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The Effect of a Brief Mindfulness Intervention on Free-Throw Shooting Performance Under Pressure

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By
Nate Wolch

A Thesis
Presented to
The Faculty of Western Washington University

In Partial Completion
of the Requirements for the Degree
Master of Science

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Abstract

Pressure situations in sport can be a source of anxiety for athletes (Craft, Magyar, Becker, & Feltz, 2003). Research indicates that a brief mindfulness training can improve math performance under pressure (Brunye et al., 2013); however, no known studies have examined the effects of mindfulness practice on an athletic performance under pressure. Therefore, this experiment investigated the effects of a brief mindfulness training on basketball free-throw shooting under pressure. Participants were 32 college-aged (M_{age} = 21.29), male competitive basketball players. Participants shot 20 free-throws in a low-pressure phase, then were pair-matched by free-throws made and randomly assigned to mindfulness (n = 16) or control (n = 16) conditions. Pressure was induced before participants listened to a 15-minute mindfulness or history of basketball recording. Next, free-throws made and free-throw shot quality were recorded for 20 free-throws. A mixed ANOVA revealed that during the high-pressure phase, the experimental groups' free-throw shooting average (M = 70.6%) was not statistically significantly different from the control groups' (M = 61.6%). Results of an ANCOVA revealed that the mindfulness group's shot quality was higher than the control group's during the high-pressure phase and approached a statistically significant difference when controlling for trait mindfulness (F = 2.33, p = .051, ηp^2 = .13). During the high-pressure phase, the mindfulness group reported statistically significantly lower levels of cognitive anxiety (t = 2.06, p = .048) and somatic anxiety (t = 2.67, p = .014) than the control group. Although the brief mindfulness intervention did not have a statistically significant effect on performance, the findings are discussed in terms of practical significance. The mindfulness group's significantly lower anxiety indicates that mindfulness training may improve athletes' subjective experience during pressure situations.

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Literature Review

Pressure situations are an inevitable part of competitive sport. The uncertainty of the moment can be thrilling. However, for some athletes, the perceived importance of the situation can be both stressful and anxiety-inducing (Craft, Magyar, Becker, & Feltz, 2003). Athletes may turn to sport psychology professionals to manage their anxiety under pressure and maximize their performance. The purpose of this review is to describe the research literature related to performing in sport under high pressure. This review will first outline terminology and theories related to motor skill acquisition. Next, terminology and theories related to anxiety and performance, sources of anxiety in performance settings, and how anxiety affects attention will be discussed. Finally, this review will examine terminology pertaining to mindfulness and research on mindfulness as a technique for improving performance.

Motor Skill Acquisition

Within a sport, athletes are often required to perform various types of skills, some of which can be more affected by pressure than others (Beilock & Carr, 2001; Reeves, Tenenbaum, & Lidor, 2007). Athletic skills can be broadly divided into two classifications: *closed* and *open* skills. A closed skill is performed in a self-paced, stable environment, with no interference from an opponent (Adams, 1999). A basketball free-throw, a field goal attempt in football, a penalty kick in soccer, and a tennis serve are all examples of closed skills. An open skill is performed in a variable, dynamic environment, in which the athlete must react and adapt depending on the athletic environment (Adams, 1999). Attempting to beat a defender in soccer, getting a rebound through a crowd of opponents in basketball, and returning a serve in volleyball are all examples of open skills because they include responding to variable environments.

