IMAGERY FOR SPORT PERFORMANCE: A COMPREHENSIVE LITERATURE REVIEW

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ABSTRACT

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There exists ample evidence that mental imagery has the potential to improve motor performance. Extensive experiential and observational research, have led to the development of applied models in the field of sport psychology which seek to highlight some of the key components required to ensure its effective implementation. The following manuscript reviews theories and applied models that have been well-documented in the literature and is supported in its validity. Furthermore, research is reviewed examining the efficacy of mental imagery interventions within sports performance with an emphasis on (a) uses of imagery, and (b) factors affecting imagery. Discussion is aimed to accentuate the significance of implementing the most appropriate imagery interventions.

Imagery for Sport Performance: A Comprehensive Literature Review

Table of Contents

Chapter One

What is Imagery?

Terms such as imagery, visualization, mental practice, and mental rehearsal have been used interchangeably among researchers, sport psychology consultants, coaches and athletes to describe a powerful mental training technique (Taylor & Wilson, 2005). In its early developments, mental practice and mental rehearsal were terms used to describe the technique of mental imagery, but these terms only referred to a general description of the strategy of rehearsing a skill mentally before the completion of a physical task, without clearly describing how it is rehearsed and what sensory or cognitive modalities were used (Taylor & Wilson, 2005). Presently, most practitioners use the broader term *mental imagery* to describe structured mental practice techniques to create or recreate an athletic performance (Holmes & Collins, 2001; Vealey & Greenleaf, 1998).

For some athletes and performers, the use of imagery is typically unstructured and may appear to serve no specific purpose and it may be difficult to verbalize the content and details of their imagery (Hardy, Jones & Gould, 1996). However, mental imagery is more than individuals spontaneously imagining performances. The value of imagery lies in its use as a structured program that incorporates written or audio scripts designed to address areas in which athletes want to improve (Taylor & Wilson, 2005). Imagery scripts have become common when implementing imagery training programs and imagery content may be influenced by the instructions and how they are communicated (Guillot & Collet, 2008). Before athletes begin imagery sessions, scripts are designed with detailed scenarios that highlight the physical setting, competitive context, specific performances, and other particular areas that need to be emphasized (Taylor & Wilson, 2005). For example, research by Bell, Skinner, and Fisher (2009) utilized guided imagery scripts, which were found to effective in decreasing putting yips in three experienced, accomplished golfers. However, sport psychology practitioners should be aware that individual experiences and outcomes may vary among individuals (Murphy & Jowdy, 1992).

To further clarify the brains functioning during imagery, researchers have reported that when individuals engage in vivid imagery, their brains interpret these images as identical to the actual stimulus situation (Marks, 1983). Imagery is reliant on experiences stored in memory, and participants experience it internally by reconstructing external events in their minds. However, imagery can be used to create new experiences by putting together pieces of any internal picture in various ways (Vealey & Greenleaf, 2006). The goal of mental imagery is to produce the athletic experience so accurately that athletes feel as if they are actually performing the sport (Hale, 1998; Holmes & Collins, 2001). All senses are important in experiencing events, therefore to help recreate an event, imagery should incorporate as many senses possible. Vealey and Greenleaf

(1998) suggests that mental imagery can involve movements, sights, sounds, touch, smells, and taste as well as emotions, thoughts and actions.

Auditory imagery can refer to hearing the swish of the nets in basketball or the crisp sound of a perfect golf drive. Olfactory refers to smell such as a swimmer smelling chlorine in the pool. Tactile is the sensation of touch, such as feeling the grip of a baseball bat or the laces of a football. Kinesthetic sense is the feel or sensation of the body as it moves in different positions. The kinesthetic sense would be important for a gymnast using imagery to practice a balance beam routine or a diver using imagery to feel the rotations before reaching the water.

In addition to the senses used in imagery, feelings and emotions associated with various sporting experiences are also significant components. Practitioners can use imagery to help other control anxiety, anger, or pain. For example, athletes could re-create their thoughts and feelings experienced during competition to understand how and why anxiety hurt their performance. In using imagery to create past outstanding performances, athletes should feel the emotions associated with those experiences such as elation, satisfaction, pride, and self-esteem (Vealey & Greenleaf, 2006).

Chapter Two

Review of Literature

The purpose of this chapter is to provide a critical overview of the literature pertaining to mental imagery and sport performance.   This chapter contains a thorough examination of theories of imagery, applied models, the various uses of imagery and factors that ultimately affect the efficacy of an imagery intervention program.

Theories of Imagery

Sport psychology practitioners have sought to explain the mechanisms that allow imagery to work. Several theories exist, as there is no one single theory that can explain the effectiveness of imagery in its wholeness. The attention-arousal set theory seeks to explain imagery rehearsal while incorporating the cognitive and physiological components (Sheikh & Korn, 1994). The theory suggests that imagery is a technique in which athletes prepare for a motor performance both physiologically and psychologically. It is suggested that in the cognitive domain, imagery may help athletes focus on task relevant cues as opposed to irrelevant stimuli, which detracts from performance (Feltz & Landers, 1983). Through this mental technique, athletes also become aware of their physiological state, reduce inhibitions to the motor action, and improve attention to cues for motor responses (Feltz & Landers, 1983; Hecker & Kaczor, 1988). It is assumed that there is an optimal state of arousal where peak performance is achieved, and imagery can facilitate an athlete's attempt to reach that optimal arousal level (Sheikh & Korn, 1994).

The bioinformational theory proposed by Lang (1979), suggests that mental images should be viewed and classified as products of the brain's information processing capabilities. He argues that an image carries on a finite amount of information in its structure which can be broken down to specific functional units. The use of imagery involves a network of representational information that is coded and stored in long-term memory (Hecker & Kaczor, 1988). The representational information presented in the image can be separated into two categories of information: information regarding the characteristics of the *stimulus* presented in the imagined situation, and the information pertaining to the physiological *responses* during the imagined scenario (Lang, 1979). The process of assessing critical information occurs when the athlete is exposed to a sufficient number of propositions. A stimulus proposition, such as imaging oneself shooting a basketball, involves descriptors of the texture and feelings of the ball and may be associated with visual stimuli (e.g. the nets of the rim). Response propositions would include muscular changes and contractions in the fingers, arms and shoulders as well as possible changes in cardiovascular and respiratory responses.

