of actions without engaging in actual physical movements involved or the “mental rehearsal of voluntary movement without accompanying bodily movement” (Milton et al., 2008a, p. 336). For reviews of research in this field, see Guillot and Collet (2010) and Moran et al. (in press). In general, two types of information – kinaesthetic/proprioceptive and visual information – contribute significantly to the capacity to simulate actions mentally. Indeed, research suggests that visual and kinaesthetic imagery are mediated by separate neural networks (Guillot et al., 2009; Solodkin et al., 2004). What is not clear, however, is how these components of imagery interact with each other. Influenced by M. Mahoney and Aveners (1977) research on imagery perspective, Decety (1996, p. 87) suggested that motor imagery “corresponds to the so-called internal imagery (or first person perspective) of sport psychologists”. Similarly, Jeannerod (1997, p. 95) distinguished between visual or “external” imagery and motor imagery, which was defined as “a ‘first-person’ process where the self feels like an actor rather than a spectator (‘internal’ imagery)”. Although intuitively appealing, these suggestions by Decety (1996) and Jeannerod (1997) have been challenged by imagery research findings in sport psychology. As Fourkas et al. (2006a) pointed out, people can form motor images using either a first-person perspective (whereby people imagine themselves performing a given action) or a third-person perspective (whereby people imagine seeing either themselves or someone else performing the action). Furthermore, there is evidence from qualitative studies (Moran and MacIntyre, 1998), descriptive research (e.g., Callow and Hardy, 2004; Callow
and Roberts, 2010) and experiments (e.g., L. Hardy and Callow, 1999) in sport psychology that motor imagery representations can be accessed consciously using a third-person visual perspective. Thus L. Hardy and Callow (1999) investigated the effects of different imagery perspectives on the performance of tasks involving form-based movements (e.g., a gymnastic floor routine). Results showed that an “external” (third-person) visual imagery perspective was superior to an “internal” (first-person) perspective in facilitating performance of such movements.

Second, very little is known about athletes’ meta-imagery processes – or their beliefs about the nature and regulation of their own imagery skills (see Moran, 1996). Within this topic, it would be interesting to discover if expert athletes have greater insight into, or control over, their imagery processes than do relative novices (see MacIntyre and Moran, 2007a, 2007b). Third, additional research is required to establish the extent to which athletes use mental imagery in the period immediately prior to competition (Beauchamp et al., 2002). Fourth, we need to tackle the old issue of how to validate athletes’ reports of their imagery experiences. As I mentioned early in this chapter, however, we may be approaching this task with the wrong theory in mind. Put simply, what if imagery were not so much a characteristic that people “have” but something – a cognitive process – that they “do”? If, as Kosslyn et al. (2001) propose, imagery and perception are functionally equivalent, interference should occur when athletes are required to use these processes concurrently in the same modality. As I indicated earlier, this possibility of creating experimental analogues of this type of interference could help to discover whether athletes are really using imagery when they claim to be mentally practising their skills. Psychophysiological indices may also be helpful in “tracking” athletes’ imagery experiences. Fifth, Cumming and Hall (2002b) raise the intriguing proposition that the theory of deliberate practice (see Chapter 6) can be explored in athletes using research on imagery processes. This idea, which is based on C. Hall’s (2001) speculation that mental and physical practice are equivalent in certain ways, could be a profitable avenue for future research. Sixth, not enough studies have been conducted on the issue of how top-level athletes use mental imagery in learning and performing complex sport skills. Seventh, Collet et al. (2011) argued that the multidimensional construct of motor imagery is best measured using a combination of psychometric, behavioural and psychophysiological tools. Furthermore, they proposed a way of combining these different imagery measures into an integrated “motor imagery index”. Clearly, this new measure requires additional validation before it can be used in research on motor imagery processes.