Before understanding the ways in which performance of a skill can change under pressure, one must know how a skill is learned. Fitts and Posner (1967) introduced a three-stage model of skill acquisition. The first stage is known as the cognitive stage. In this stage the learner is just beginning to acquire the skill, commits many errors, and is still gathering information about which external cues are relevant and irrelevant. The second stage, the associative stage, is an intermediate stage in which the learner begins to associate environmental cues with the required movements and refine performance to be more effective. The third stage is the autonomous stage, in which the learner becomes very advanced. In the autonomous stage, the learner can perform the skill without much conscious attention or effort. An athlete in the autonomous stage is characterized by having ample confidence and freedom from major errors. An athlete learning to shoot a basketball may begin in the cognitive stage, paying careful attention to hand placement, foot placement, the shooting motion, and follow through. As the learner progresses into the associative stage, they have fewer thoughts about the technical aspects of shooting and develop more consistency in performance. Finally, as the learner reaches the autonomous stage of learning, he or she may be able to perform a basketball shot with little to no conscious thought. For example, in the autonomous stage, the learner may be able to make several shots in a row while holding a conversation about something unrelated to basketball. However, as described later in this review, when the learner is performing a skill during a high-pressure situation during competition with high levels of anxiety, the execution of the skill often becomes more challenging (Beilock & Carr, 2001; Masters, 1992).

Anxiety and Performance Terminology

There are several theoretical constructs and terms that describe various aspects of anxiety and performance that will be used throughout this review. *Cognitive anxiety* refers to negative thoughts or concerns about future situations or consequences (Morris, Davis, & Hutchings, 1981). *Somatic anxiety* can be understood as a heightened physiological state that results from one's concerns about the future (Morris et al., 1981). The difference between cognitive and somatic anxiety is that cognitive anxiety is a mental phenomenon, while somatic anxiety is manifested more so in the body, such as feeling jittery or feeling as though one's heart is racing.

Anxiety can also be conceptualized as having both *state* and *trait* components (Barnes, Harp, & Jung, 2002). State anxiety is a term to describe anxiety felt in the present moment that fluctuates depending upon the situation (Barnes et al., 2002). State anxiety becomes more intense during perceived stressful situations and less intense during non-stressful situations (Barnes et al., 2002). Trait anxiety is a term to describe more stable anxiety that is integrated with personality and refers to an individual's general tendencies to experience anxiety (Barnes et al., 2002). Both state and trait anxiety, as well as cognitive and somatic anxiety can be elevated during certain situations in athletic competitions (Hill, Carvell, Matthews, Weston, & Thelwell, 2017).

Anxiety can lead to changes in performance on athletic skills in certain situations (Hill et al., 2017). Athletes who experience a dramatic decrement in their performance under pressure, despite striving to achieve optimal performance, can be described as experiencing a phenomenon called *choking* (Hill, et al., 2017). Choking is a negative outcome related to anxiety (Hill et al., 2017) that could potentially cause a tennis player to double fault on match point when she has not double faulted in the match, or an 85% free-throw shooter to miss two crucial free-throws in the final minute of a basketball game. Choking is a term used when the stakes are high, effort is high, yet performance is poor (Baumeister, 1984). Anecdotally, choking experiences may be both frustrating and humiliating for athletes. It is important to note that choking results in an extreme decrement in performance (Hill et al., 2017). Perceived pressure and increased anxiety do not automatically lead to choking, however, less extreme, yet significant performance decrements can occur (Mesagno & Beckmann, 2017).

Not all athletes choke under pressure. *Clutch performance*, or superior performance that occurs under pressure circumstances, is possible for athletes as well (Otten, 2009). Swann et al. (2017) investigated the psychological states involved in clutch performance of 26 athletes (13 males, 13 females) from various countries, skill levels, and sports. The researchers identified two distinct psychological states underlying clutch performance. The first was a flow-like psychological state, characterized by a feeling of being on autopilot; operating with smoothness and fluidity without excessive effort. *Flow state* has been defined by Csikszentmihalyi (1990) as a state characterized by total immersion in an activity with an optimal balance between challenge and skill. The second psychological state underlying clutch performance was conceptualized as a clutch state, which was described as a gritty or grinding state involving intense and forceful effort. Otten (2009) concluded that the flow states and clutch states are separate, yet possibly interactive phenomena that both result in high performance under pressure.