According Lang's (1979) bioinformational theory, in order for imagery rehearsal to have beneficial effects on athletic performance, response propositions providing a model for the explicit motor action, must be generated to facilitate the proper adjustments

(Hecker & Kaczor, 1988). It has been argued that although the processing of response propositions is associated with detectable psycho-physiological changes, several factors heavily influence whether or not athletes show psycho-physiological changes during imagery rehearsal (Hecker & Kaczor, 1988). First, the scene being imagined during the session needs to be descriptive in a way that if encountered, in vivo, would include some physiological response (Lang, Kozak, Miller, Levin & McLean, 1980). Second, the activation of a physiological response is facilitated by instructions that clearly direct the individual to experience the image physiologically, such as references to muscular and visceral responses (Lang, Levin, Miller & Kozak, 1983). Third, the activation of physiological responses is more likely when the images presented are more relevant in such that the participant has previously experienced the imagined scene (Feltz & Landers, 1983).

Ahsen's (1984) triple code model expands on the bioinformational theory of imagery by highlighting three effects of the image that are essential to the imagery program. Ahsen (1984) identifies these effects as ISM; (I) the image itself, (S) the somatic response, and (M) the meaning of the image. The image generated is a representation of the individual's perspective in reality and the sensory mechanisms incorporated allows the individual to experience and respond to the image as it were in reality (Ahsen, 1984). The somatic response implies that during the imagining, psycho-physiological changes occur in the body (similar to Lang's bioinformational theory). Every image imparts a personal meaning or significance to the individual and the same set of imagery instructions will never produce the same imagery experience for any two individuals (Ahsen, 1984; Weinberg & Gould, 2006). The individual's personal meaning attached to the image has to be accounted for in the imagery scripts.

Suinn (1982) developed a cognitive enhancement technique termed visuomotor behavioral rehearsal (VMBR), combining progressive relaxation and mental imagery practice. More specifically, VMBR practice consists of three stages: (1) having the athlete achieve a relaxed state by way of a progressive relaxation technique, (2) mental practice highly relevant to the requirements and demands of the athletes' respective sport and (3) physically practicing specific skills under simulated lifelike conditions (Suinn, 1982). In the early introduction of VMBR training, reports were anecdotal lacking experiential control, prompting researchers to provide empirical support for its use and efficacy. For example, VMBR training has been shown to enhance performance of a variety of athletic tasks including free-throw shooting (Hall & Erffemeyer, 1983; Onestak, 1997), karate (Weinberg, Seabourne, & Jackson, 1981), serving in tennis (Noel, 1980), racquetball (Gray, 1990), and golf, track and field, gymnastics, and diving (Lohr & Scogin, 1998). It is suggested that by repeating the VMBR process of incorporating specific skills during mental training, the enhanced coordination of the imagery component with the physical performance allows for minor adjustments in the skill and/or the imagery process (Behncke, 2004).

During the early uses of imagery, such as in VMBR training, athletes were usually recommended to achieve a relaxed state before and during imagery sessions (e.g. Weinberg et al., 1981). In particular athletes were introduced to some breathing technique such as a centering breath to promote relaxation. The centering breath is a breathing technique intended to yield physical balance and allow the individual to mentally focus before attempting the task at hand (Nideffer, 1994). This technique involves a deep breath (from the stomach not chest), awareness of muscle tension, and a strong exhalation to relax the muscles, therefore promoting physical balance (Rogerson & Hrycaiko, 2002). The centering breath allows an individual to control physiological arousal and ignore irrelevant stimuli, ultimately improving concentration on the mental images (Nideffer & Sagal, 2006). However, data exists that suggests relaxation is not essential to imagery training, and actually has the potential to limit the benefits of imagery when the purpose of the intervention is to improve learning and performance of specific motor skills (Rushall & Lippman, 1998). It is believed that athletes should attain a level of arousal similar to that during the actual performance. Although athletes should feel comfortable before engaging in imagery, it is not required that imagery is directly associated with relaxation, especially in instances where the goal is to improve motor performance and adjust technical aspects. Alternatively the association with relaxation would be much stronger in imagery whose purpose is to achieve some motivational and/or self-confidence goals. It is reasonable to agree with Janssen and Sheikh (1994), who reported that relaxation may facilitate the generation of vivid mental images, but should not be maintained throughout the entire imagery session. In short, athletes may incorporate relaxation to reduce attention to irrelevant distractions just before an imagery session, but they should be able to regulate their arousal levels, similarly to how they would during actual performance (Guillot & Collet, 2008).

Sackett (1934) was the first to propose the symbolic learning theory, a motor-based explanation to the role of mental practice. The primary assumption of the symbolic learning theory is that movement patterns are symbolically coded in to one's central nervous system (Janssen & Sheik, 1994). Therefore it is proposed that imagery act as a cognitive coding system that provides athletes with a mental blueprint for specific movement patterns (Martin, Moritz, & Hall, 1999). Consequently, imagery is effective because it enables athletes to become more familiar with the movements and facilitates automaticity through cognitive processes. Sackett (1934) demonstrated that mental rehearsal improved performance on a finger maze task, and suggested that the improvement was seen due to the fact that the task was primarily cognitive in nature and could be easily symbolized (Janssen & Sheikh, 1994). There has been research conducted to further support Sackett's (1934) original proposal, shedding light on the greater effects that mental practice has on fundamentally cognitive (symbolic) tasks as opposed to strictly motor tasks (e.g. Wrisberg & Ragsdale, 1979; Ryan & Simons, 1983). Furthermore, Feltz and Landers' (1983) meta-analysis of mental practice studies found this inclination to be consistently present across varying research populations, designs, and methodologies. From the 60 studies included, an average medium effect size of .48 was obtained across all studies for the effects mental practice, suggesting that mentally practicing a motor skill influences performance somewhat better than no practice at all (Martin et al., 1999). Moreover, additional comparisons were employed to examine mean differences between effect sizes of distinct variables. Results from further analyses indicated that the most significant comparisons existed between cognitive and motor task, and cognitive and strength tasks. Studies examining cognitive tasks reported a larger average effect size (M = 1.44) than motor tasks (M = .43) or strength tasks (M = .20). Results provide greater support to the validity of the symbolic learning theory and the reported benefits of mentally practicing a motor skill.

