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Imagery is a common technique for performance enhancement in sport and performance domains. Research has provided evidence for the use of imagery in improving confidence (Callow, Hardy & Hall, 2001; Callow & Waters, 2005), managing competition anxiety (Hanton & Jones, 1999; Evans, Jones & Mullen, 2004; Mellalieu, Hanton & Thomas, 2009), improving self-efficacy (Jones et al., 2002; O, Munroe-Chandler, Hall & Hall, 2014), and enhancing motor skill performance (Hinshaw, 1991; Driskell, Copper & Moran, 1994). Image vividness, or clarity of the image, has been shown to have a moderating effect on the effectiveness of interventions in athletic populations (Isaac, 1992). Research into the effects of engaging in relaxation techniques prior to imagery training are equivocal. Some advocate that strategies aimed at creating a "calm mind-aroused body" should be used (Holmes & Collins, 2001).

The purpose of the present study was to determine if mindfulness meditation prior to imagery enhances imagery vividness and performance of a self-paced closed motor skill relative to imagery in isolation. A within-subjects counter-balanced design was used. Participants were assessed on their state-trait anxiety and imagery ability before engaging in either a mindfulness exercise followed by imagery (mindfulness plus imagery), or imagery in isolation. Participants were assessed on performance of the closed motor skill and asked to rate the vividness of their imagery. No significant differences in performance or vividness were observed between the two conditions. There was a significant effect of day, as participants' had lower levels of error on day two and higher levels of vividness on day two. A significant interaction was found such that those with higher levels of trait anxiety had lower error after mindfulness plus imagery, while those with lower levels of trait anxiety earned lower error scores after imagery in isolation. Practical implications and suggestions for future research are discussed.

THE EFFECTS OF MINDFULNESS MEDITATION PRECEDING IMAGERY ON PERFORMANCE AND IMAGE VIVIDNESS OF A CLOSED MOTOR SKILL

by

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CHAPTER I

INTRODUCTION

Imagery is a common technique for performance enhancement in sport and performance domains. Research has provided evidence for the use of imagery in improving confidence (Callow, Hardy & Hall, 2001; Callow & Waters, 2005), managing competition anxiety (Hanton & Jones, 1999; Evans, Jones & Mullen, 2004; Mellalieu, Hanton & Thomas, 2009), improving self-efficacy (Jones et al., 2002; O, Munroe-Chandler, Hall & Hall, 2014), and enhancing motor skill performance (Hinshaw, 1991; Driskell, Copper & Moran, 1994). An investigation by Hall, Mack, Paivio, and Hausenblas (1998) revealed that sport imagery may be used for 5 main functions. These are (1) cognitive specific, (2) cognitive general, (3) motivational specific, (4) motivational general-arousal, and (5) motivational general-mastery. Cognitive specific (CS) imagery refers to imaging a sport-specific skill for better understanding and subsequent performance. Although multiple theories of the mechanistic processes of imagery have influenced the development of its use, what exactly makes imagery effective is not entirely clear.

Recently, one of the more popular theories explaining the performance benefits of imagery is that of functional equivalence. This stems from neuroscientific evidence showing that similar brain regions and processes are present in physically performing a task and imaging the task (Stephan et al., 1995; Montoya et al., 1998; Decety et al., 1990; Deiber et al., 1991; Roland, 1984). Holmes and Collins (2001) proposed a functional equivalence model of imagery known as PETTLEP. PETTLEP stands for physical, environment, task, timing, learning, emotion, and perspective; all characteristics that should be similar both when imaging the task and performing it in reality. However, little research has looked at testing specific components of the PETTLEP model.

When it comes to imaging sport or performance-related motor skills, optimal levels of psychological arousal are not known. Should athletes be relaxed when performing imagery, or should their arousal level be close to that of actual performance? Based upon PETTLEP, the answer is likely related to the nature of the motor skill; particularly, whether it is a closed or open motor skill. Gentile (2000) defined closed skills as those that are performed when the regulatory conditions of the environment are stationary and do not change from trial to trial. In contrast, open skills are performed when the environment or people in it are in motion, and regulatory conditions change across performances. Since most closed skills are self-paced and concerned with accuracy, lower levels of arousal may be advisable for correct execution compared to higher levels. Furthermore, drive theory posits that as arousal increases, the more dominant or well-learned response of a skill occurs (Hull, 1943). So, if a skill is not well-learned by the performer and arousal is high, the dominant (incorrect) response will occur. For performers who are not well-learned in a skill and who are performing a closed skill with accuracy demands, inducing a relaxed state during imagery is expected to be more beneficial to performance enhancement.

In contrast to those arguing for identical arousal levels for both physical performance and imagery of a skill, some researchers argue for the facilitative effect of relaxation on imagery effectiveness irrespective of the specific demands of the task. Harvey, Krenz, McQueen, and Krenz (1994) are among those who postulate that relaxation is a necessary antecedent to induce the correct mental state to optimize imagery. Additionally, relaxation may result in reduction of mental distractions that could help performers improve the effectiveness of imagery (Miller, 1994; Janssem & Sheikh, 1994; Sheikh, Sheikh, & Moleski, 1994). With the proposed reduction in mental activity and tension induced from relaxation techniques, it is predicted that the imager is able to focus solely on creating a vivid and accurate imagery experience. In contrast, some proponents of imagery offer the counterargument that relaxation may induce a level of psychological arousal that is incongruent with that of actually performing the skill.

Research into the effects of combining relaxation techniques with imagery are equivocal. One technique that has been empirically supported is visuo-motor behavioral rehearsal (VMBR) (Suinn, 1972). VMBR consists of three main stages for each session: (1) an initial stage to induce relaxation, (2) visual imagery of a stressful situation, and (3) performance in a simulated stressful situation. Weinberg et al. (1981), using Suinn's VMBR technique, showed that relaxation may reduce state anxiety and thus have beneficial effects on actual performance. By contrast, in a case study with a collegiate football player, Gray, Haring and Banks (1984) found that combining relaxation with imagery decreased efficacy expectations and imagery vividness, compared to imagery only and imagery combined with arousal induction. More recently, Louis et al. (2011)

found that although imagery vividness did not differ between aroused and relaxed conditions, relaxation contributed to a slower imagery time of the skill. This difference in timing of the skill during imagery has been argued against by Holmes and Collins (2001) in their discussion of the PETTLEP model. Relaxation may hinder the effectiveness of imagery by creating an incongruence between the timing of imaging a skill and actually physically performing a skill. However, in self-paced closed skills, the timing of the skill is usually initiated and controlled by the athlete, and is not dependent on environmental cues. In an investigation of imagery vividness, Anuar, Cumming and Williams (2016) found that PETTLEP imagery resulted in higher ease and vividness ratings compared to traditional imagery. Holmes and Collins (2001) advocate that strategies aimed at creating a "calm mind-aroused body" should be used. Therefore, relaxation may be used without compromising the effectiveness of imagery on performance of closed skills where accuracy is rewarded.

One relaxation technique that may be used to induce this "calm mind-aroused body" state in performers is mindfulness. Sport participation often occurs in highly competitive environments, and often the pressure to perform is high. In some cases, this perceived pressure may create anxiety in athletes or performers (Martens, Vealey, & Burton, 1990). Numerous techniques have been used with athletes and performers with the goal of fostering relaxation in an attempt to quell high levels of sport anxiety. Mindfulness, in empirical literature, was originally developed and proposed by Kabat-Zinn (2005) to combat the symptoms of chronic health problems. Mindfulness involves meditation accompanied with a focus on the present moment and staying in the here and now. Additionally, mindfulness practicers are encouraged to maintain a non-judgmental awareness of the thoughts and feelings they experience, and to label thoughts as "thinking" and feelings as "fear", "excitement", "anxious", and so on. Kabat-Zinn's original model of mindfulness was mindfulness-based stress reduction (MBSR). Variations of this therapeutic technique have provided numerous benefits, including improving one's ability to self-regulate negative reactions to stress (Brown & Ryan, 2003), increasing activity of the prefrontal cortex (Creswell, 2007), increasing tissue density in the brain's hippocampus (Holzel, 2011), improving immune system functioning (Hofmann, 2010), and reducing symptoms of anxiety (Roemer, Orsillo, & Salters-Pedneault, 2008), depression (Teasdale, 2000), substance abuse (Bowen, 2006), eating disorders (Tapper, 2009), and chronic pain (Grossman, 2004).