Theoretical Understanding of the Relationship Between Anxiety and Performance

The effect of anxiety and arousal on athletic performance is complex and several models offer explanations of the anxiety-performance relationship. This section includes a review of the inverted-U model (Yerkes & Dodson, 1908), the catastrophe model (1996), and Individual Zones of Optimal Functioning Model (IZOF, Hanin, 1997). One proposed model for the anxiety-performance relationship that describes the effect of an excess of anxiety is the inverted-U model (Yerkes & Dodson, 1908). According to this model, medium levels of arousal or somatic anxiety are ideal for achieving peak performance (Yerkes & Dodson, 1908). Yerkes and Dodson (1908) suggested that too little arousal leads to a poor performance state. On the opposite end of the spectrum, high levels of arousal can lead to a non-ideal performance state according to the inverted-U model. Therefore, peak performance is most likely to occur with a moderate level of arousal; however, the inverted-U model is not inclusive of the effects of cognitive anxiety on performance.

The catastrophe model is an extension of the inverted-U model of anxiety and performance and includes a multidimensional approach in which cognitive and somatic anxiety have unique impacts on performance (Hardy, 1996). The model indicates that physiological arousal is facilitative up to a point, and then becomes gradually debilitative, just as the inverted-U model suggests. According to this multidimensional model, an increasing level of cognitive anxiety is facilitative to performance to a certain point, until cognitive anxiety levels become overwhelming and result in a rapid drop-off in performance, commonly referred to as choking (Hardy, 1996). An important part of this theory, according to Hardy (1996), is the stance that cognitive anxiety and physiological arousal have unique, yet interactive effects on performance. Hardy (1996) chose to label the physical component of the model as physiological arousal rather than somatic anxiety in order to allow for the appraisal of physical states as facilitative or debilitative to performance. The primary claim of the catastrophe model is that certain levels of cognitive anxiety and physiological, are needed for high performance, but a catastrophic decline (i.e., choking) in performance can occur once cognitive anxiety levels cross a certain threshold (Hardy, 1996). A limitation to this model is that it does not account for individual differences in optimal levels of physiological arousal and cognitive anxiety.

A theory that does account for individual differences in optimal levels of cognitive and somatic anxiety and its relationship to performance is the Individual Zones of Optimal

Functioning Model (IZOF, Hanin, 1997). Hanin's (1997) central claim in this model is that each performer has an individualized optimal level of arousal associated with their highest level of performance. The IZOF model may help to explain some of the mixed findings for the anxiety-performance relationship (Hanin 1997) because certain tasks may require high levels of arousal for successful performance (e.g., power lifting), while others may require low levels (e.g., archery). The same concept can be applied to individual performers, such that certain individuals may perform better when highly aroused, while others may experience optimal levels of performance with only low levels of cognitive and physiological arousal (Hanin, 1997). According to this model, when athletes' arousal levels are outside their optimal zones, they may experience a performance decline. Therefore, the optimal level of arousal for performance depends on the individual's optimal level and the task being performed.

These three models are all illustrations of the relationship between arousal and performance, and according to Hanin (1997), every person has an idiosyncratic optimal level of anxiety for performance.

Theoretical Explanations for Sources of Pressure

The models described above are helpful for understanding the relationship between anxiety and performance, but they do not explain why anxiety increases during some performances. Yet, such information on the origins of performance anxiety are critical to understand to design effective interventions that help athletes perform better under pressure. One proposed source of pressure is self-presentation, or impression management (Leary, 1992). According to Leary (1992), people monitor and attempt to control how they are perceived by others, which in turn leads to increased anxiety and self-consciousness when they perform in front of other people. Hill et al (2017) found evidence for this model as a contributor to choking, using a qualitative study to explore choking experiences of nine elite athletes from a range of sports including rugby, netball, cricket, golf, and tennis. When describing instances of choking, the athletes in this study reported having a desire to avoid negative judgment from spectators regarding their sport performance and abilities, low self-presentation efficacy, and preoccupation with self-presentation before and during the choke (Hill et al., 2017). On the other hand, the same athletes reported that during clutch performances, they had a desire to receive favorable judgments from spectators about their sport performance and abilities and that they also had high self-presentation efficacy (Hill et al., 2017). These findings provide evidence for self-presentation as a contributor to performance anxiety, however an athlete's perception of their ability to perform may be a factor in determining whether the athlete delivers clutch performance or chokes.

