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Imagery in sport

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Brief Summary

Imagery is one of the hottest topics in sport psychology. This chapter explains what imagery is and how it is commonly used by athletes to enhance performance. We explain why imagery is such a potent tool for enhancing your sports performance, and provide guidelines based on sport psychology and neuroscience research aimed at making imagery the most effective it can be.

Learning Outcomes

By the end of this chapter, students should be able to:

- Define imagery and explain how it is commonly used by athletes.
- Identify the different imagery types and understand how these may be used in different situations to improve sports performance.
- Explain the key mechanisms and processes that increase the effectiveness of imagery and how these impact on the imagery experience.
- Name and describe the elements of the PETTLEP model and explain how these could be integrated into an imagery intervention.

What is imagery?

Imagery can be defined as “using all the senses to recreate or create an experience in the mind” (Vealey & Walter, 1993, p.201). One of the first reported references to imagery was by Virgil in 20BC. In his poem he explains that "possunt quia posse videntur" which translates as “they can because they see themselves as being able".

More recently, many studies have focussed on imagery, the ways in which it can improve performance, the target population that would benefit most, and different types of imagery that can be used.

A study by Vandell, Davis and Clugston in 1943 on free-throw shooting and dart throwing found that mental practice was beneficial in improving performance, and almost as effective as physical practice. Many other studies have shown that mental practice produces higher scores than controls, but lower ones than physical practice (MacBride & Rothstein, 1979; Mendoza & Wichman, 1978). However, many studies that included combination groups found that combinations of physical and mental practice can be as effective as physical practice alone (Oxendine, 1969).

In order to clarify the effect of imagery on performance, several authors have completed

KEY NOTE:

A meta-analysis is a study which accumulates previous research on a topic and draws general conclusions about the effectiveness of an intervention from a number of different studies.

meta-analyses on the topic. Richardson (1967a,1967b) reported on 25 mental practice studies and concluded that this technique was effective in improving motor performance. In 1983, a meta-analysis of 60 studies carried out by Feltz and Landers found an average effect size of .48 (indicating a large effect on performance) and another meta-analysis (Hinshaw, 1991) revealed an average effect size of .68. A further meta-analysis within this area compared 35 studies, using strict selection criteria (Driskell, Copper, & Moran, 1994). This concluded that mental practice is an effective way to enhance performance, and found that the effects of mental practice were stronger when cognitive elements were contained within the task.

It appears, therefore, that imagery is effective in improving sports performance. The mechanisms behind imagery and how this effect on performance can be optimised were unclear at the time. However, we are now beginning to understand these issues and these will be explored later in the chapter.

How is it used by athletes?

Imagery training is commonly used amongst elite and aspiring athletes in order to improve performance. This is due to the number of benefits that can be gained from its use. Imagery training can increase self-awareness, facilitate skill acquisition and maintenance, build self-confidence, control emotions, relieve pain, regulate arousal, and enhance preparation strategies (Moran, 2012).

Currently, imagery is used with the specific aim of improving athletic performance. It is arguably the most widely practiced psychological skill used in sport (Gould, Tammen, Murphy & May, 1989; Jowdy, Murphy & Durtschi, 1989; Moran, 2012). For example, Jowdy et al. (1989) found that imagery techniques were used regularly by 100% of consultants, 90% of athletes and 94% of coaches sampled. Athletes, especially elite athletes, use imagery extensively and believe that it benefits performance (Hall, Mack, Paivio & Hausenblas, 1997).

KEY NOTE:

Brazilian football star Ronaldinho makes extensive use of imagery in his pre-match preparation:

"When I train, one of the things I concentrate on is creating a mental picture of how best deliver the ball to a teammate, preferably leaving him alone in front of the rival goalkeeper. So what I do, always before a game, always, every night and every day, is try and think up things, imagine plays, which no one else will have thought of, and to do so always bearing in mind the particular strength of each team-mate to whom I am passing the ball. When I construct those plays in my mind I take into account whether one team-mate likes to receive the ball at his feet, or ahead of him; if he is good with his head, and how he prefers to head the ball; if he is stronger on his right or his left foot. That is my job. That is what I do. I imagine the game".