Neural mechanisms of imagery.

It is suggested that during mental practice, the same neuromotor pathways that are involved in the physical execution of a specific motor task are activated (Kosslyn, Ganis, & Thompson, 2001; Martin et al., 1999). The motor programs in the motor cortex, which are responsible for movement, are then strengthened as a result of the activation of the neural pathways during mental imagery. Consequently, mental imagery may aid in skill learning by improving the appropriate coordination patterns and by priming the corresponding motor neurons of the muscles necessary to carry out the motor task (Mackay, 1981). In short, mental practice activates peripheral activity, which provides afferent information to the motor cortex which serves to strengthen the motor program.

With the development of neuroimaging technologies, researchers are able to test various theories of imagery (Halgren, Dale, Sereno, & Tootell, 1999). Researchers have taken steps to show that mental imagery incorporates similar neural mechanisms that are used in memory, emotions, and motor control. The primary motor cortex, which is part of the frontal lobe, works in association with the pre-motor areas to plan and execute movements. Many researchers have shown that areas of the cortex that are activated in movement control also play a role in motor imagery (Klein, Paradis, Poline, Kosslyn, & LeBihan, 2000; Kosslyn, Thompson, Kim, & Alpert, 1995).

Neuroimaging studies have shown that the human premotor cortex is activated when humans observe other people's actions, which may signify the existence of "mirror neurons" in the human brain. In the Rizzolatti, Fogassi and Gallese (2001) study, researchers found that a subpopulation of neurons, now termed "mirror neurons", in the premotor cortex area of the brain responds selectively when an animal performs specific actions with their hands and when the animal observes the same actions being performed by another. It is plausible that "mirror neurons" may be involved in motor imagery, based on the idea that athletes often transform images by imagining what they would see if the objects are manipulated to fit the desired image (Kosslyn et al., 2001).

After thorough examination of pertinent literature, researchers have provided support for the proposition that mental practice alone may be sufficient enough to promote the activation of the neural circuits involved in the early stages of learning new motor skills (Feltz & Landers, 1983; Martin et al., 1999). Researchers have posited, the increased regional blood flow in the brain indicates that mental simulation of movements activates some of the neural central structures required for the physical movement (Kosslyn et al., 2001).

Applied Models of Imagery

Martin et al. (1999) proposed a four-component model that sought to describe how varying types of motor imagery (MI) has the potential to impact cognitive, affective, and behavioral outcomes. Researchers examined the use of imagery in sporting situations, and examined the use of motor imagery during training in preparation for a competitive event, immediately prior to, and during competition, as well as during rehabilitation. The imagery types highlighted in this model are very similar to those of the model by Paivio (1985) and Hall, Mack, and Paivio (1998), (i.e. Cognitive General, Cognitive Specific, Motivational General-Arousal, Motivational General-Mastery and Motivational Specific). Based on Martin et al. (1999), the examination of studies that have assessed the effects of motor imagery in sport, three outcomes have been reported. Motor imagery in sport was most frequently used for facilitating skill and/or strategy learning and performance, modifying cognitions associated with self-efficacy, self-confidence, effort and/or motivation, factors associated with regulating arousal and competitive anxiety. Additionally, individuals' ability to generate accurate mental images has an impact on performance (Martin et al., 1999). When developing the applied model, Martin et al. (1999) stated that they purposely attempted to reduce the numerous imagery-related variables to the smallest possible theoretically significant factors. As a result, many variables (e.g. imagery perspective, positive/negative imagery, and/or number of sessions) are pertinent to the model, even though they were excluded from the conceptual framework. The model has been supported by studies that have provided evidence that this model was a reliable guideline framework for imagery interventions, highlighting several variables for athletes' use of imagery (Boyd & Munroe, 2003; Mamassis & Doganis, 2004; Munroe-Chandler & Hall, 2007).

The PETTLEP model developed by Holmes and Collins (2001) incorporates seven elements (i.e. physical, environment, task, timing, learning, emotion and perspective) all derived from neuroscientific and behavioral functional disciplines. *Physical* relates to the individual's physical nature and feelings during imagery (i.e.

increased HR, or feeling relaxed), while *Environment* refers to the inclusion of stimulus materials that help mimic motor performance. *Timing* signifies the importance of incorporating the imagery to mimic the actual performance duration. The *task* component includes the exact nature of imagery to be performed, the expertise level of the performer, as well as the imagery perspective. *Learning* relates to the use of imagery for the purpose of becoming familiar with new motor skills, and for the correction of some technical aspects required of the skill. *Emotion* relates to the individualistic incorporation of meaningful emotional components in the mental images presented in imagery. Lastly, *perspective* supports the use of an internally imagery perspective, while indicating the importance of an external perspective as it relates to the characteristics of the motor skill being performed.

The authors also ensured to highlight the importance of the interaction between the components within the model. The authors have identified crucial factors of imagery training (i.e. expertise level's effect on learning new skills or the environment's effect on perspective) that must be considered by the facilitator and the athlete to improve the efficacy of imagery intervention programs (Holmes & Collins, 2001). However, there were still specific aspects of imagery not incorporated (e.g. vividness, control, outcome of imagery, use of kinesthetic imagery, imagery for pain management, and imagery in the motor recovery processes). Specifically, authors did not address the role of imagery in promoting healing and pain management, as well as its effect on the motor recovery process following sporting injuries.