A second variable, closely related to self-presentation, that may influence anxiety levels in pressure situations is a fear of negative evaluation (FNE) or apprehension about being perceived negatively by other people (Mesagno, Harvey, & Janelle, 2012). Mesagno and colleagues (2012) designed an experiment to investigate the relationship of FNE on performance under pressure. A sample of 89 experienced basketball players from ages 14 to 54, completed the revised Brief Fear of Negative Evaluation Scale (BFNE-II; Carlton, McCreary, Norton, & Asmundson, 2006). Participants then took 50 shots under low- and high-pressure conditions. Participants with high FNE were significantly more cognitively and somatically anxious than participants with low FNE. From low to high pressure conditions, participants high in FNE also displayed significant decreases in performance, while participants low in FNE exhibited no significant differences in performance. These findings suggest that FNE may be another source of anxiety that contributes to performance decrements under pressure, and that having low FNE may buffer against such decrements.

A third factor that may contribute to an athlete perceiving a situation as pressure-filled is *perceived control*, which is an individual's subjective ability to predict and control the outcome of a performance (Otten, 2009). Otten (2009) designed an experiment involving 243 undergraduate psychology students with an average of 6.95 years of basketball playing experience (90 females, 153 males, M_{age} of 20.13 years), to examine the relationship between anxiety, explicit knowledge of free-throw shooting, self-confidence, self-consciousness, and performance using structural equation modeling (Otten, 2009). Participants completed 15 free-throws under low and high pressure (pressure induced by adding a video camera) conditions after completing various surveys. The results indicated that higher cognitive anxiety was significantly associated with poorer performance, and that perceived control was a significant predictor of higher performance under pressure. Perceived control also had a significant inverse relationship with both cognitive and somatic anxiety. Based on the results of this experiment, it can be extrapolated that an athlete's level of perceived control over the outcome of a pressure situation may affect whether or not they perceive a situation to be threatening (Otten, 2009). Therefore, if an athlete perceives high levels of control over a pressure situation, the athlete may have more manageable levels of cognitive and somatic anxiety and achieve optimal performance.

Each of the three aforementioned factors, self-presentation, fear of negative evaluation, and perceived control, appear to be related to an individual's cognitive anxiety in pressure situations. Therefore, if athletes experience cognitive anxiety due to self-presentation concerns, FNE, and a lack of perceived control, their performances in high-pressure scenarios may suffer. For example, a study involving 45 experienced male and female (M_{age} of 23.56) field hockey players examining multiple sources of pressure by testing the effects of separate pressure manipulations (performance-contingent monetary incentive, video camera recording, and audience presence) on anxiety and performance on penalty stroke shooting indicated that athletes exposed to self-presentation manipulations like audience presence experienced performance decrements (Mesagno, Harvey, & Janelle, 2011). Moreover, the relationship between the self-presentation groups and performance was mediated by cognitive anxiety, as cognitive anxiety was higher for participants exposed to self-presentational pressure manipulations. Somatic anxiety did not differ between the different types of manipulations. Based on the results of this study, self-presentation may be a contributor to performance decrements, and athletes' levels of cognitive anxiety may explain decreased performance.