Let us now turn to the issue of whether or not imagery research has any implications for the pursuit, in mainstream cognitive psychology, of how the mind works. Moran (2002a) considered several ways in which research on mental imagery in athletes can enrich mainstream cognitive psychology. Up to now, however, cognitive psychology has devoted little attention to the world of athletic performance (although Frederick Bartlett used tennis and cricket examples when explaining his theory of schemata in the early 1930s). Nevertheless, imagery research in
sport may help to enrich cognitive theory in at least three ways. First, it can provide a natural laboratory for the study of neglected topics such as kinaesthetic and meta-imagery processes. Second, it offers a sample of expert participants (top-class athletes) and a range of imagery tests (T. Morris et al., 2005) which may help researchers to make progress in understanding individual differences in cognitive processes. Interestingly, Kosslyn et al. (2001) observed that the issue of why people differ so much in imagery abilities remains largely unresolved. Third, research on athletes could facilitate our understanding of the neural substrates of imagery. To explain, some studies (Behrmann, 2000; Kosslyn et al., 2001) show that people with vivid imagery show significantly increased blood flow in the occipital region when visualizing. Does this pattern also emerge when functional brain-mapping techniques are applied to athletes skilled in the use of imagery? What neural activation is elicited by kinaesthetic imagery processes in sport performers? These are just some of the cognitive issues raised by research on imagery processes in athletes.

**Ideas for research projects on imagery in athletes**

Here are five suggestions for possible research projects on the topic of mental imagery in sport and exercise psychology.

1. It would be interesting to explore the relationship between imagery perspective (i.e., the viewpoint that a person takes during imagery – either a first-person or a third-person perspective) and the performance of a closed skill such as a tennis serve. To illustrate the difference between these rival perspectives, consider two different ways of visualizing the serve. For this skill, an “external” imagery would involve watching oneself serving from the perspective of an outside observer (e.g., as if one were looking at someone else performing this skill on television). Conversely, an internal perspective would entail the simulation of what one would actually experience if one were physically serving the ball. According to M. Mahoney and Avenen (1977), task performance should improve when participants adopt an internal (or first-person) rather than an external (or third-person) imagery perspective. However, L. Hardy and Callow (1999) found that the adoption of an external visual imagery perspective was superior to that of an internal perspective when learning skills in which correct “form” is important (e.g., karate, gymnastics). It would be useful to design a study that could arbitrate empirically between these rival theoretical predictions using the skill of tennis serving. In conducting such a study, however, it is essential to match participants for motor imagery ability as measured by a scale such as the revised version of the Vividness of Movement Imagery Questionnaire (VMIQ-R: R. Roberts et al., 2008).

2. Using the mental chronometric paradigm (see Guillot and Collet, 2005), it would be interesting to investigate the extent to which the level of expertise of the performer affects the congruence between his or her imagined and actual time taken to execute a given skilled action.
Given the relative dearth of mental practice studies on elite athletes in field settings, it would be interesting to conduct a field study with athletes such as elite rugby or basketball players on the efficacy of mental practice in enhancing skills such as place-kicking or free-throwing, respectively.

What is the effect of the mental image speed on their performance of a self-paced action like golf putting? It would be interesting to extend O and Munroe-Chandler’s (2008) research addressing this question.

It would be interesting to investigate the nature and types of mental imagery used by expert and novice athletes from different sports (see Nordin and Cumming, 2008).

Summary

- Mental imagery is a cognitive process which enables us to represent in our minds experiences of things which are not physically present. Although this ability is valuable in many everyday situations (e.g., in reminding you to perform a certain task), it is especially useful for the planning of future actions. So, the term mental practice (MP) or visualization refers to a form of symbolic rehearsal in which people “see” and “feel” themselves executing a skilled action in their imagination, without overt performance of the physical movements involved.
- The second section outlined the nature and characteristics of mental imagery, and explained the term mental practice.
- The third section explored research on mental practice in athletes; special attention was devoted to the imagery validation problem (namely, how do we know that athletes are really using imagery when they purport to be engaged in mental rehearsal?) as well as to the relative dearth of field studies on MP in athletes.
- The third section also featured a review of three main theories of mental practice – the neuromuscular, cognitive and bio-informational models.
- The fourth section examined the measurement of mental imagery skills in athletes.
- The fifth section assessed the main research findings on athletes’ imagery use.
- The sixth section evaluated some old problems and new directions in research on imagery processes in athletes.
- Finally, five ideas for possible research projects on imagery processes in sport and exercise psychology were suggested.