Munroe, Giacobbi, Hall, and Weinberg (2000) helped identify where, why, what type and when (Four W's) athletes should use imagery. The authors used a qualitative approach based on a six stage model, which described how athletes may integrate imagery into their sporting context. *Where* differentiates between training and competitive environments, while *when* identifies the use of imagery during sporting activity as opposed to outside practice, in addition to immediately before, during and after a competitive event. *Why* refers to the use/purpose of the imagery (i.e. cognitive or motivational functions). The length and frequency, nature, surroundings, effectiveness and controllability refers to *what* the athlete should imagine. The last two stages of the model include many other essential components, one being the type of imagery (e.g. auditory, kinesthetic, olfactory), the imagery perspective (internal vs. external visual imagery), or the inclusion positive and negative images. In the domain of competitive sporting situations, this model may very well serve as a guide for the development of effective imagery interventions (Guillot & Collet, 2008). The major strength of the model emerged from its qualitative design in that a number of key components of imagery use emerged from the questionnaires proposed by the authors. However, the list of components is not extensive and does not consider the specificity of each component as it relates to the athletes' expected outcomes. Furthermore, the model did not account for the effects of imagery during the injury rehabilitation process.

Uses of Imagery

It has been proposed that mental imagery enhances performance by improving key mental factors that heavily influence athletic performance (Callow & Hardy, 2001;

Taylor & Wilson, 2005). Specifically, Moritz, Hall, Martin, and Vadocz (1996) suggested that mental imagery can improve performance when athletes rehearse general strategies and tactics, specific skills and plays, successful use of positive self-talk, and the overall performance. Furthermore, mental imagery can be used to facilitate effective responses to competitive stress and emotions, and produce feelings of a successful performance and achieving a desired goal (Mortiz et al., 1996).

Arousal, motivation, and confidence.

Issues such as anxiety and low self-efficacy have been addressed by specific types of imagery that have been identified and classified by using a taxonomy developed by Hall and colleagues (Hall et al., 1998). Vadocz, Hall, and Moritz (1997) explored the relationship between imagery use and ability, competitive anxiety, and performance among fifty- seven elite junior athletes. All participants completed the revised Movement Imagery Questionnaire (MIQ-R) evaluating imagery ability, the Sport Imagery Questionnaire (SIQ) assessing imagery use, and the Competitive State Anxiety Inventory -2 (CSAI-2) measuring state anxiety and self-confidence. From the multiple analyses conducted, researchers concluded that imagery ability and MG-A imagery, were the greatest predictors of cognitive state anxiety. Athletes who reported using more MG-A imagery also reported higher levels of cognitive anxiety prior to performance. Given that competitive state anxiety can be both debilitating and facilitating (Jones, 1995), in an applied setting the use of MG-A imagery may be detrimental for an athlete with higher levels of competitive state anxiety. Alternatively, an athlete who has difficulty becoming motivated/aroused may greatly benefit from the use of MG-A imagery prior to competition. Additionally, it was found that imagery ability was correlated to somatic state anxiety, while MG-M imagery was predictive of self-confidence. Those athletes, who more often engaged in imagery of themselves controlling difficult situations and being mentally resilient, reported higher levels of self-confidence. Given that MG-M imagery and self-confidence are related, it is suggested that MG-M imagery be employed with less confident athletes, given that self-confidence has been acknowledged by coaches and athletes as detrimental to athletic performance (Moritz et al., 1996).

Paivio (1985) suggested that a critical function of mental practice for athletes may be their motivation level when other reinforcers are not clearly present. Motivational–Specific (MS) imagery involves specific goals and goal-oriented behaviors, such as imagining oneself winning an event, receiving a trophy, and being congratulated by teammates and coaches for a good performance. Motivational general-mastery (MG-M) imagery serves as a motivational and mastery perspective function (Murphy & Martin, 2002). The content of MG-M imagery includes effective coping and mastery of challenging situations, such as imagining being confident, focused and resilient during competitive sporting situations. Motivational general-arousal (MG-A) imagery focuses on emotional experiences in the sporting context. MG-A imagery represents feelings of relaxation, stress, arousal, and anxiety in conjunction with sport competition (Murphy & Martin, 2002).

Paivio (1985) argued that imagery may enhance the performance of motivated behaviors by means of facilitating the frequency, persistence, and efficiency of physically practicing motor skills. Martin and Hall's (1995) study randomly assigned 39 university students, who were all beginner level golf players, to either imagery performance or control groups. All participants completed six training sessions on how to putt a golf ball, where the first three sessions were solely focused on training the technique of putting and the last three were focused on performance. Results indicated that participants in the imagery training group spent significantly more time practicing the golf-putting task during the free-time period following the supervised training than those in the control group. Additionally, it was found that participants in the imagery treatment group had higher self-efficacy, more realistic expectations, and adhered more to their training program outside of the experiential setting. From these findings it may be inferred that mental imagery may have a great influence on motivation to practice and continue adhere to training when one is aimed to achieve a specific goal. In line with Paivio's imagery-motivation relationship, the specific motivational function of imagery may incorporate goal-oriented behaviors, where imagery is used to embody desired goals as well as the activities and consequences related to attaining those goals.

Skill learning and performance.

Cognitive-General (CG) imagery refers to the game-plan and strategies related to a competitive event, such as a trapping defense in basketball, or an onside kick in football (Hall et al., 1998). Most of the mental practice literature heavily examines the effects of Cognitive-Specific (CS) imagery. CS imagery is heavily based on the rehearsal of specific sport skills. Rather popular skills included are free-throw shooting in basketball, balance beam routines in gymnastics, pitching in baseball, and practically the entire game of golf.