Imagery is traditionally practiced by athletes in the training phases of sports performance to aid with competition. However, it can also be used during the competition phase. Athletes, especially elite athletes, use imagery extensively and believe that it benefits performance (Hall, Mack, Paivio & Hausenblas, 1997).

Imagery types

As noted above, imagery can be used to obtain various outcomes. Hall et al. (1998), in developing a questionnaire to measure imagery use, the Sport Imagery Questionnaire, noted that there are five basic types of imagery that athletes can perform. These are as follows:

- Cognitive specific (CS): imagery of specific sport skills (e.g. taking a basketball free throw).
- Cognitive general (CG): imagery of strategies and routines (e.g. a golfer's pre-putt routine, a football team's defensive strategy).
- Motivational specific (MS): imagery of specific goals and goal-orientated behaviour (e.g., a weightlifter lifting a record weight, holding up the winner's trophy).
- Motivational general arousal (MGA): imagery of emotions associated with performance (e.g. excitement felt when competing in front of a large crowd).
- Motivational general mastery (MGM): imagery of mastering sport situations (e.g. a footballer keeping when focused while being barracked by opposition fans).

Research has shown that all five types of imagery are used by athletes, but motivational imagery is used more than cognitive imagery. However, Hall et al. never claimed that their five imagery types represented all the imagery used by athletes, and indeed researchers have uncovered other types of imagery used in sport that do not fall easily into one of the above categories.

For example, Nordin and Cumming (2005) found that competitive dancers often use imagery of body posture. Also, dancers reported imaging characters and roles related to their dance pieces. Metaphorical imagery, where athletes image movements, sensations or pictorial images that are not necessarily possible, is also commonly used by aesthetic sport athletes such as dancers and bodybuilders. According to a study by Dreidiger et al. (2006), injured athletes use physiological images of their injuries healing.

Therefore, depending on the particular aim of the athlete, various types of imagery can be used. Not surprisingly, CS imagery can enhance performance of the specific skill being imaged, as per the studies mentioned in the "What is imagery?" section. However, as mentioned previously, there can be other benefits too. For example, studies have shown that CS imagery can lead to greater motivation to practice, and increase confidence. CG, MS and MGA imagery can also be effective in enhancing confidence, and MGA imagery can be very useful in psyching up or calming down athletes, getting their arousal to an optimal level so they can perform their best. Athletes should, therefore, use a combination of imagery types depending upon their specific preferences and goals. However, if improved skill is the aim, CS imagery is usually the most appropriate type to focus on primarily.

How imagery works.

KEY NOTE:

Whatever type of imagery is being used, it appears that athletes with a greater imagery ability (i.e., who find it easier to image clearly) will benefit most from imagery use. However, using structured and theoretically-based imagery techniques (such as those described in the section on PETTLEP imagery below) will help athletes achieve vivid imagery.

a

nd

combined (Decety, 1996).

processes that occur during physical performance of an action or skills occur in the brain during motor imagery.

Different areas of the brain contribute towards movement. Therefore, if a ‘functional equivalence’ exists some of the same neural areas working during imagery would be expected to be activated during actual performance. Scientists have developed a number of methods to discover whether this is the case.

One way in which this can be tested is to measure cerebral activity. When areas of the brain are being specifically used, the blood flow to these areas will increase. This can then be mapped during imagery and actual performance to assess whether the same areas are being activated. A study that examined this, using a technique known as functional Magnetic Resonance Imaging (fMRI), was performed by Kuhtz-Buschbeck and colleagues in 2003. These researchers asked participants to imagine performing finger movements, finding that some of the same motor-related brain areas were active during both real and imaged movements, notably the left dorsal and ventral premotor areas and the supplementary motor area. This and other studies have also used a technique known as transcranial magnetic stimulation (TMS), in which a magnetic field is used to cause activity in parts of the brain. In the TMS part of their study, the excitation of task-relevant muscles increased during imagery of complex, but not simple, finger movements. Li et al. (2007), also using TMS, found that the excitability of the nervous system during imagery.