Mindfulness has since been adapted by Kaufman et al. (2009) into Mindfulness Sport Performance Enhancement (MSPE), which is tailored to be used specifically with athletes. Using this model, Kaufman et al. (2009) provided evidence for benefits on trait confidence and trait mindfulness, as well as state flow and state mindfulness for recreational archers and golfers. More recently, Baltzell et al. (2014) designed a variation of sport-specific mindfulness training called Mindfulness Meditation Training for Sport (MMTS). In a qualitative study with division I female soccer players, they found that players perceived direct benefits from mindfulness training, including enhanced mindfulness, awareness, and acceptance of emotional experiences. However, present research has not provided conclusive evidence on the use of a combination of mindfulness and imagery for the benefits of imagery vividness and motor skill performance. As previously mentioned, the usefulness of mindfulness relaxation for enhancing imagery may be limited to specific performance tasks, where higher levels of arousal may be debilitative rather than facilitative. The present study examined the effectiveness of the use of mindfulness and imagery as compared to imagery in isolation in the context of a self-paced closed motor skill.

Purpose

The purpose of this study is to see if mindfulness-based relaxation combined with imagery enhances imagery vividness and performance of a self-paced closed motor skill relative to imagery in isolation.

Hypothesis

It is hypothesized that participants will experience increased performance of the skill after engaging in mindfulness followed by imagery, compared to imagery only. Furthermore, it is hypothesized that participants will experience increased imagery vividness of the skill after the combined relaxation and imagery session compared to the imagery only session. A within subjects counter-balanced design was used, so participants can serve as their own controls.

CHAPTER II

EXTENDED LITERATURE REVIEW

Definitions of Imagery

Imagery has been the subject of numerous empirical research studies in the realm of sport psychology and motor learning. Imagery has been defined in different ways in not only the sport psychology literature, but the cognitive psychology literature as well. Morris, Spittle and Watt (2005) noted these differing definitions in the literature, and developed a comprehensive working definition incorporating the over-arching concepts that characterize imagery. They defined imagery as “the creation or re-creation of an experience generated from memorial information, involving quasi-sensorial, quasi-perceptual, and quasi-affective characteristics, that is under the volitional control of the imager, and which may occur in the absence of the real stimulus antecedents normally associated with the actual experience” (Morris, Spittle & Watt, 2005, p. 19). In the literature, the term has often been used interchangeably with terms such as visualization and mental practice.

Research has revealed that imagery use by athletes is multifaceted, and that there are several functions imagery may serve to improve performance. An investigation by Hall, Mack, Paivio, and Hausenblas (1998) revealed that there are 5 main functions of imagery in sport. These are (1) cognitive specific, (2) cognitive general, (3) motivational specific, (4) motivational general-arousal, and (5) motivational general-mastery. Cognitive specific (CS) imagery involves imaging actual skills respective to each sport. Cognitive general (CG) refers to imaging specific strategies pertinent to successful performance. Motivational specific (MS) involves imaging specific sport-related goals or goal-directed behavior. Motivational general-arousal (MG-A) involves imaging events evoking feelings of relaxation, stress, arousal and other emotional states pertinent to performance. Motivational general-mastery (MG-M) involves imaging scenarios with effective coping, self-confidence, focus and control.

Imagery Use and Experience

When it comes to using imagery for sport-specific purposes, research has shown distinctions between an athlete's experience and his or her use of imagery. Early assessments of elite athletes revealed that upwards of 90% of them employ imagery during training and competition (Orlick & Partington, 1988). In comparison to less skilled or sub-elite athletes, it appears that elite athletes tend to use imagery more often. In their assessment of imagery use by 150 Canadian athletes from a wide range of sports (badminton, basketball, soccer, swimming, tennis, etc.), Cumming and Hall (2002) found that provincial and national athletes reported using more imagery in a typical week than their recreational counterparts. National athletes also perceived imagery to be more pertinent to their respective sport performance than recreational or non-elite athletes. Additionally, Salmon et al. (1994) found that elite-level soccer players tend to employ more imagery use than their sub-elite and non-elite counterparts. Given the widespread use of imagery by elite athletic populations, it is no wonder why imagery interventions have become one of the most popular techniques when it comes to increasing performance in sport domains.

Imagery Outcomes in Athletes

The vast amount of research that has been conducted into imagery use, and the multiple theoretical approaches that have been proposed to explain its effectiveness, have led to intervention studies that feature imagery training to affect psychological states or performance in athletes. These studies have incorporated interventions across multiple sports, measuring multiple outcomes to affect change in their populations. When it comes to affecting psychological states, the most common outcomes assessed have been confidence, performance anxiety, flow, and self-efficacy. In addition to psychological constructs, motor performance has been examined to assess the enhancement of sport performance through imagery training. As will be discussed, performance tends to either be directly assessed or inferred from relevant constructs. First, the evidence of imagery training on psychological constructs will be examined.

One construct that has been investigated as an outcome of imagery training is confidence. Self-confidence has been shown to be positively associated with coping with adversity and negatively associated with sport anxiety (Creswell & Hodge, 2004). Feltz (1988), in a review of self-confidence and performance, drew some important conclusions about the relationship between the two variables. Most notably, not only is there a significant relationship between self-confidence and performance, but there is evidence that self-confidence may serve as both an effect and cause of performance (Feltz, 1982; Feltz, 1988; Feltz and Mugno, 1983; McAuley and Gill, 1983). One of the first studies to look at applying an imagery intervention in a population of athletes to affect confidence was done by Callow, Hardy and Hall (2001). A 3-week imagery intervention was employed to increase the sport confidence of elite-level badminton players. Consistent with their purpose and the functions of imagery, motivational general-mastery imagery was implemented. Findings indicated increases in sport confidence for 3 out of 4 of the players. Subsequently, Callow again looked at imagery and its utility in manipulating levels of confidence of elite athletes, this time, with three horse jockeys. The three-week intervention was successful in increasing the sport confidence levels of 2 out of the 3 jockeys, but did not seem to affect their actual performance in races (Callow & Waters, 2005). Nevertheless, research has shown that imagery may be an effective way to improve confidence and athletes, and indirectly, aspects of sport performance.

Anxiety revolving around competition in sport may be a common symptom of many athletes and performers (Martens, Vealey, & Burton, 1990). Specifically, empirical research has focused on competition or pre-competition anxiety. Often times, interventions have aimed to manipulate the perception of the *direction* of the anxiety on a debilitative and facilitative spectrum. In other words, anxiety may be perceived as helpful (facilitative) or hurtful (debilitative) to performance. Hanton and Jones (1999) provided the first forays into manipulating competition anxiety when they used motivational general-arousal imagery to maintain facilitative interpretations of anxiety in elite swimmers. The imagery intervention occurred over a 5-month period and was part of a multimodal intervention of 4 swimmers that also included goal setting and self-talk.

Swimmers were selected specifically because they had debilitative interpretations of anxiety. A single-subject multiple-baseline across-subjects design was used, and the subjects who received the intervention reported facilitative interpretations of anxiety post intervention, and also after a 5-month follow up. Further evidence of this use of imagery is provided by Evans, Jones and Mullen (2004), who conducted a case study of an imagery intervention with an elite rugby player. They found that this athlete was able to control his competition-related anxiety to a greater extent after the imagery intervention. Mellalieu, Hanton and Thomas (2009) also found support for the benefits of imagery on sport anxiety. A motivational general-arousal imagery approach was used in a multiple baseline single-subject design with five male collegiate rugby players over the course of a 20-week season. Visual inspection revealed that all five participants had more facilitative interpretations of cognitive anxiety as a result of the intervention. In contrast, Ramsey, Cumming, Edwards, Williams and Brunning (2010) found that an imagery intervention improved performance in female soccer players, but did not improve their anxiety or performance. Thirty-three male and female university soccer players were assigned to either a skill-based PETTLEP (physical, environment, task, timing, learning, emotion, perspective) imagery, emotion-based PETTLEP imagery, or stretching group. Although increased performance on a penalty kicking task was observed for both imagery groups, there were no effects on interpretations of anxiety.

Another psychological variable related to sport performance is self-efficacy. Jones et al. (2002) assigned novice female climbers to either a motivational general-mastery, motivational general-arousal, or a light exercise control group. Partial support was found for the benefits of imagery on self-efficacy, as the climbers in the motivational general-mastery group reported significantly higher levels of self-efficacy prior to a climbing task. Shearer et al. (2009) employed a motivational general-mastery approach in their imagery intervention with ten members of the Great Britain wheelchair basketball team, and found that their intervention may be useful in increasing levels of collective efficacy for players on elite sport teams. In the aforementioned Ramsey et al. (2010) study, the researchers also looked at self-efficacy of the participants, but did not find any significant improvements. O, Munroe-Chandler, Hall and Hall (2014) used a single-subject multiple-baseline design to assess the effects of an individualized motivational general-mastery intervention on self-efficacy in 5 youth squash players. Results revealed that 3 of the 5 athletes reported improvements in self-efficacy. Although only a few imagery intervention studies have aimed to affect self-efficacy specific to sport, early findings are promising.