Theoretical Models of Attention and Performance

Thus far, this review has included an overview of research on the effects of anxiety on performance and causes of elevated anxiety. This section outlines the process by which well-learned skills suffer due to excessive anxiety due to compromised attentional resources. Nideffer (1976) proposed a model of attention, which posits that attention exists along two dimensions: broad to narrow and internal to external. The broad to narrow continuum refers to how much information is filtered out of attention, with broad attentional styles (highly unfiltered) including a wide breadth of stimuli and narrow attentional styles (highly unfiltered) including very few stimuli. The internal to external continuum in this model represents whether attention is on one's own cognitions and feelings versus the external environment (Nideffer, 1976). Nideffer proposed four different attentional styles based on the two dimensions: broad-internal (e.g., a coach planning a game strategy before addressing her team), broad-external (e.g., a soccer player searching the field of players for an open teammate to pass the ball to), narrow-internal (e.g., a baseball player ruminating on a recent strikeout), and narrow-external (e.g., a quarterback checking the play clock on the scoreboard before the play). According to this model, anxiety about performance represents an internal and narrow attentional style. In addition to the narrowing and internalization of attention, it is theorized that anxiety inhibits an individual's ability to shift attention between stimuli and different styles of attentional foci (Nideffer, 1976). Therefore, an athlete's performance on tasks that require shifting between attentional styles, like a basketball player shifting from shooting a free-throw (narrow-external) to playing defense (broad-external), may suffer due to heightened anxiety. When heightened anxiety impairs athletes' abilities to shift their attention from one stimulus to another or is not optimal for the given task, their ability to execute a well-learned skill may be more likely to suffer.

There are two predominant schools of thought in the research literature describing why performance on athletic skills may suffer under pressure due to attentional disruptions: the distraction model and the self-focus model.

Distraction model. The first model that will be reviewed, the distraction model, is based on the idea that lapses in performance in pressure scenarios come from distraction by external stimuli (Eysenck & Calvo, 1992; Eysenck, Derakshan, Santos, & Calvo, 2007; Mesagno & Beckmann, 2017). In this case, distraction refers to thoughts or stimuli that place a load on an individual's attentional capacity. Distraction-based explanations for performance decrements under pressure have received some support in the literature (e.g., Beilock & Carr, 2005; Eysenck, et al., 2007; Mullen, Hardy, & Tattersall, 2005). Attentional control theory, a theory congruent with distraction-based models of choking, posits that when anxiety is high, attentional processes such as inhibition and shifting are impaired during performance (Eysenck et al., 2007). According to attentional control theory, activities that require high working memory loads and require frequent attentional shifting are theorized to be susceptible to choking under pressure because anxiety is taxing on mental resources. Specifically, Eysenck et al (2007) stated that when anxiety is high, and a threat is perceived, the threat occupies a portion of attentional resources. Thus, decrements in performance may result from a lack of attention to task-relevant information and too much attention to task-irrelevant stimuli. Attentional control theory was supported by research conducted by Beilock and Carr (2005), who investigated the effect of pressure on math performance of 95 undergraduate students. Pressure was increased by offering performance-contingent rewards. The results of the study indicated that participants' performance on problems that demanded more working memory were more affected by pressure than problems that demanded little working memory. Further, participants with high working memory capacities experienced performance decrements on a working memory task under pressure, while those with low working memory did not. These findings indicate that anxiety decreases performance by disrupting working memory and attentional capabilities, providing evidence for the distraction model of choking. The more cognitively demanding a task is (or the more working memory capacity required), the more it appears to be affected by pressure (Beilock & Carr, 2005).

Evidence for the distraction model of choking under pressure on an athletic skill comes from a golf putting study in which the researchers assigned 24 male amateur golfers (ages ranging from 19 to 62) to three groups (Mullen et al., 2005). The golfers were assigned to secondary task-relevant (related to golf putting), task-irrelevant (unrelated to golf putting), or no secondary task groups. Participants' putting scores were analyzed in high- and low-pressure conditions, with a monetary reward offered to induce pressure. The task-relevant secondary task (identifying three self-coaching points) was designed to draw the participants' attention inward, invoking awareness of the step-by-step process of putting. Meanwhile, the task-irrelevant secondary task (counting the number of recorded beeps) was designed to distract the participant from the primary putting task, inducing an outward attentional focus. The participants experienced similar decrements to performance in both the task-relevant (inward attention) and irrelevant (outward attention) secondary task conditions when pressure was applied. The researchers concluded that introducing a second task, regardless of whether the task turns attention inward or outward, distracted participants from the primary putting task, which is consistent with the distraction model of choking. Based on these research findings, it appears that performance on an athletic skill may suffer when the attentional style is too internal or divided between multiple external stimuli. A brief intervention intended to regulate attentional focus could potentially benefit athletes during high-pressure situations.