Robin, Dominique, Toussaint, Blandin, Guillot, and Le-Her (2007) examined the effects of imagery training on the motor performance improvement of the service return accuracy in skilled tennis players. Participants were placed into three groups based on their Movement Imagery Questionnaire score (good imager, poor imager or control) and physically performed 15 service returns toward a target during the pre-test. During the intervention phase, participants completed 15 imagery training sessions, where each session consisted of 2 series of 15 imagery trials and 15 physical trials. Lastly, forty-eight hours after the final training session, participants completed a post-test similar to the pre-test. Results indicated that the motor imagery intervention significantly improved the accuracy of the service returns in skilled players. Furthermore, following the 15 imagery sessions, those deemed as good imagers, significantly improved their accuracy in direction and were less variable compared to those of lower imagery ability.

Surburg, Porretta, and Sutlive (1995) sought to examine the effects of imagery as a supplementary form of rehearsal/practice for the learning and performance of a throwing task. The study included 40 participants, who were classified as 15-18 yr old adolescents with mild mental retardation based on the Stanford-Binet Intelligence test and certain behavioral characteristics. The process of preparing participants for imagery *practice* involved multiple trials of closing the eyes and rehearsing the task while avoiding the use of overt movements. Participants engaged in seven *practice* sessions during which *performance* scores of a throwing task were recorded an analyzed. Participants stood behind a line 4.57 m from three concentric circle targets and executed an underhand throw with the non-dominant hand, attempting to hit the bull's eye. The non-dominant hand was used to *enhance* the novelty of the throwing task, ensuring that all participants had roughly minimal experience with the task. At the completion of the seven session training/testing period participants who engaged in imagery practice displayed a greater performance on the motor skill task than those individuals who did not engage in imagery.

Strategies and problem-solving.

In addition to using imagery to learn and rehearse individual motor skills, athletes have also reportedly used imagery to learn and rehearse game plans, tactics and strategies (Feltz & Landers, 1983; Hecker & Kaczor, 1988; Paivio, 1985). It is suggested that CG and CS imagery may be beneficial when used to rehearse tactical skills and strategies and for solving unexpected problems that may arise during a competitive event (Guillot & Collet, 2008). Thus far, there has been a fairly limited amount of research to investigate the use of imagery to develop cognitive plans for athletic events. It is suggested that game plans and strategies may first be developed and learned through the use of CS and CG imagery, and subsequently mentally practiced (Guillot & Collet, 2008). Imagery should incorporate positive images of what should be done and possible alternatives to help make correct decisions during the planning of performance (Martin et al., 1999). In the domain of team sports, athletes may heighten their awareness of each member's respective role and see how to temporally and spatially position themselves among other participants involved (Guillot, Nadrowska & Collet, 2009). Furthermore, both players and coaches may develop game plans and strategies to employ against specific opponents before the competition (Martens, 2004). Imagery can also be integrated into an athlete's pre-performance routine as a means to refine a specific strategy before engaging in the competitive event (Guillot & Collet, 2008). Lastly, athletes can use imagery to deal with timing, technical or tactical challenges that may arise during an event or against a specific opponent.

Pain management and rehabilitation.

Psychological interventions featuring relaxation and im*agery* components have been found to be effective for helping people cope with a wide range of painful medical conditions including fibromyalgia (e.g., Haanen, Hoenderdos, Romunde, Hop, Malle, Terwiel, & Hekster, 1991), headaches (e.g., Zittman, van Dyck, Spinhoven, Linssen, & Corrie, 1992), and various forms of chronic *pain* and surgery (e.g., Lambert, 1996; Malone & Strube, 1988; Mauer, Burnett, Oulette, Ironson, & Dandes, 1999). Imagery is among the most frequently advocated psychological interventions for the rehabilitation of sport injuries as it can greatly enhance the healing process by reducing anxiety and tension in muscles, increasing blood flow, and stimulating strength gains (Green, 1993; Smith, Collins, & Holmes, 2003; Taylor & Taylor, 1997). Athletes who sustain both chronic and acute injuries can use imagery to manage the pain that occurs during both rehabilitation and during competition (Taylor & Wilson, 2005).

For instance, acute tearing of the anterior cruciate ligament (ACL) of the knee is one of the more prevalent and debilitating sport and recreation related injuries (Roos, Ornell, Gardsell, Lohmander, & Lindstrand, 1995). Cupal and Brewer’s (2001) study incorporated imagery for thirty participants ranging from recreational to competitive athletes in the process of rehabilitation for ACL reconstruction. Sessions were scripted, audio-taped, and identical for all treatment group participants. Content for the first session included viewing individualized arthroscopic videotapes of the reconstructed ACL and learning progressive relaxation through breathing. The second session was designed to encourage reduction of knee trauma, pain management, and acceptance of limited range of motion. The third through fifth sessions focused on facilitating general flexibility and knee range of motion, reduction of edema, and psychological coping. The sixth through eighth sessions addressed acquiring strength, increasing range of motion, establishing proprioceptive awareness, and reducing anxiety. The ninth session emphasized acquiring strength, endurance, and full range of motion, as well as increasing confidence in the integrity of the replaced ligament. The tenth session included imagery involving anatomical and neurological mental comparisons, peak physical performance, as well as a review of imagery goals. Participants were asked to listen to their audiotaped session at least once daily until the next session.

The treatment group completed ten relaxation and guided imagery sessions in addition to a normal course of physical therapy. Researchers found the relaxation- and imagery-based psychological intervention to be effective in facilitating recovery following ACL reconstruction compared to both placebo and standard, no-treatment control groups. Specifically, the treatment consisting primarily of relaxation and guided imagery produced significantly greater knee strength and significantly lower levels of pain and re-injury anxiety relative to placebo and control conditions at 24 weeks post-surgery (Cupal and Brewer, 2001).

Imagery and physical practice.