A few studies looked specifically at using imagery for performance enhancement or improving motor performance, with somewhat mixed results. Smith and Holmes (2004) examined the effect of the modality of an imagery intervention on putting performance. They examined the differential effects of written script, audio, and video imagery interventions and a control group on golfing performance. The interventions that incorporated audio and video stimuli improved performance, while the ordinary written script and control group did not. Munroe-Chandler, Hall, Fishburne and Shannon (2005) used cognitive-general imagery to influence performance of game plans and strategy in a group of young-elite soccer players. Group imagery sessions of 10-15 minutes were conducted once a week for two weeks for each of three specific soccer strategies over a 7-week period. Although they did not find significant performance enhancement, their operational definition of performance was somewhat flawed and may have limited the power of their study. Effective performance of soccer strategies was assessed by two experts with coaching experience by rating each strategy on a scale from 0 to 4 on four items. Actual competitive games were videotaped so that the experts could rate the execution of each strategy. Although description and video examples of soccer strategies were provided and ratings were done independently by experts, no training program for the experts was administered and no reliability scores were assessed. Similarly, Jordet (2005) used a 10 to 14-week imagery intervention (featuring both cognitive specific and cognitive general elements) in three elite soccer players to assess effects on exploratory activity and performance in competition. Exploratory activity referred to the head movements away from the ball that players make when taking in information about the environment. Participants met with the lead author once a week to engage in the imagery program, and also were given a recording and were encouraged to do one session per week on their own. Although two of the three participants appeared to improve their exploratory activity, only one participant marginally improved his performance in competition. However, when it comes to studying sport performance in applied settings, it can be sometimes difficult to assess and measure “performance”. In Jordet’s study, performance in competitive matches was assessed by two trained “soccer game analysts” on a scale from 1-7, and as such had an obvious subjective component. No training program was administered for the analysts, and inter-observer reliability ranged from 71-

90% total agreement, depending on the variable. In contrast, Post, Muncie and Simpson (2012) did find convincing improvements in swimming performance of elite swimmers after incorporation of a three-week imagery intervention in their training routine. Four youth competitive swimmers were assessed on their swimming performance via a 1000-yard practice set, with three out of the four improving their times post intervention.

Results from Meta-Analyses

Although some studies on the effects of imagery and mental practice on performance have failed to show a benefit, results of meta-analyses support a benefit on performance. In a review of 21 published studies, Hinshaw (1991) found an overall effect size of 0.68 on motor skill performance. In addition, internal imagery was more favorable than external imagery, and the optimal session-length of mental practice sessions should either be less than one minute, or between 10 to 15 minutes. Another meta-analysis by Driskell, Copper and Moran (1994) also reported a significant and positive effect of mental practice on performance. They reported that significant moderators of effects on performance were the type of task, the retention interval, and length of the intervention. Specifically, effects were stronger when tasks featured more cognitive components than strictly physical components, when the retention interval is shorter rather than longer, and when interventions were given over a three-week period.

However, one notable limitation when it comes to assessing sport performance is the researcher's operational definition of performance. Specifically, the operational definitions used to measure performance tend to have both objective and subjective components, depending on the performance context. For example, studies assessing performance of closed skills in closed sports tend to be more objective when measured. In golfing, archery, dart-throwing, and other shooting sports, performance may be easily assessed by distance from the target. In swimming, track, skiing, and other racing sports, performance can be objectively measured by time to completion. However, when it comes to measuring performance of skills in open sports, objectivity tends to be harder to maintain. In team-based ball sports, the ever-changing environmental characteristics mean that the performance of the same skill is rarely ever the same. Although certain measures may come close to "performance" (number of passes completed, goal-to-miss ratio, points scored, win or loss, etc.), one could debate whether these are truly objective means of measuring performance. Furthermore, the context in which performance is measured should also be of concern. Chiefly, are the subjects being measured on performance in a non-competitive training or practice environment, or during a competition? The motivational and emotional characteristics of the subject are likely to differ between these two environments. If the ultimate objective is to improve sport performance, is it appropriate to measure performance in a non-competitive environment? Does successful performance of a skill in a non-competitive environment transfer to successful performance of the skill in a competitive environment? Although it would be a logical assumption, the most convincing evidence for the use of mental practice and imagery to enhance sport performance should feature interventions that show benefits on performance in a competitive context.

Theories of Imagery

Beneficial outcomes from imagery interventions in athletes have received substantial support based upon the results of meta-analytic reviews, but how, exactly, does imagery result in these benefits? Early theories included both neuromuscular and cognitive systems. Psychoneuromuscular theory posits that the act of imagery rehearsal replicates the minute muscle innervations that occur during actual performance. The muscle innervations are weaker in magnitude but identical in the pattern observed when physically executing a skill (Jacobson, 1932). According to this view, imagery affects change through neuromuscular processes. However, evidence in support of psychoneuromuscular theory is equivocal. Wehner, Vogt, and Stadler (1984) tested this theory to see if this activation is task-specific. They recorded electromyography (EMG) activity in the biceps while subjects in (1) active, (2) mental practice, or (3) control groups completed a paced-contour tracking task. EMG activity was similar between the active and mental practice groups, but not in the control group, suggesting there may be some support for psychoneuromuscular theory. In contrast, Slade, Landers, and Martin (2002) compared EMG activation in active and passive arms during an imaged dumbbell-curling task. Although, activity in the active arm increased relative to the passive arm, the activity recorded did not mirror that of actual performance.

Lang's bio-informational theory has also received attention in the literature, stating the importance of stimulus and response propositions (Lang, 1979). This theory is cognitive in nature, and theorizes that learning and performance involve aspects of the "scene" (stimulus propositions) and their association with feelings and symptoms (response propositions) that normally result from the scene. Therefore, performers may be able to favorably modify their response to situations through imagery. Although research in non-sport literature provides evidence for bio-informational theory (Bradley, 1991; Lang, Melamed, & Hart, 1970), the evidence in the sport psychology literature is less clear. Ziegler (1987) failed to find a difference in effect of stimulus and response propositions or stimulus only propositions on basketball free-throw performance. Female university students were randomly assigned to one of five groups: control, physical practice (PP), passive imagery (I), active imagery with kinesthetic cueing (IC), and imagery plus physical practice (I/PP). After 3 practice sessions per week for three weeks, the I and IC groups improved significantly more than the PP group. However, there were no differences in improvement between any of the imagery groups, suggesting no benefits of including response propositions. Smith, Holmes, Whitemore, Collins, and Devonport (2001) examined the benefits of imagery in novice field hockey players from a bio-informational perspective, with a stimulus and response imagery group, a stimulus-only group, and a control group. Imagery was performed three times per week for seven weeks. Both imagery groups showed improved performance on a penalty flick shot task as assessed using a point system, with the stimulus and response group showing significantly higher scores than the stimulus-only group. This study offers some support for Lang's bio-informational theory.

More recently, the functional equivalence model of imagery has come to dominate the framework for imagery in sport. Functional equivalence operates on the hypothesis that imagery and physical movement recruit common processes and functions in the brain, and the only distinction is that during imagery, execution of the movement is blocked. One of the more recent models of imagery based on functional equivalence was Holmes and Collins' (2001) PETTLEP model for imagery training. PETTLEP is an acronym for the physical, environment, task, timing, learning, emotion, and perspective characteristics of imagery. *Physical* refers to including sporting implements and perhaps performing some motor movements. *Environment* refers to including environmental prompts and auditory or visual aids. *Task* refers to performing imagery that is cognitively appropriate for the skill and level of expertise of the performer. *Timing* refers to imaging the skill in real time. *Learning* involves manipulating the content of the image as the imager progresses and learns. *Emotion* refers to tapping into the meaning of the image to the imager. *Perspective* involves imaging from an internal perspective for the most part, and external for more form-based skills. Since neuroscientific evidence has revealed that similar brain regions and processes are present in physically performing a task and imaging the task (Stephan et al., 1995; Montoya et al., 1998; Decety et al., 1990; Deiber et al., 1991; Roland, 1984), the degree of similarity (functional equivalence) should correlate with the effectiveness and optimization of the session. In order for covert, self-generated images to satisfy the components of PETTLEP, they should be as similar to or as vivid as the actual experience. Building off of this, practitioners implementing imagery interventions should be concerned about the most effective way to encourage imagery that is as vivid as possible. One technique that has been incorporated and expected to satisfy this requirement is relaxation.