Another technique used is mental chronometry. This is based on the comparison of time taken to complete an activity and the time taken to imagine it. Many studies have found a strong relationship between these, such as the classic study by Decety and Michel (1989). They compared the times needed to complete actual and imagined movements on two tasks: drawing a cube and writing a sentence. Participants were required to do both of these tasks twice, once using their dominant hand and once using their non-dominant hand. Results showed that participants were slower when completing the tasks with their non-dominant hand, but that this was also reflected in the length of time needed to imagine the tasks. Interestingly, Malouin et al. (2008) found that in healthy individuals the timing of imagery was quite consistent, but that is was much more variable in individuals affected by stroke, suggesting that the damage suffered by the motor system was reflected in their imagery too.

Within the sports setting, Moran and MacIntyre (1998) completed a study focussing on the kinaesthetic imagery experiences of elite canoe-slalom athletes. As part of this study, the athletes were required to image themselves completing a recent race. The time taken to image the race was then compared to the actual race completion time and a positive correlation between the two was apparent. These studies indicate that a central mechanism is responsible for the timing of motor imagery.

A further technique used to establish the relationship between imagery and actual performance focuses on the autonomic system. If actual movement and imagery use the same neural mechanisms, this should also be apparent within the body's responses. Involuntary responses such as heart rate and respiration have been found to increase without delay during the onset of actual or imagined exercise (Decety Jeannerod, Durozard & Baverel, 1993; Decety et al., 1991; Wuyam et al., 1995).

Finally, a technique known as EEG has been used to examine the similarities in the electrical activity of the cerebral cortex during imagery and actual movement, and has tended to find very similar movement-related neural activity in the brain prior to and during actual and imagined movements (Miller et al., 2010; Naito & Matsumura, 1994; Smith & Collins, 2004).

KEY NOTE:

Electroencephalography (EEG) involves measuring the level and location of electrical currents within the brain by placing electrodes on the skull and measuring the trace of this current.

Research using all of the techniques described above support the idea that a functional equivalence exists between imagery and overt movement. There is evidence that imagery shares a common mechanism (mental chronometry), utilises some similar areas of the brain (EEG & fMRI), producing similar physiological responses (autonomic system). However, to date, this research has not been considered fully within the sports setting and, as a result of this, many athletes may not be completing imagery capable of having an optimal effect on performance. Also, it is important to note that although there are similarities between brain activity in some regions during imagery and movement, there are also a number of differences, and therefore the idea that imagery is simply a scaled-down version of actual performance may be oversimplistic (see Dietrich, 2008 for an excellent discussion of this issue).

How should imagery be performed?

Many sport psychology publications promote imagery as an important psychological intervention and give advice on how it should be implemented to provide the most effective results. However, such advice is often provided with nothing in the way of theoretical justification or empirical support. One reason for this may because the field is relatively narrow, and sport psychology has often ignored theories from other fields (Murphy, 1990). In an attempt to rectify this, Holmes and Collins (2001) developed a model (for an update of and review of this see Wakefield et al., 2012) based on the cognitive neuroscience research findings noted above, aiming to produce effective mental simulation: the PETTLEP model. PETTLEP is an acronym, with each letter standing for an important practical issue to consider when implementing imagery interventions. These are; Physical,

KEY NOTE:

PETTLEP stands for

- **Physical**
- **Emotion**
- **Task**
- **Timing**
- **Learning**
- **Emotion**
- **Perspective**

Environment, Task, Timing, Learning, Emotion and Perspective. It is thought that by increasing the behavioural matching between imagery and physical practice, maximised functional equivalence will also be achieved.