The combination of mental and physical practice has been suggested to be more efficient than physical practice alone in the case where there is no significant decrease in physical training (Feltz & Landers, 1983). Guillot et al. (2009) examined the effects of motor imagery on learning and executing tactical offensive movements in 10 national level female basketball players. Efficacy of the participants movements were evaluated by a qualified national level basketball coach. Three offensive attack movements were evaluated for the effectiveness and execution of the strategy and each athlete's effectiveness within the game plan. The first game strategy was physically and mentally practiced twice a week, over a 6-week duration. The second offensive attack move was physically practiced, while the third movement was evaluated at baseline and at the end of the session, but was not trained. The first tactical schema was physically and mentally practiced in three series of three mental simulations lasting 10-12 minutes total. Athletes performed a total of 108 motor imagery (9 trials per session during 12 physical practice sessions) trials in combination with physical practice on the two offensive attack movements. According to the scores awarded by the coach, the combination of motor imagery and physical practice significantly improved motor performance during the post-test assessment of the tactical schema, whereas, motor imagery was not found to be significantly more efficient than physical practice alone. Findings of this study lend further support for the use of imagery practice and physical practice in combination.

Pre-competition imagery.

In order to achieve improvements in performance athletes must use imagery in a continuous and systematic manner. Research suggests that imagery immediately prior to performance may improve performance (Malouff, McGee, Halford, & Rook, 2008; Mamassis, & Doganis, 2004; Martin et al., 1999). It is important to note that most athletes report that they most often use imagery immediately preceding performance. However, the overall effects of imagery immediately before an athletic performance are still somewhat unclear, with some studies showing positive effects and others not (for reviews, see Gould, Damarjian, & Greenleaf, 2002). Athletes commonly use positive imagery as a part of their routine in the time leading up to an athletic performance, with the expectations of optimal performance (Cumming, Nordin, Horton & Reynolds, 2006). Yet, Short, Bruggeman, Engel, Marback, Wang, Willadsen, and Short (2002) included 83 students from various physical education and exercise science courses at a mid-size university to examine the effects of facilitative imagery on performance and self-efficacy. Findings of the study suggest that using facilitative imagery immediately before performance improved performance and increased individuals' self-efficacy on a golf putting task.

Malouff et al. (2008) evaluated the effects of pre-competition positive imagery and self-instructions on serving accuracy of 115 adult tennis players in a tennis serving competition. Participants were assigned to one of three conditions: self-instructions, positive imagery or a control group. Before each serve, participants were instructed to imagine, the entire serve, including seeing the ball going into the target zone. Each participant attempted 20 serves with the objective to score as many points as possible by hitting a serve in the correct service box. Results revealed that participants in both the imagery and self-instruction conditions served significantly more accurately than those in the control condition. Researchers offered the explanation that during pre-competition imagery practice, athletes are focusing on how to efficiently perform the task, excluding distracting negative thoughts related to poor performance and the negative consequences that may follow. Additionally, it is suggested that the anxiety-reduction effect could best explain the greatest difference between the experimental and control groups

Factors Affecting Imagery

To fully benefit from mental imagery practice, participants must be able to engage in mental imagery effectively. While a vast amount of literature has examined the effects of imagery interventions on performance enhancement (Feltz & Landers, 1983; Martin et al., 1999; Weinberg & Gould, 2006), the reported benefits amongst the numerous imagery programs vary. Individual's imagery ability, vividness and control of images are of primary concern when evaluating the effects of a mental training program (Munroe et al., 2000). Additionally, specific aspects of motor skill performance have shown to be enhanced by adopting the two imagery perspectives (i.e. internal and external) (Guillot et al., 2009; Hardy & Callow, 1999). Lastly, various psychological traits and affective states of the participant must be considered when evaluating an imagery program (Guillot & Collet, 2008).

Imagery ability.

One explanation as to why results vary may be the individual differences which can influence the learning and the performance of motor and cognitive skills (Vealey & Greenleaf, 2006). Researchers cannot control for imagery ability, controllability, and past experiences. Imagery ability has two influential factors: (1) how clearly athletes can see an image and how detailed the image appears to them and (2) the athlete's ability to manipulate aspects of the images they wish to change (Vealey & Greenleaf, 2006).

Imagery requires organized, repetitive practice for it to have the desired effect on performance. Research has shown systematic practice effectively increased imagery ability (Evans, Jones & Mullen, 2004). Images must be controllable so that athletes can manipulate images in productive ways to prepare themselves to perform at an optimal level. In addition to controllability, the other essential factor to effectively using imagery in a mental training program is vividness. Vividness can also involve such components as whether the image is in color, how many senses are involved, and what emotional or physical sensations are experienced when engaging in the imagery. Most researchers have assessed athletes' imagery ability through self-report inventories such as questionnaires (Martin et. al., 1999; Robin et al., 2007; Vadocz et al., 1997). Ryan and Simon's (1982) study assessed the effects of imagery practice on participants' ability to balance on a stabilometer. According to participants scores reported on the Movement Imagery Questionnaire (MIQ; Hall & Pongrac, 1983), researchers concluded that participants with reportedly high imagery ability improved performance on the task more than those identified with poor imagery ability.

Calmels, Holmes, Berthoumieux, and Singer (2004) employed a multiple baseline across-subjects design to examine the effects of a structured imagery intervention on self-reported vividness of movement imagery in four elite national softball players. During the baseline phase, measures of softball players' movement imagery vividness was evaluated via the Vividness of Movement Imagery Questionnaire (VMIQ; Isaac, Marks, & Russell, 1986) once a week while participants continued to practice as usual. The imagery intervention treatment was staggered across participants to ensure that the changes in the VMIQ were due to treatment, rather than uncontrolled variables. Participants completed a total of twenty-eight intervention sessions incorporating five phases of imagery training. Participants practiced a ten minute audio taped imagery program that described the varied situations that a hitter may encounter during competitive situations. During the first ten intervention sessions the batter imaged multi-environment conditions from and internal and external perspective. During the next four sessions, participants imaged performing successfully in all situations that they may be exposed to during competition. During the remaining fourteen sessions, the researchers progressively added images of runners on base, the trajectory of the ball, desired contact with bat, and simulated environmental stimuli (i.e., the weather, crowd noise). Researchers also made the participant aware of cognitive distracters such as the reputation of the pitcher, score, and a perceived unfair umpire. The results, as indicated by the changes in the plotted data points, showed general improvement in vividness scores on both external and internal imagery perspectives, with increases of 5.6% to 32.3% between baseline and treatment phase for all the participants. Researchers concluded that vividness can be enhanced through an effective, response propositionladen imagery training program that significantly relates to previous experiences (Calmels et al., 2004).