Vividness refers to the clarity of the self-generated image, and how similar it manifests compared to reality, while controllability refers to the imager's ability to manipulate and influence the image's content (Gould, Voelker, Damarjian & Greenleaf, 2014). In particular, imagery vividness has been shown to have a moderating effect on the effectiveness of interventions in athletic populations. Isaac (1992) compared novice and expert trampolinists on the performance of three skills specific to trampolining. Both experts and novices were assigned to one of two groups that either engaged in 5 minutes of mental practice of the skills or 5 minutes of a mental task unrelated to trampoline. Although all of the participants in the mental practice group improved significantly more than the control group, participants who were classified as "high imagers" (more vivid imagery) in the experimental group improved significantly more than "low imagers". Given the aforementioned benefits of relaxation on mental state (decreased activity, increased focus, etc.), it may be possible that relaxation training may help performers create more vivid images and control their content and progression.

Relaxation

There have been numerous methods and techniques used for the purpose of inducing a relaxed state in human populations. These involve breathing exercises, visualization, muscle tension exercises, mindfulness, meditation, and combinations of these techniques to elicit states of relaxation. The populations that have been targeted with these relaxation techniques encompass a wide range of domains, from healthy functioning individuals to clinical populations. To understand how relaxation has been achieved, some of the most popular techniques will be discussed.

When it comes to the benefits of imagery training in athletes, the effects of combining imagery with relaxation are less clear. One relaxation-imagery technique that has been shown in the realm of sport to have a beneficial effect is Visuo-Motor Behavioral Rehearsal (VMBR). VMBR was first developed by Suinn (1972) to treat a doctoral student with severe examination anxiety. VMBR consists of three main stages for each session: (1) an initial stage to induce relaxation, (2) visual imagery of a stressful situation, and (3) performance in a simulated stressful situation. Weinberg et al. (1981) compared VMBR training with a relaxation only group, an imagery only group, and a control group of collegiate karate athletes on their state anxiety and performance. The intervention lasted 6-weeks and upon its conclusion, the VMBR and the relaxation group showed lower levels of state anxiety than the imagery and control groups. Additionally, only the VMBR group showed beneficial effects on sparring performance. These findings offer some support for the amalgamation of relaxation and imagery to enhance sport performance, specifically using VMBR.

Hamberger and Lohr (1980) conducted another early investigation of the relaxation-imagery interaction. Students in an introductory speech course completed five sessions of progressive relaxation with imagery over a 1-week intervention, compared to an information/placebo control group. Although controllability of imagery did not differ between groups upon conclusion, progressive relaxation did decrease EMG activity and self-reported tension.

While these early findings appear promising for the inclusion of relaxation in an imagery intervention, additional studies have found debilitative effects on imagery. A case study in the 1980s of imagery and relaxation was done by Gray, Haring, and Banks (1984). A single varsity collegiate football player was assessed in the week prior to a bowl game. A total of three sessions were implemented with the subject, one each of no altered arousal (control), relaxation, and arousal induction. The researchers found that in the arousal induction and control sessions, the athlete reported higher ratings of imagery vividness and increased efficacy expectations. However, this particular study was limited and weak in several areas. Not only was it a case study of one single athlete, but the duration of the intervention was only 1 week in its entirety.

When it comes to "how much" imagery or mental practice is required to demonstrate an effect, the answer is unclear. Evidence of how much imagery is required to modify aspects of imagery ability itself is lacking. Recently, Louis et al. (2011) examined imagery used after 10 minutes of physical practice (aroused), 10 minutes of relaxation, or 10 minutes of talking with an experimenter (control) in 16 male competitive athletes from football (soccer), gymnastics, basketball, handball, cycling, tennis, dance, and boxing. First, each athlete performed a respective skill from their sport for six trials, during which the respective skill was timed from start to completion. Then, they performed three imagery sessions in random order, one for each condition. Participants triggered a timer upon starting to image the physical skill and then stopped the timer upon completion of the imaged skill. Analysis revealed that, when imaging the skill in the relaxed condition, the times were significantly slower than the actual time it took to perform the physical skill. Furthermore, imagery vividness did not differ between relaxed and aroused conditions. Although performance was not assessed in this study, the temporal incongruence between the actual speed of a skill and its imaged speed could actually degrade performance based upon the PETTLEP expectations.

Biofeedback

Biofeedback (BFB) training is a technique that has been used with athletic populations for arousal-control and performance enhancement. Biofeedback was first introduced into the empirical realm for clinical populations with severe mental disorders. A working definition, as provided by Blumenstein, Bar-Eli, and Tenebaum (1995), is that biofeedback is a technological interface providing normally inaccessible information about biological states to a client. The modalities that have been used include electrocardiogram (ECG), heart rate (HR), electrodermal (ECD), electromyogram (EMG), and electroencephalogram (EEG). Information about biological processes from these methods is shown in real time to the athlete, giving them concrete feedback about their arousal and allowing them to attempt to manipulate these variables.

The empirical research for BFB training alone to impact performance and arousal in athletes is promising. Landers et al. (1991) used one session of EEG biofeedback in 16 pre-elite archers, finding that “correct” BFB versus “incorrect” BFB improved performance, while “incorrect” BFB actually led to decrements in performance, as measured by score on a 27-shot pretest and postest. Bar-Eli et al. (2002) used a combination of HR, EMG and galvanic skin response (GSR) with youth competitive swimmers over a 14-week period while a control group underwent various relaxation activities for the same amount of time. Although both the BFB combination and control group showed increases in performance, the BFB group exhibited significantly greater increases in performance than the control, which was measured via technique evaluation and time in a 50-meter freestyle swim. A 6-week heart rate variability (HRV) BFB intervention was used by Tanis (2012) with collegiate volleyball players to assess the effects on performance of volleyball skills in competitive games. Performance scores from games prior to the intervention were compared to scores from games during the intervention. Although quantitative analysis did not reveal an effect of BFB on performance, qualitative analysis revealed that the volleyball athletes perceived a reduction in physical and mental stress, and enhancement of physical and mental states pertinent to performance.

Biofeedback, Relaxation and Imagery

Given the empirical support for the use of imagery and BFB in athletes, a combination of the performance enhancement modalities might be expected to have a beneficial effect. BFB measures presented to athletes may be an optimal way to train athletes to induce a relaxed state for when they perform their imagery. However, interventions incorporating a combination of both imagery and BFB training are almost nonexistent. Blumenstein et al. (1995) looked at the effects of autogenic relaxation, imagery training, music, and BFB (via EMG) in college physical education students on physiological variables and performance on a 100-meter run. Subjects either received autogenic and imagery training, music and imagery training, or autogenic music and imagery training. Autogenic training is a relaxation technique aimed at reducing muscle tension (Schultz, 1970). Although the direct effect of BFB on these variables was unable to be determined, an augmenting effect was found when combined with autogenic, imagery, and music training. To date, no study has looked specifically at the effects of the use of BFB to induce relaxation during imagery training in athletes.

Additionally, few studies of BFB in athletes have looked at HR beats per minute (bpm) explicitly as an effective modality for arousal regulation. Rather, HR BFB has been used with more complex technology for measurement, such as EEG and other tools for HRV training. Given the increasing accessibility of HR monitors to athletic populations, and the increasing trend of coaches and athletes to incorporate HR bpm to measure and determine training loads, it offers an advantage over more expensive and less accessible modalities such as ECG, EMG, and EEG. Jane et al. (1999) used a 6-week intervention incorporating HR BFB as presented in bpm to sub-elite long distance runners, improving their running economy and lowering their oxygen ventilation. This finding offers initial support for the use of BFB as measured via HR bpm to improve athletic performance.