Self-focus model. A second conceptual model that describes the process of performance decrements in pressure situations is the self-focus model. The self-focus (or self-monitoring) model is based upon evidence that turning attention inward during pressure situations interferes with the execution of previously automated, well-learned skills (Baumeister, 1984; Beilock & Carr, 2001; Masters, 1992). When a learner reaches the autonomous stage in performing a motor skill, the skill can be performed automatically, without conscious attention (Fitts & Posner, 1967). However, when pressure is applied, self-focus models of choking posit that attention is turned inward, which compromises performance on well-learned skills because they were encoded to be performed automatically without conscious attention (Masters, 1992). Multiple studies investigating this model using golf putting have shown that when participants were asked to explicitly monitor their putting technique while under pressure, a performance breakdown occurred (Beilock & Carr, 2001; Masters, 1992; Lewis & Linder, 1997).

Masters (1992) refers to the self-focus process of exhibiting manual control over previously automated processes as *reinvestment*; an athlete who consciously exhibits control over an automatic process is reinvesting mental resources into the skill, which disrupts performance. In a putting experiment, Masters (1992) found that having 40 novice participants (ages 18 to 46), learn to putt while simultaneously performing a secondary task buffered against choking under a later high-pressure condition. Because the participants had initially learned to putt without consciously monitoring themselves (implicit learning), they were less likely to monitor themselves when asked to putt under pressure (Masters, 1992). A second group who learned to putt by reading a step-by step manual (explicit learning) experienced a degradation in putting performance under pressure. These results provide evidence for the self-focus model because performance decrements only occurred when attention was drawn inward to the procedural components of the putting task. Likewise, the results also suggest that less attention on the step-by-step procedure of executing a skill is conducive to successful performance. The fixation of attention on the procedures of performing a motor task appear to serve as an internal source of distraction from task-relevant attention.

While attending to the explicit procedures of a well-learned skill can induce self-focus and disrupt performance, increasing self-consciousness by videotaping participants may produce a similar effect (Lewis & Linder, 1997). Lewis and Linder (1997) built upon the research by Masters (1992), by investigating 129 introductory psychology students' putting performance under pressure. All participants completed a series of putts in a low pressure (practice) condition and a high-pressure condition, which was induced by performance-contingent incentives. Distraction was induced to half of participants by a dual-task, in which participants counted backwards from 100 by 2. A self-awareness adaptation was created by having half of the participants go through the low-pressure phase while being videotaped, thus creating four conditions (dual-task only, self-awareness only, dual-task and self-awareness, and no treatment). Results of this experiment indicated that during the low-pressure phase, the highest performing group was the group with no dual-task or videotaping (no treatment). However, during the high-pressure trials, participants who were not exposed to the self-awareness adaptation (video recording) in the low-pressure phase performed significantly worse than those who were exposed to the self-awareness adaptation treatment in the low-pressure phase. These findings suggest that prior exposure to self-focus can ameliorate the effects of pressure during actual pressure situations and suggest that self-focus contributes to performance decrements under pressure.