Imagery perspective.

When an athlete is engaged in mental imagery, there are two distinct imaging perspectives in that the athlete can experience the imagined situation, an external or internal perspective. Mahoney and Avener (1977) defined external imagery perspective as a third person view, where the participant assumes the position of an observer, as if watching a film or recording of a previous performance. On the contrary, an internal imagery perspective, has been defined as requiring an approximation of the real-life experiences, in which that the participant imagines being inside his/her body, while experiencing the sensations that they may expect to encounter in the actual situation (Mahoney & Avener, 1977). The first stage in learning novel motor tasks is called the cognitive stage because the learner initially uses verbal and cognitive cues to represent the task, and the dominant sensory system is vision (Fischman & Oxendine, 1993). Therefore, in the early stages of learning, an external perspective may be more beneficial as it allows learner to examine the motor skills involved in the skill from outside of their body giving the most inclusive view of their limbs and relevant visual cues. For tasks that rely on kinesthetic awareness, internal imagery has often been advocated and implemented as opposed to external imagery is because the internal perspective is presumed to have a stronger relationship to kinesthetic sensations (Jowdy et al., 1989). The internal perspective is believed to have the potential to incorporate kinesthetic imagery (the feel of the movement) while the external perspective may be insufficient to produce such sensations (Rodgers, Hall & Barr, 1990).

Specific aspects of motor skill performance have shown to be enhanced by varying types of imagery (Guillot et al., 2009; Hardy & Callow, 1999). For example, Hardy and Callow (1999) suggests that external visual imagery may be more beneficial than an internal perspective to enhance the performance of a motor skill task where form and technique are most important. Conversely, it is suggested that an internal visual imagery perspective may be most beneficial for open/reactive skills that depend heavily on perception (White & Hardy, 1995). However, all imagery research is not consistently in agreement with these suggestions, and more extensive research is needed to verify the prevalence of specific imagery types as it relates to the characteristics of movement, and to gain a more in-depth understanding or the inconsistencies in the research (Guillot & Collet, 2008). Consequently, it is not possible to establish a guideline for a preferential imagery type associated with the specific form and technique of a motor skill.

The ability to effectively examine mental imagery perspective has been difficult for various reasons; the most notable involves the athlete switching perspective during imagery (Harris & Robinson, 1986). Although it has been suggested that there is no assurance of the control over imagery perspective, Hall and Erffemeyer (1983) proposed various methods for insuring a stable imagery perspective including the use of video recorded visual aides, and guided imagery scripts. Mahoney and Avener (1977) exploratory study was the first in sport psychology to distinguish between internal and external imagery perspectives. Researchers concluded that elite gymnast who qualified for the Olympic team reported using internal images more frequently as opposed to external images compared to those gymnasts that did not qualify. Rotella, Gansneder, Ojala, and Billing (1980) examined cognitive strategies of elite level skiers in preparation for competition which provided support to Mahoney and Avener's (1977) findings. Researchers found that more successful skiers focused on the difficult parts of the racecourse using an internal imagery perspective compared to less successful athletes who mentally practiced from an external perspective. The findings of the study may also suggest that less successful athletes adopt a third person (external) view during rehearsal because they have not yet mastered the technical requirements of the skills. Consequently, the results of these two studies provide correlational support in regards to the relationship between an internal imagery perspective and enhanced performance on motor skill tasks.

However, more recent research has presented equivocal findings concerning the efficacy of internal and external imagery perspectives For example, Glisky, Williams and, Kihlstrom (1996) examined the effects of two variables, imagery perspective and task type, of which both may influence the efficacy of imagery practice. Results of the study signified that participants who predominately use an external perspective exhibited greater performance on a motor/kinesthetic task (balancing a stabilometer), while solely internal imagers showed greater improvement on a cognitive/visual task (estimating angle of reflection). Additionally, Gordon, Weinberg, and Jackson (1994) investigated the effectiveness of an internal versus external imagery training program on performance of high school cricket bowlers. Groups were matched according to bowling ability and imagery vividness. Although performances improved across six training sessions for each group, no significant performance differences were found between the internal, external, experimental, and control groups. Consistent with the findings of previous studies (e.g. Harris & Robinson, 1986: Mahoney & Avener, 1977), the cricketers in the investigation reported that an internal imagery perspective was both easier to use, and utilized more often than an external perspective. Findings from these studies suggest that an internal imagery perspective may not always be the sufficient perspective for optimal enhancement of performance on motor/kinesthetic tasks.

Chapter Three

Suggestions for Future Research

Reported studies have demonstrated that imagery can enhance self confidence in a variety of tasks (e.g., Callow & Hardy, 2001; Mamassis & Doganis, 2004) because imagery facilitates feelings of competence and successful skill performance. Research has also revealed that imagery is effective in reducing competitive anxiety and allowing athletes to regulate their arousal levels as if engaged in the competitive event (Vadocz et al., 1997). It is suggested that in order for imagery to be efficient, the content should be based on positive images, such as performing the skill successfully (Cumming et al., 2006). It is reported that negative mental images may have a detrimental impact on motor performance and have been commonly reported by athletes (Guillot & Collet, 2008). Alternatively, negative images may be facilitative as they prepare athletes to cope with worst-case scenarios. Given that competitive anxiety can be both debilitative and facilitative (Jones, 1995), in an applied setting, imagery should be tailored to regulate anxiety to a level that will ultimately enhance performance. Further research is needed to investigate how athletes cope with negative images and their ability to transform negative images into positive images.