Mindfulness-Based Stress Reduction

One of the most popular techniques and recent trends in the realm of inducing a relaxed state is that of mindfulness-based stress reduction (MBSR). MBSR was originally developed and proposed by Kabat-Zinn (2005) to combat the symptoms of chronic health problems. MBSR involves meditation accompanied with a focus on the present moment and staying in the here and now. A specific therapeutic technique, known as mindfulness-based cognitive therapy (MBCT) has since evolved and developed from Kabat-Zinn’s original model. MBCT has been shown to have a number of benefits on the functioning of those who practice it. These include improving one’s ability to self-regulate negative reactions to stress (Brown & Ryan, 2003), increasing activity of the prefrontal cortex (Creswell, 2007), increasing tissue density in the brain's hippocampus (Holzel, 2011), improving immune system functioning (Hofmann, 2010), and reducing symptoms of anxiety (Roemer, Orsillo, & Salters-Pedneault, 2008), depression (Teasdale, 2000), substance abuse (Bowen, 2006), eating disorders (Tapper, 2009), and chronic pain (Grossman, 2004). The recent abundance of empirical interest in this meditational technique and support in numerous clinical populations lends confidence to its use and adoption as a verified form of relaxation. MBSR's influence has also made it into the realm of sport performance. Kaufman et al. (2009) adapted the characteristics of MBSR and MBCT into a new program specific to athletes, termed Mindful Sport Performance Enhancement (MSPE). Like Kabat-Zinn's original conceptualization of mindfulness, MSPE draws on promoting mindfulness skills and acceptance in the focus of sport performance. Kaufman et al. used a 4-week program with sessions lasting from 2.5 to 3 hours each. Trait measures of sport anxiety, perfectionism, thought disruption, sport confidence, mindfulness, and flow were assessed at baseline and immediately after the last workshop in week 4. State measures of mindfulness and flow were assessed immediately after mindfulness sessions and after practice or competitions, respectively. Benefits were found on trait confidence and trait mindfulness, as well as state flow and state mindfulness.

Opposing Theories of Relaxation and Imagery

The conflicting results from empirical investigations of the relationship between relaxation and the effectiveness of imagery interventions reflect the opposing theories behind the impact of relaxation on this process. Arguments for a facilitative effect of relaxation on imagery center on preparing the mental state of the client for the experience. Harvey, Krenz, McQueen, and Krenz (1994) are among those that postulate that relaxation is a necessary antecedent to induce the correct mental state for athletes to optimize the imagery intervention. Miller (1994) agreed, stating that the act of relaxation is the best way help the athlete remove mental distractions. Relaxation may also improve concentration, reduce somatic tension, and limit outside distraction (Janssem & Sheikh, 1994; Sheikh, Sheikh, & Moleski, 1994.) With the proposed reduction in mental activity and tension induced from relaxation techniques, the client is able to focus solely on creating a vivid and accurate imagery experience. As this would allow the self-generated image and progression to be more realistic, a facilitative effect would be present from relaxation on the imagery process.

In contrast, arguments for a debilitative effect of relaxation on the imagery process center around the incongruence in arousal it may cause between the imagery experience and the actual physical experience of the imaged event in reality. In an overview of the current state of the literature regarding imagery use in sport, Murphy (1994) reported that although relaxation appears to interact with imagery, it does not seem to be a necessary mediating variable for effective imagery interventions, based on the findings that mental practice and imagery studies without relaxation have shown beneficial effects (Clark, 1960; Corbin, 1967; Woolfolk, Parrish, and Murphy, 1985) Additionally, the modification of imagery times as discovered by Louis, Colletand Guillot (2011) may lead to a violation of the PETTLEP model, which suggests that timing of imagery should be as close as possible to its actual experience. Research into the relationship of arousal and performance is based on the foundational concept of the inverted U relationship, as put forth by Yerkes and Dodson (1906). Essentially, moderate arousal levels are associated with peak performance, with low and high levels associated with decreases in performance. However, individual variation must be taken into account when generalizing to performers. A "moderate" level of arousal for one performer may be too low or too high for another performer, and vice versa. Relaxation may therefore reduce arousal levels below optimal for some athletes who perform better with higher levels of arousal.

In light of these two opposing arguments of relaxation effects on imagery, it stands to reason that the optimal arousal level for an imagery experience is sport, skill, context, and athlete-dependent. For example, for many performers in closed-skill sports, such as golf, archery, and gymnastics, lower levels of arousal may be optimum to maintain and facilitate performance. The skills required to be successful in these sports are fairly similar from competition to competition, and involve only minimal manipulation. In contrast, performers in open-skill sports may benefit from higher levels of arousal where anticipation and quick reactions are critical to success. Athletes in these sports are presented with changing and new environments from moment to moment, and skills must not only be adapted to fit the current situation, but also appropriate in their timing in response to the environment. Specific to imagery ability and the effectiveness of interventions with athletes, imagery vividness is often a factor that is assessed, and that is used to judge success of the intervention.

Given this potentially unique interaction between nature of skill and the optimal level of arousal, future studies need to identify when relaxation is beneficial to imagery training. Therefore, the primary purpose of the present study was to see if mindfulness relaxation training with imagery training has differential effects on vividness and performance of a closed motor skill compared to imagery alone. The relaxation technique used was Kabat-Zinn's mindfulness-based stress reduction. This technique was selected because of its promising results from empirical literature, over the other relaxation techniques aforementioned

CHAPTER III

METHOD

Participants

Twenty-three (9 male, 14 female) college-aged individuals from a mid-sized public university were recruited for participation. An a priori power analysis was conducted by averaging the three effect sizes found from previous meta-analytic reviews (Feltz & Landers, 1983; Driskell et al., 1994; Hinshaw, 1991), which was 0.56, and calculating the sample size for a power of .80 which indicated that 22 participants were needed. Participants were screened to identify if they have any physical limitations or injuries that could limit their ability to perform the motor task. Participants were asked if they currently experience any pain or movement limitations in their wrist, arm, or shoulder, or if they have any other current physical injuries that would limit or preclude their ability to participate. Participants were given a questionnaire to determine their prior experience with the game of cornhole. Each participant signed an informed consent approved by the University's Institutional Review Board detailing that participation is voluntary, and that they would receive no penalty if they elect to drop out of the study.

Measures

State-Trait Anxiety. Prior to engaging in each imagery session, participants were given the state-trait anxiety inventory for adults (STAI-AD). This measure is designed to assess participants' state and trait levels of anxiety

Imagery Ability. Prior to engaging in study procedures, participants were assessed on imagery ability via the Movement Imagery Questionnaire-Revised second edition (MIQ-RS). The MIQ-RS is a 13-item measure designed to assess both kinesthetic and visual imagery ability, and it has been shown to be highly correlated to the MIQ-R for both kinesthetic (r = 0.80) and visual (r = 0.82) imagery ability (Gregg, Hall & Butler, 2007).

Imagery Vividness. After each imagery session, participants were asked to report the vividness of their imagery from that session on a sliding scale from 0 to 100, with 0 being "not at all vivid" and 100 being "extremely vivid", consistent with a study done by Morina, Leibold and Ehring (2013) in the realm of clinical psychology. This was used to examine if imagery vividness is affected by the experimental manipulation.

Cornhole Experience. Participants were asked to completed a 3-item questionnaire regarding their previous experience with the game of cornhole. Item 1 asked participants to indicate if they had ever played cornhole before ("yes" or "no"). Item 2 asked participants to indicate how many times they had played in the last month (if any). Item 3 asked participants to rate their skill in cornhole on a scale from 0 to 10, 0 being "poor", 5 being "average", and 10 being "elite".

Performance. Participants were assessed on motor performance by a series of bean bag tosses to a target. The task was similar to the game of cornhole except that participants were tossing bean bags to a target on the floor rather than to a hole in a board. Cornhole involves a relatively simple closed motor movement, and it is hypothesized that most of the target population will have only recreational experience with the game. No feedback was given to the participants during performance, only the immediate visual feedback from each toss was present. Additionally, the nature of the task allows for an obvious measure of performance so that it may be measured as objectively as possible. Participants completed 30 performance trials after 3 practice trials each day of the two-day study. Participants tossed the bags toward a grid with a center target and vertical and horizontal coordinates. For shots that landed in on the center target, a score of zero was given. Trained observers recorded the X and Y coordinate for each throw. From these coordinates, mean radial error (MRE) and bivariate variable error (BVE) were calculated for each participant as an expression of performance on the motor task. MRE expresses the distance from the bag to the target. Radial error was calculated for each trial by squaring the X and Y coordinate, summing these two numbers, and taking the square root of the sum. Then, MRE was calculated by summing radial error from each trial and dividing by 30. BVE is an expression of consistency, and refers to participants' average deviation from their centroid. The centroid was calculated by summing participants' X and Y coordinates, and dividing the respective sums by 30 to obtain the average. For each trial, the centroid was subtracted from the trial X and Y, and these values were squared and summed. The resulting values were summed from all 30 trials, divided by 30, and then the square root was taken to express BVE.