PETTLEP aims to closely replicate the sporting situation through imagery, including physical sensations associated with performance and the emotional impact that the performance has on the athlete. The PETTLEP model is comprised of seven key elements and each one of these needs to be considered and implemented as fully as possible for the imagery to be most effective.

The Physical component of the model is related to the athlete's physical responses in the sporting situation. Some authors claim that athletes are able to most vividly imagine a skill or movement if they are in a completely relaxed and undisturbed state. However, most studies have not found any significant benefits from combining imagery and relaxation and it seems unlikely that this approach would be beneficial. Holmes and Collins (2002) point out that the physical effect of relaxation is in complete contrast to the physical state of the athlete during performance.

Smith and Collins (2004) found that imagery is more effective when it includes all of the senses and kinaesthetic sensations experienced when performing the task. The inclusion of these sensations will lead to the imagery being more individualised and may increase the behavioural matching between imagery and actual movement. Holmes and Collins (2002) describe various practical ideas that can be used to enhance the physical dimension of an athlete's imagery. These include using the correct stance, holding any implements that would usually be held, and wearing the correct clothing.

The Environment component of the model refers to the environment in which imagery is performed. In order to achieve the behavioural matching advocated by the model, the environment when imagining the performance should be as similar as possible to the actual performing environment. In a study by Smith, Wright, Allsopp and Westhead (2007) hockey player participants were required to complete their imagery stood on a hockey pitch. Results revealed that this intervention, which also included wearing hockey kit during imagery, had a strong positive effect on hockey penalty flick performance. If a similar environment is not possible, photographs of the venue or audio tapes of crowd noise can be used. Hecker and Kaczor (1988) conducted a study and reported that physiological responses to imagery occurred consistently when the scene was familiar. By using photographs or video tapes of venues, athletes can become more familiar prior to the competition and therefore the imagery will be more effective.

The Task component is an important factor as the imagined task needs to be closely matched to the actual one. According to Holmes and Collins (2002) the content of the imagery should be different for elite and non-elite performers. This is primarily because the skill level, and therefore the specific skills being imaged, will be different. When the non-elite performers improve, and begin to display characteristics of the elite, it is then necessary for the imagery script to be altered in accordance with this change. The task should be closely related and specific to the performer, focussing on individual emotions.

The Timing component refers to the pace at which the imagery is completed. Some researchers advocate using imagery in slow motion to experience the action fully (see Guillot et al. for an excellent review of this issue). However, precise timing is often very important in actual game situations and in the execution of specific skills. It would clearly match the desired behaviour more closely if the imagery was completed at the same pace at which the action would be completed.

The Learning component of the model refers to the adaptation of the imagery content in relation to the rate of learning. As the performer becomes more skilled at a movement, the imagery script should be altered in order to reflect this. Morris, Spittle and Perry (2004) explained that the complexity of imagery may change as the athlete improves his or her performance of a skill and Holmes and Collins (2001) suggested that regularly reviewing the content of the imagery is essential to retain a realistic image.

The Emotion component refers to the emotions included within the imagery, which should be closely related to those experienced during actual performance. During the imagery the athlete should try to experience all of the emotion and arousal associated with the performance, to aid the athlete in dealing with the emotions prior to and during competition.

Finally, the Perspective component refers to the way imagery is viewed. Imagery can be internal (first person) or external (third person). Internal perspective refers to the view that an athlete would have when he was actually performing, whereas external perspective would be like watching yourself performing on a video tape. From a functional equivalence perspective, internal imagery would appear preferable as it more closely approximates the athlete's view when performing. However, some studies have shown external imagery to be beneficial when learning form-based skills such as gymnastic moves (Hardy & Callow, 1999; White & Hardy, 1995). Research indicates that the more advanced performers will be able to switch from one perspective to another (*cf.* Smith et al., 1998) and, in doing this, gain advantages from both perspectives, optimising the imagery experience and enhancing the athlete's performance.