In regards to the duration and number of imagery sessions, researchers are still searching for greater clarification, as there is no general agreement (for reviews, see Feltz & Landers, 1983; Martin et al., 1999). It has been proposed that a range of one to two-hundred sessions, lasting from a few seconds to 3 hours will produce beneficial effects Feltz & Landers, 1983; Driskell Cooper & Moran, 1994). Overall, it has been shown that athletes have difficulty maintaining focus during many imagery sessions and mental fatigue can be attained quickly (Guillot & Collet, 2008). Further research that examines specific outcomes may better clarify the duration and frequency needed for imagery interventions to produce beneficial effects.

Although athletes commonly complete mental imagery sessions in a secluded, relatively quiet environment, some recent experimental designs suggests that the benefits will be maximized when imagery is practiced in an environment similar to that of actual competition (Holmes & Collins, 2001; Callow, Roberts, & Fawkes, 2006). It is suggested that the competitive environmental conditions can facilitate the athlete's ability to recall and rehearse the motor skills, while engaged in the environmental stimuli. In order to establish more specific guidelines, experiential studies should be geared to assessing the influence of the environmental conditions during imagery practice.

To date, there exists a fairly limited amount of studies that have examined the connection between imagery use at different times throughout the season and type of sport (individual or team). Individual sport athletes have reported imagery to be significantly more effective than team sport athletes when using imagery during practice and competition (Weinberg & Gould, 2006). To achieve a greater understanding, more longitudinal research is needed on this topic. Another area that has received little attention is athletes' use of imagery during the off-season. Since athletes most likely engage in some form of physical activity and/or sport specific training during their off-season, it appears worthwhile to further investigate this area.

Imagery perspective (internal vs. external) has received a great deal of attention in the literature, yet has continuously produced inconsistent results. Hardy & Callow (1999) suggests that external visual imagery may be more beneficial than an internal perspective to enhance the performance of a motor skill task. Alternatively, it is suggested that an internal visual imagery perspective may be most beneficial for open/reactive skills that depend heavily on perception (White & Hardy, 1995). As a result, researchers have suggested that adopting either or both perspectives during imagery may be effective in enhancing performance. As stated earlier, all imagery research is not in agreement with these suggestions, and more extensive research is needed to verify the prevalence of specific imagery perspectives as it relates to the characteristics of movement (Guillot & Collet, 2008).

Chapter Four

Conclusion

The aforementioned research, exploratory studies, and anecdotal reports underline the importance of incorporating differing types of imagery to achieve various outcomes. Since its early introduction and application into the sports domain, sport psychology practitioners have continuously sought to elucidate the mechanisms that allow imagery to work and produce favorable outcomes. Over time, numerous theories emerged as research studies were completed, while each theory expanded on the results and conclusions of prior studies. Most theorists have been in agreement as it relates to the importance of incorporating physiological and psychological components into imagery interventions to maximize the effectiveness of the imagery session. It appears evident that the same set of imagery instructions, propositions, and images may never produce the same response and experience for any two individuals. Ahsen (1984) provided support for Lang's (1979) bioinformational theory, emphasizing the importance taking into account the personal meaning/significance attached to the images presented in the imagery intervention. Many researchers have been in agreement with Sackett's (1934) symbolic learning theory, which concluded that imagery is effective because it enables individuals to become more familiar with the movements and facilitates automaticity though cognitive processes. Additionally, neuroimaging technologies have provided support for theories that have suggested that neural mechanisms play a role in imagery via incorporating the same neural pathways that are used in memory, emotions, and motor control.

Numerous applied models have provided evidence that the proposed models were reliable frameworks for imagery interventions, highlighting several variables for athletes' use of imagery (Guillot & Collet, 2008; Wilson et al., 2007). Martin et al. (1999) applied model emerged after examining studies that have assessed the effects of motor imagery use by athletes during training, competition, and rehabilitation. Similar to Paivio (1985), the five functions of imagery (e.g. MG-A, CS) were highlighted and three outcomes were reported. It was concluded that motor imagery in sports was most often used for (a) facilitating skill learning, (b) modifying cognitions associated with self-confidence and motivation, and (c) factors relevant to regulating arousal and competitive anxiety. Holmes & Collins's (2001) PETTLEP model, comprised of seven components, highlighted the importance of the interaction between the components within the model, such as the environment's effect on perspective during imagery. Researchers are in agreement that the various models presented may very well serve as a guiding framework for the development of efficacious imagery interventions (Boyd & Munroe, 2003; Guillot & Collet, 2008; Mamassis & Doganis, 2004; Munroe et al., 2000).

Most often, the goal of a mental training program is to improve mental skills such as relaxation, concentration, and confidence, which heavily influence athletic performance (Taylor & Wilson, 2005). Relaxation and concentration are considered to be crucial components when executing sport specific skills such as free-throw shooting in basketball, serving in tennis, and balance beam routines in gymnastics (Hall et al., 1998). Being that imagery has been shown to improve such key mental skills, in theory, the use of imagery should improve subsequent skill performance.

In summary, imagery research has, over time, evolved and advanced the field of sport psychology and its applied practice since its early review by Feltz and Landers (1983). Researchers have not only focused on imagery as one aspect of mental practice, but also its influence on various mental skills (e.g., confidence, arousal, concentration). Additionally, imagery has been effectively used for rehearsing general strategies, learning sport specific skills, and facilitating effective responses to competitive scenarios and stressful emotions. More recent theoretical developments (e.g., Four W's, PETTLEP) has expanded the understanding of imagery in sporting contexts regarding how to improve imagery's effectiveness as well as describing why, when, and what type of imagery may be most effective. Although the aim of this manuscript focuses on imagery for sport performance, it is worthwhile to note that recent research has indicated that imagery can be helpful for non-athletes in exercise settings as well. Further research that tests the predictions of previously established guidelines will only advance the field as researchers and practitioners should be enthused to develop even more effective imagery interventions. Finally, as noted earlier, as the field continues to advance, sport psychology practitioners may be presented with numerous opportunities to assess how imagery can help individuals in a variety of ways and settings.

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