Treatment Conditions. A within-subjects approach was used, with two conditions for each participant. In one condition (Mindfulness plus Imagery), participants engaged in 5 minutes of mindfulness relaxation prior to imaging the bean bag toss. The

Headspace Application developed by Headspace Inc. was used for the 5-minute mindfulness exercise. The Headspace App is a guided meditation and mindfulness application for smartphones, and has been empirically supported as a mindfulness intervention (Bennike, Wieghorst & Kirk, 2017; Howells, Ivtzan & Eiroa-Orsoa, 2016). Participants were asked to sit comfortably in a chair in the lab space. The lights were turned off, and participants listened to the guided mindfulness exercise via a portable audio speaker. Immediately after completing the mindfulness exercise, participants listened to an audio script (see Appendix F) of cognitive-specific guided imagery focusing on the performance of the bean bag toss. The details of the second condition (Imagery) were the same, but without the 5-minute mindfulness exercise. Conditions were randomized and counter-balanced to control for practice effects of imagery use.

Procedures

Each participant was asked to report for two days to complete the study. On day 1, participants were asked to complete the informed consent and the STAI-AD. Next, participants watched a video illustrating the proper technique to use when throwing bean bags (https://www.youtube.com/watch?v=owZ38wsO0jI). Participants were then briefed on imagery and its use for performance enhancement of sport skills, and were asked to complete the MIQ-RS. Participants then completed 3 practice trials of the bean bag toss, with experimenter feedback given as necessary. Participants were then brought back to the lab for the first session. Participants were exposed to the first experimental condition (Mindfulness plus Imagery or Imagery). Immediately upon completion, participants were asked to rate the vividness of their imagery on the 0-100 sliding scale. Participants returned to the lab to perform 30 trials of the bean bag toss task.

On day 2 of the study participants returned to the lab to be exposed to the second experimental condition (Mindfulness plus Imagery or Imagery). Following completion of the treatment, they rated the vividness of their session. The protocol was the same as day 1, with the completion of 30 trials of the bean bag toss.

Analysis

The present study was a counter-balanced repeated measures design. All participants received the control and experimental manipulation, and were measured on baseline state and trait anxiety, imagery ability, imagery vividness and physical performance of the motor task. Results for performance on the motor task were evaluated using a dependent samples t-test to test the effects of imagery only and imagery preceded with mindfulness. A dependent samples t-test was used to evaluate the effect of day on participants' performance and imagery vividness, to determine if a learning effect was present. Results for imagery vividness of the sessions were evaluated using a dependent samples t-test to test the effects of the experimental manipulation. Results for imagery ability were evaluated using a Pearson *r* correlation to determine if imagery ability was correlated with imagery vividness of the session and performance on the task. Finally, based upon the order of the experimental conditions (mindfulness plus imagery on day 1, or mindfulness plus imagery on day 2), participants were split into a high and low group based on trait levels of anxiety. That is, for example, a median split was conducted for participants in the mindfulness plus imagery day 1 group and separately for participants in the mindfulness plus imagery on day 2 group. This was done to ensure that the high trait anxious group and the low trait anxious group had equivalent numbers of participants from the two orders. The benefits of mindfulness on anxiety are well-supported, and a between-subjects repeated measures ANOVA was used to evaluate the effect of trait anxiety on performance, and any interactions with condition. A between-subject ANOVA was used to evaluate the effect of trait anxiety, condition, and their interaction on vividness.

CHAPTER IV

RESULTS

Twenty-three participants were recruited for the study. Nine participants were male, and 14 participants were female. The ethnic breakdown was 34.8% Caucasian, 21.7% African American, 13% Asian/Pacific islander, 13% percent Hispanic, 4.3% other, and 13% mixed. The average age of participants was 22.65 (SD = 2.84), and most participants (n = 20) had played cornhole at least once before. Participants self-reported cornhole skill ranged from 1 to 8 (M=4.39, SD = 1.83). Two participants reported they had played cornhole once within the past month, while the remaining twenty-one reported they had not played at all within the past month.

Imagery Vividness

Descriptive statistics are presented in Table 1. A dependent-samples t-test revealed no significant difference in vividness of imagery between the mindfulness plus imagery and the imagery only conditions [$t(22) = -1.090$, $p>.05$]. However, there was a significant difference between day 1 and day 2 [$t(22) = -2.275$, $p<.05$], such that vividness of imagery was higher on day 2. Vividness averaged across both conditions was not significantly correlated with mean radial error averaged across both conditions ($r = -.012$, $p>.05$) or with bivariate variable error averaged across both conditions ($r = .2386$, $p>.05$).

Performance

Descriptive statistics are presented in Table 1. A dependent-samples t-test revealed no difference in mean radial error (MRE) between the mindfulness plus imagery and imagery only conditions [$t(22) = 0.224$, $p > .05$]. There was no significant difference in BVE between conditions [$t(22) = -.370$, $p > .05$]. There was a significant difference between day 1 and day 2 [$t(22) = 3.876$, $p < .05$] such that MRE was lower on day 2. An effect of day on BVE was also significant, as participants' had lower levels of BVE on day 2 [$t(22) = 3.054$, $p < .05$].

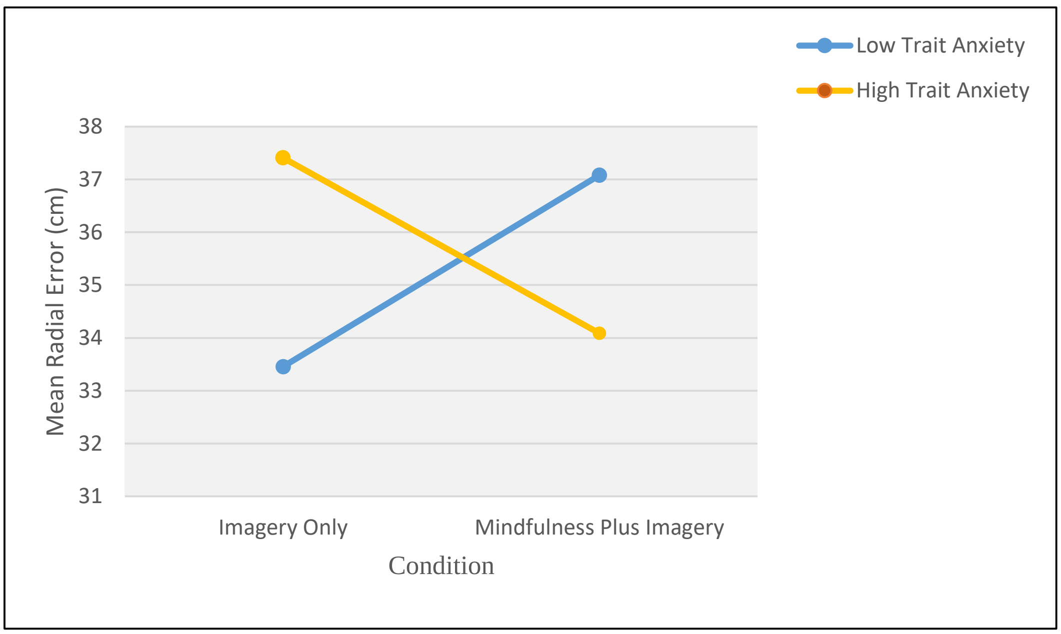
Imagery Ability

Pearson *r* correlations revealed that combined ability as measured via the MIQ-RS was positively correlated with vividness ($r = .367$, $p < .05$). Combined imagery ability was not correlated with MRE ($r = -0.034$, $p > .05$) or BVE ($r = .118$, $p > .05$) on the motor task.

Trait Anxiety

Due to anxiety being a variable often associated with the benefits of mindfulness, the participants were split into two groups according to their score on the trait portion of the STAI. The top half were identified as "high trait anxiety", and the bottom half were identified as "low trait anxiety". A mixed within and between subject's ANOVA was used to determine if performance for those with high levels of trait anxiety differed by condition compared to those with low levels of trait anxiety. There was no significant main effect of condition on MRE [$F(1, 21) = .113$, $p > .05$], and no significant main effect of trait anxiety on MRE [$F(1, 21) = .032$, $p > .05$]. There was a significant interaction between trait anxiety and condition on MRE [$F(1, 21) = 4.710$, $p<.05$], such that those with low trait anxiety had higher MRE during the mindfulness plus imagery condition while those in the high trait anxiety group had lower MRE during the mindfulness plus imagery condition. There was not a significant main effect of condition on BVE [$F(1, 21) = .229$, $p>.05$]. There was not a significant main effect of trait anxiety on BVE [$F(1, 21) = .835$, $p>.05$]. There was not a significant interaction between trait anxiety and condition on BVE [$F(1, 21) = 3.900$, $p= .062$.]. Descriptive statistics are presented in Table 2.