Since the PETTLEP model was developed, several studies have been performed to explicitly test it, either as a whole or in parts. For example, Smith et al. (2007) compared the use of PETTLEP imagery and more traditional, primarily visual imagery of a full turning gymnastics jump. They found that, over six weeks performing the interventions, the PETTLEP imagery group improved, but the 'traditional' imagery group did not. Also, the PETTLEP imagery group improved to the same extent as a group who physically practiced the skill. This supports the use of an individually-tailored PETTLEP approach when producing an imagery intervention. The PETTLEP imagery group also completed their imagery whilst stood on the beam in their gymnastics clothing, which may have led to an improved behavioural matching and subsequent performance benefit.

In a follow-up study by the same authors, PETTLEP interventions were employed with a hockey penalty flick task. The study compared a sport specific group (incorporating the physical and environment components of the PETTLEP model, wearing their hockey strip and doing their imagery on the hockey pitch) with a clothing-only group (who also wore their hockey strip while doing their imagery but did their imagery at home) and a traditional imagery group (who did their imagery sat at home in their everyday clothing). They found that the sport-specific group improved by the largest amount, followed by the clothing-only group, and then the traditional imagery group. This supports the PETTLEP model as, when adding components of the PETTLEP model to the intervention, a greater improvement in performance was apparent.

A study by Smith, Wright and Cantwell (2008) tested the effects of combining PETTLEP imagery and physical practice on golf bunker shot performance. Here, county or international level golfers were split into 4 groups: PETTLEP imagery, physical practice, PETTLEP imagery + physical practice, and a control group. The PETTLEP imagery group completed their imagery wearing their golf clothing and stood in a tray of sand to mimic the necessary bunker shot. Results showed that the group combining PETTLEP imagery and physical practice exhibited the largest performance improvements. However, despite also both improving performance, there was no apparent difference in the usefulness of PETTLEP imagery and physical practice.

Furthermore, Wakefield and Smith (2011) conducted a longitudinal study examining the effect of PETTLEP imagery on bicep curl strength over a period of 22 weeks. The multiple-baseline, single-case design aimed to assess the effectiveness of various frequencies of imagery interventions (i.e., completing imagery either once, twice or three times per week). Results indicated that, as the frequency of imagery increased, so too did the associated performance effect. Therefore the authors recommended that, whilst completing imagery once per week can be useful, more effective results will be apparent from conducting imagery more frequently (three times per week).

Example imagery study.

Traditionally, studies into imagery and mental practice consist of a pre-test in a specific motor skill, followed by an intervention period, a post-test in the same skill, and possibly a follow-up retention test after a period of time when the intervention has been withdrawn. Groups typically include a physical practice group, an imagery group, a control group, and often a group that combines physical practice with the imagery intervention. This allows each intervention to be tested to establish its effectiveness.

A study was completed by Smith and Collins to assess the effect of including stimulus and response propositions in imagery on the performance of two tasks. Stimulus propositions are units of information relating to the content of a scene, whereas response propositions are units of information relating to the individual's response to being in that situation. For example, if a footballer was imaging performing in an important match, stimulus propositions would include the sight of the other players and the sound of the crowd, and response propositions would include increased heart rate, sweating and feelings of butterflies in the stomach. Smith and Collins compared groups using physical practice, stimulus and response proposition and stimulus proposition only interventions. The task used was a contraction of the abductor digiti minimi (the muscle responsible for moving the little finger away from the hand). They also measured the late CNV (a negative shift that occurs in the brain prior to movement) to assess any differences between the groups during the movement. They found that the physical practice group, stimulus and response proposition group and the stimulus proposition only group all improved significantly from pre-test to post-test. However, there was no significant difference in the magnitude of their improvement. The CNV waves were also apparent in all conditions (see Figure 1).