Figure 1. MRE by Condition for Low and High Trait Anxiety



There was not a significant main effect of condition on vividness [$F(1, 21) = 1.161$, $p>.05$]. There was not a significant main effect of trait anxiety on vividness [$F(1, 21) = 1.890$, $p>.05$]. There was not a significant interaction between trait anxiety and condition on vividness [$F(1, 21) = .076$, $p>.05$].

Table 1

Performance by Condition and Order

Condition		
<u>Mindfulness + Imagery</u>	<u>M</u>	<u>SD</u>
MRE (cm)	35.65	7.08
BVE (cm)	38.90	7.48
Vividness of Imagery	82.04	14.08
<u>Only Imagery</u>		
MRE	35.34	5.92
BVE	38.10	7.23
Vividness of Imagery	84.48	11.59
Order		
<u>Day 1</u>	<u>M</u>	<u>SD</u>
MRE	37.54	5.71
BVE	41.30	7.39
Vividness of Imagery	80.91	13.58
<u>Day 2</u>		
MRE	33.47	6.66
BVE	35.71	6.14
Vividness of Imagery	85.61	11.82

Table 2

Performance by Trait Anxiety

High Trait Anxiety (n = 12)		
Mindfulness + Imagery	M	SD
MRE (cm)	34.55	8.55
BVE (cm)	37.92	9.23
Only Imagery		
MRE	36.86	6.47
BVE	40.98	6.93
Order	N	
Mindfulness + Imagery Day 1	6	
Mindfulness + Imagery Day 2	6	
Low Trait Anxiety (n = 11)		
Mindfulness + Imagery	M	SD
MRE	36.85	5.19
BVE	39.98	5.19
Only Imagery		
MRE	33.69	5.03
BVE	34.95	6.43
Order	N	
Mindfulness + Imagery Day 1	6	
Mindfulness + Imagery Day 2	5	

CHAPTER V
DISCUSSION

The purpose of this study was to determine if mindfulness-based exercise preceding imagery of a self-paced closed motor skill would enhance image vividness and subsequent performance as compared to imagery in isolation. Previous research using relaxation techniques before imagery has been inconclusive in showing benefits on vividness and performance. The PETTLEP model of motor imagery suggests that techniques that induce cognitive relaxation ("calm-mind, aroused-body") should be used prior to imagery. The type of task is salient, as closed-skill tasks may reward lower levels of cognitive arousal. In the present study, mindfulness was used to accomplish this requirement in a within-subjects design.

It was hypothesized that participants would have higher levels of vividness and lower error after the mindfulness and imagery condition. Results from dependent samples t-tests did not support this hypothesis, as there were no significant differences between performance or vividness as a function of condition. An effect for day was found, in that participants had significantly lower levels of MRE and BVE on the second day of testing than the first day, and significantly higher levels of vividness on the second day. This is indicative of a learning effect for participants on the motor task and imagery, likely due to participants' lack of familiarity with the task when they initiated their participation.

One possible explanation for the lack of a benefit of mindfulness on imagery vividness is participants' lack of experience and familiarity with the game of cornhole. As reported, imagery tends to be most effective when images are as close to the actual experience as possible. Although participants were familiar with the game of cornhole and had played before, they had never performed the task required in this study. Therefore, images and feelings they were asked to generate during the imagery process may have still been novel and unfamiliar to participants, and as such, the gains in vividness due to practice were still salient. It may be that cognitive arousal is only a minor concern , and what ultimately allows individuals to generate more vivid imagery is practice of the imagery process itself. Imagery is a skill that must be practiced, and cognitive arousal may be more salient when performers are skilled in imagery, and when the learning process has already occurred. Another explanation may be the time interval between the practice trials on the motor task prior to imagery was different between experimental conditions. When participants received imagery in isolation, the interval between the practice trials and engaging in imagery was minimal (2 to 3 minutes). In the mindfulness and imagery condition, the interval was greater (6 to 7 minutes), due to participants engaging in mindfulness before imagery. It is possible that benefits due to mindfulness were cancelled out by the extended time delay, as the stimuli from their practice may have been less "fresh" in their minds. Examining the relationship of time delay between physical practice of a task and subsequent imagery of that task may be a proper next step.

Another point to consider is that participants were asked to perform 30 trials on both days of the study immediately after 3 practice trials. It is possible that for a number of the earlier trials, participants were still becoming familiar with the specific constraints of the task. A lack of additional trials for familiarization may have prevented seeing noticeable differences as a result of condition. Incorporating a larger number of familiarization trials, or using a pretest-posttest design, may allow for observable benefits on performance.

Mindfulness meditation is still not fully understood. There are currently no recommendations or support for dose-response (De Vibe et al., 2012). Therefore, the one brief 5-minute session of mindfulness participants received may have been inadequate to realize the benefits shown in other studies on performance-related outcomes. Previous studies finding these benefits (Kaufman et al., 2009; De Petrillo et al., 2009; Baltzell et al., 2014; John et al., 2011) have employed training protocols. These studies used multi-week training programs to increase flow state, performance, confidence, and to decrease sport-related worry. Future research should examine the benefits of mindfulness to imagery and performance in a training protocol.

This study specifically looked at a closed motor skill. The motor task was similar to the game of cornhole and involves a gross motor movement (throwing), that occurs in a stable environment unaffected by any external changes or demands. Variation in such skills are likely more susceptible to irrelevant attentional allocation and task-irrelevant thoughts. It is for this reason that this type of skill was examined in the context of mindfulness meditation, which involves attentional control, together with imagery practice. This was in hope of achieving identical levels of cognitive arousal between imagery and successful performance of the skill in reality. Overall, the results do not suggest mindfulness confers these benefits on a closed skill. Rather, for those who have higher trait levels of anxiety or performance anxiety, mindfulness may confer benefits on performance on closed skills.

Pearson *r* correlations did not reveal a relationship between participants' self-reported vividness of imagery and subsequent performance on the task. The PETTLEP model of motor imagery suggests that the closer self-generated imagery is to the actual experience, the more effective the imagery (Holmes & Collins, 2001). The present study did not support this claim. Participants' combined imagery ability as measured via the MIQ-RS was positively correlated with vividness, but neither imagery ability nor vividness were correlated with performance. As such, present findings do not support a relationship between imagery ability or vividness and overt performance. One important factor to the relationship of imagery ability to performance may be participants' previous experience with the actual task (Hinshaw, 1991; Highlen & Bennett, 1983). Given participants' relative lack of experience on the task, this could explain why imagery ability and vividness were unrelated to performance.

Subsequent analyses yielded some interesting findings. There was a significant interaction on MRE between high and low trait anxiety and experimental condition, in that those with higher levels of trait anxiety had lower MRE during the mindfulness and imagery condition, while those with lower levels of trait anxiety had higher MRE (see Figure 1). These results suggest level of trait anxiety may be a factor in the utility of mindfulness and imagery for motor performance. Some have argued that mindfulness and imagery should not be combined for performance enhancement (Gardner, 2016), and this study may lend support to this claim, at least for a low trait anxious demographic. The higher levels of MRE for the low trait anxious group could indicate that the combination of mindfulness and imagery raised cognitive arousal above ideal for the low trait anxious group. Furthermore, due to the plethora of evidence for the benefits of mindfulness on symptoms of anxiety, it is understandable that the benefits of mindfulness with imagery were observed in the high trait anxious group. Models of anxiety performance relationships (Inverted-U, reversal theory, catastrophe theory, etc.) in sport psychology postulate that high levels of cognitive anxiety can lead to decreased performance. It may be that the benefits of mindfulness on motor performance are most pronounced in a high anxious demographic. When asked to perform in evaluative situations, those with generally higher levels of anxiety may benefit from mindfulness practice. Due to the nature of the experimental manipulation, it is impossible to tell if this finding was due to a beneficial combination of mindfulness with imagery, or from the previously mentioned benefits of mindfulness on performance. The small sample size for each group (n = 12 for high trait anxiety, n = 11 for low trait anxiety) should be noted when interpreting results.