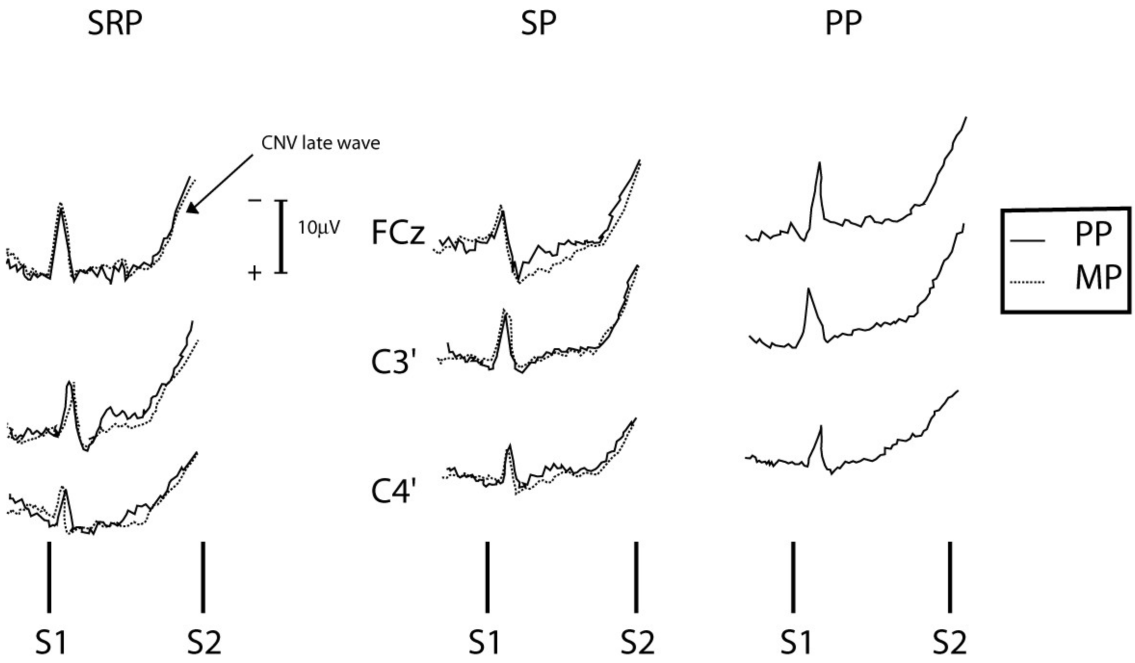

Figure 1: The late CNV prior to physical and mental practice of the finger strength task. PP = physical practice MP = mental practice, SRP = stimulus and response proposition imagery, SP = stimulus proposition imagery. S1 = warning stimulus (instruction to get ready to move), S2 = imperative stimulus (instruction to move).

The second of this series of studies compared similar groups on a barrier knock-down task. They found that the stimulus and response imagery group and physical practice group improved significantly from pre-test to post-test, whereas the stimulus-only group did not. Additionally, the late CNV was observed preceding real or imagined movement in the physical practice and stimulus and response imagery groups, but not in the stimulus-only group (see Figure 2).