A number of implications for future research are suggested. While most participants had some experience with the game of corn hole, all were relative novices on the task. To eliminate the confounds of a learning effect, future studies should examine skillful or competitive athletes on self-paced closed skills and observe the effects of mindfulness and imagery on imagery vividness and performance. The interaction on

MRE between trait anxiety and condition is of note. The design of the study prevents inference about if the interaction is due to the combination of mindfulness and imagery, or due to the presence of mindfulness alone. Future studies may aim to examine mindfulness in isolation and imagery in isolation to further understand the relationship with performance and anxiety. Additionally, looking at trait anxiety as a moderator of the benefits of mindfulness on performance would be a logical next step. However, given there was not interaction on vividness between trait anxiety and condition, vividness does not seem to have support as a mechanism for performance benefits. Mindfulness has been described as a form of attentional control, and it may be that improvements in attentional allocation may be the mechanism for improvements in performance. Subsequent investigations should aim to examine changes in measures of attention related to performance, such as flow, to determine if this is a more promising avenue for research on the mechanisms of mindfulness training. A number of practical implications may be suggested from the results of this study. Individuals in any performance domain (athletes, musicians, soldiers, etc.) may be assessed on trait levels of performance or general anxiety. For those who tend to have higher levels of these variables, mindfulness training in combination with imagery may be recommended as a promising avenue for performance enhancement. In addition to performance benefits, these individuals are likely to reap the mental health benefits in turn. That being said, mindfulness meditation training may not be the optimal method of performance enhancement for every individual. Those not prone to performance or general anxiety may have minimal performance benefits to gain from formal training, and although mental health benefits may be conferred, other forms of psychological skills training may be more promising.

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APPENDIX A

STATE TRAIT ANXIETY INVENTORY

SELF-EVALUATION QUESTIONNAIRE

STAI AD Form Y-1

Please provide the following information:

Name________________________________Date__________S____

Age______________ Gender (*Circle*) **M** **F** T____

DIRECTIONS:

A number of statements which people have used to describe themselves are given below. Read each statement and then blacken the appropriate circle to the right of the statement to indicate how you feel *right* now, that is, *at this moment*. There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe your present feelings best.

	NOT AT ALL	SOMEWHAT	MODERATELY SO	VERY MUCH SO
1. I feel calm	1	2	3	4
2. I feel secure	1	2	3	4
3. I am tense	1	2	3	4
4. I feel strained	1	2	3	4
5. I feel at ease	1	2	3	4
6. I feel upset	1	2	3	4
7. I am presently worrying over possible misfortunes	1	2	3	4
8. I feel satisfied	1	2	3	4
9. I feel frightened	1	2	3	4
10. I feel comfortable	1	2	3	4
11. I feel self-confident	1	2	3	4
12. I feel nervous	1	2	3	4
13. I am jittery	1	2	3	4
14. I feel indecisive	1	2	3	4
15. I am relaxed	1	2	3	4
16. I feel content	1	2	3	4
17. I am worried	1	2	3	4
18. I feel confused	1	2	3	4
19. I feel steady	1	2	3	4
20. I feel pleasant	1	2	3	4

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SELF-EVALUATION QUESTIONNAIRE

STAI AD Form Y-2

Name____Date_________

DIRECTIONS

A number of statements which people have used to describe themselves are given below. Read each statement and then blacken in the appropriate circle to the right of the statement to indicate you *generally* feel.

	ALMOST NEVER	SOMETIMES	OFTEN	ALMOST ALWAYS
21. I feel pleasant	1	2	3	4
22. I feel nervous and restless	1	2	3	4
23. I feel satisfied with myself	1	2	3	4
24. I wish I could be as happy as others seem to be	1	2	3	4
25. I feel like a failure	1	2	3	4
26. I feel rested	1	2	3	4
27. I am "calm, cool, and collected"	1	2	3	4
28. I feel that difficulties are piling up so that I cannot overcome them	1	2	3	4
29. I worry too much over something that really doesn't matter	1	2	3	4
30. I am happy	1	2	3	4
31. I have disturbing thoughts	1	2	3	4
32. I lack self-confidence	1	2	3	4
33. I feel secure	1	2	3	4
34. I make decisions easily	1	2	3	4
35. I feel inadequate	1	2	3	4
36. I am content	1	2	3	4
37. Some unimportant thought runs through my mind and bothers me	1	2	3	4
38. I take disappointments so keenly that I can't put them out of my mind	1	2	3	4
39. I am a steady person	1	2	3	4
40. I get in a state of tension or turmoil as I think over my recent concerns and interests	1	2	3	4

APPENDIX B

DEMOGRAPHICS AND CORNHOLE EXPERIENCE

Participant ID: ______

Date: ____________

Demographics

Age: _______ Date of Birth ___________ Sex: Male Female

Ethnic Background: African American/Black Asian/Pacific Islander
Caucasian/ White Hispanic
Native American Other: ___________________

Education Completed: College/Secondary School: 1 2 3 4

Degree program: ______________________________

Graduate School: Yes/No

If yes, then degree and year: _______________________

Height: ________________

Weight: ___________________

Cornhole Experience

1. Have you ever played cornhole before? Yes or No

2. During the past month, how many times have you participated in cornhole? _________

3. How would you rate your cornhole skill on a scale of 1-10?

←---→

1	2	3	4	5	6	7	8	9	10
Poor				Average					Elite

APPENDIX C

IMAGERY VIVIDNESS

Participant ID ________
Day: ________

Please rate the vividness of your imagery on a scale from 0 to 100

←---→

0 50 100

Not at all vivid Extremely vivid

Score: ____________

APPENDIX D

MINDFULNESS SCRIPT

"Sit back, relax, and allow the body and mind to unwind…So just take a moment to get comfortable…doesn't matter whether your sitting on a chair, on the floor, whatever feels best…I'd like you to begin with your eyes open…Not staring to intently, just aware of the space around you…And just maintain that soft focus with the eyes, just starting with a couple of big deep breaths, breathing in through the nose, and out through the mouth…as you breathe in, just feeling the lungs expand as they fill with air…and as you breathe out, just noticing how the muscles soften as the body exhales…just one more time…and as you breathe out this time, just gently closing the eyes, and allowing the breath, to return to its natural rhythm, in and out through the nose…."
"So just take a moment, just to…feel the weight of the body pressing down against the seat beneath you…the feet on the floor, the hands the arms, just resting on the legs…starting to notice the space around you, any sounds…just allowing those sounds to come and go…and then just bringing the attention back to the body…just noticing how the body feels right now…and just to help with this, starting with the top of the head, just gently scanning down through the body…notice what feels comfortable, what feels uncomfortable…smooth, even steady, from head to toe…and as you scan down just starting to notice the movement of breath in the body…how the breath creates a rising and falling sensation…for some people that's in the stomach, for others the chest, sometimes the diaphragm, if you can't feel anything, just gently placing your hand on the stomach…just noticing that movement…Don't worry if your mind wanders off, that is perfectly normal, as soon as you realize its wandered, just gently bringing the attention back to the breath again.

"Starting to notice whether the breaths are long or short, deep or shallow…and then just for a few seconds, letting go of that focus on the breath and just allowing, the mind to whatever it wants to do. So if it wants to think, just let it think now…and then bringing the attention back to the body again. Just coming back to that feeling of weight pressing down…perhaps noticing the sounds around you again, and you can just open your eyes in your own time…

"So now you'll have a minute to relax. If you feel you need to stretch, or to shift your position to get comfortable, you may do so. As a reminder, after the 1-minute break, I'll be guiding you through imagining the bean bag throwing task…"

"So now we are going to start the imagery process. It is important to note that now, your task is to generate images and feelings as vividly as possible. I'd like you to get comfortable, and close your eyes…"

APPENDIX E

IMAGERY SCRIPT

"Now I will guide you through imaging the bean bag toss you just performed…As a reminder, please try your best to generate images as vividly as possible…Start off by imagining the target in the distance. Notice it's dark grey color, and the speckled felt material…Notice the black grid lines, and the bright red target…Picture this as clearly as if you were looking directly at it…Now, you notice the white floor, and the yellow tape that marks the throw line…Notice the bean bag in your hand. Notice its bright red color. Notice its weight, feel, and the hushed shifting of the beads as you move it in your hand…Now notice your feet, and the position of your body. Prepare to take your stance behind the yellow tape…You hold the bean bag with half the beads in your hand…Your grip is comfortable, and you are confident…You straighten your arm and hold it down along your side. You take one more look at the target. You bring your arm back, smooth and controlled, and then move your arm forward releasing the bag with a flick of your wrist. You see the bag rotating as it sails through the air and lands directly on the red target with a "thud"…Then again, you feel the next bag in your hand. You achieve a comfortable grip. You are confident as you set your feet to throw. Again, you see the target in the distance. You bring your arm back and forward, flicking your wrist as the bag leaves your hand. The bag drops directly on the target with a "thud".