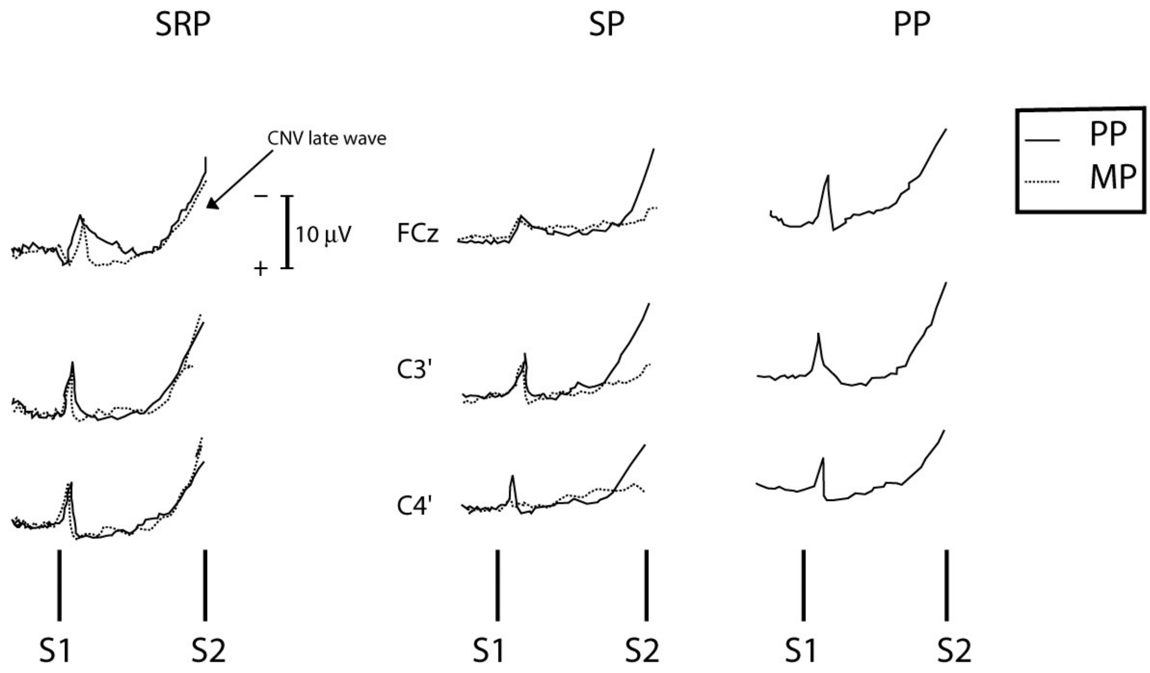

Figure 2: The late CNV prior to physical and mental practice of the barrier knock-down task.

This has strong implications for imagery interventions, as it appears that physical practice is more accurately mimicked by the inclusion of response propositions. The inclusion of these propositions may also enhance the functional equivalence of the intervention, which would explain the larger increase in performance by the stimulus and response group.

KEY NOTE:

There are ethical issues to consider when administering any intervention. Participants must give informed consent, and be free to withdraw from the studies at any time without repercussions. Additionally, if the intervention used can benefit the participant (from exam preparation to stroke rehabilitation) then the intervention should be offered to all of the other participants after the study has finished. This ensures that the group allocation does not lead to a useful intervention being withheld from some of the participants.

Conclusion

Imagery can be a very effective means of enhancing sports performance. Although it is very commonly used by athletes, often they may not get the most out of it as it is often performed in an unstructured and unrealistic (not behaviourally matched) way. There are several different types of imagery that can be used by athletes, all of which may have different effects on performance and self-confidence. To make the most of the various kinds of imagery that can be performed, imagery needs to be practiced consistently in a purposeful and structured way, and also need to be as realistic as possible. Using the guidelines of the PETTLEP model can be very helpful in achieving these goals for imagery training.

Key phrases/concepts

- Imagery is commonly used as a performance enhancing technique.

- Many studies have shown imagery to have strong positive results on sporting performance.

- There are many different benefits of using imagery and these can be linked to the imagery types.

- Recently, the concept of functional equivalence has led to the development of the PETTLEP model: a model aiming to give guidelines on behavioural matching to optimise the positive effects of imagery interventions.

- The mechanisms occurring during imagery are still unclear, and research is continuing into this area.

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Sample essay titles

1) There are many different positive effects that imagery can have on performance. Choose one imagery type and describe how implementing it may benefit performance.

2) Describe how functional equivalence can be strived for by behaviourally matching imagery, using the example of a golf tee shot.

3) Explain how a study could be organised to compare different interventions, and the benefits of including each of the interventions.