Beilock and Carr (2001) conducted an additional golf putting study to investigate which types of skills are susceptible to performance decrements under pressure and whether practicing under conditions of self-focus can prevent decreases in performance in future pressure situations. In two separate experiments, using samples of 108 and 32 undergraduate students with no golf experience, they found that pressure-induced (via video recording) performance decrements occurred on a golf-putting task but not on an arithmetic task, suggesting that physical tasks involving multiple steps may be more vulnerable to performance decrements under pressure. Further, the researchers found that participants who practiced putting while being filmed (i.e., self-consciousness training) became accustomed to performing at higher levels of anxiety and were inoculated to the later pressure manipulation. Consequently, those who practiced with self-presentational pressure did not experience performance declines under pressure, while the performance of those who were not exposed to increased levels of self-awareness was significantly worse when they were exposed to pressure. Based on these findings by Lewis and Linder (1997) and Beilock and Carr (2001), it appears that acclimating individuals to pressure situations by practicing with heightened levels of self-focus can prevent a deficit in performance under pressure, and that self-focus can be viewed as both a contributor to performance decrements and an intervention.

While the distraction and self-focus models of attentional breakdown both explain certain instances of pressure-induced performance decline, the self-focus model appears to be more relevant to experienced athletes because the skills that they are required to execute are often well-learned and frequently practiced (Beilock & Carr, 2001; Liao & Masters, 2002; DeCaro, Thomas, Albert, & Beilock, 2011). This claim is supported by an examination of the effects of performance-contingent pressure (e.g., monetary incentives) versus self-presentational pressure, which revealed that performance-contingent pressure was more detrimental to cognitive performance on tasks requiring high working memory capacity, such as solving a math problem in one’s head, while self-presentational pressure was more detrimental to physically oriented tasks (DeCaro et al., 2011).

Additional evidence for the self-focus model of attentional disruption on athletic skills emerged from a two-part study (Liao & Masters, 2002). Liao and Masters (2002) found that increased levels of anxiety for college hockey players coincided with higher levels of self-consciousness, self-focused attention, and anxiety (cognitive and somatic), and that levels of all three increased leading up to an important competition. In part two of the study, the researchers found that for novice basketball players, consciously attending to the mechanics of shooting a basketball led to a decrease in performance under pressure (which was induced by monetary incentives and video recording). The results of this study indicate that anxiety and self-focus lead to the deterioration of automatized skills, and that self-presentation is a likely contributor to the anxiety-related performance decrements in sport, as many sports involve audience presence.

Integrated model of anxiety and performance. Nieuwenhuys and Oudejans (2012) proposed a model to explain the anxiety-performance relationship by integrating both distraction and self-focus models. According to this integrated model, anxiety affects the perception of stimuli, selection of subsequent action possibilities, and execution of a movement; also, the quality of performance is contingent upon the performer's attentiveness to task-relevant information. When anxious, an individual becomes more likely to attend to (task-irrelevant) threat-related stimuli (Nieuwenhuys & Oudejans, 2012). Nieuwenhuys and Oudejans (2012) claim that performance is affected by inefficiency in attention and physical movement due to anxiety, and that the inability to attend to task-relevant stimuli is related to subpar performance. The authors also suggest that the self-focus and distraction models of anxiety and performance may not be mutually exclusive. Although the authors asserted that the distraction model is more accurate in explaining anxiety-induced performance decrements, they also claim that self-focus may be a form of distraction, especially on well-learned skills. Therefore, Nieuwenhuys and Oudejans (2012) concluded that an individual will perform increasingly less effectively as he or she is less attentive to the task, whether the distraction is an internal or external stimulus.

An example of the interrelatedness of performance and attention that provided support for this integrated model (Nieuwenhuys & Oudejans, 2012) comes from the findings of a study on the gaze behavior of 10 male (M_{age} of 20.3) university basketball players (Wilson, Vine, & Wood, 2009). The participants shot free-throws in low- and high-pressure conditions while wearing an eye-tracking device. The researchers found that earlier and longer visual fixations (i.e., prolonged task-relevant attention) on the target were associated with successful shots, and that the duration of fixations was reduced by 34% during the high-pressure condition, thus decreasing task-relevant attention. These findings indicate that task-relevant (visual) attention is related to higher levels of performance on free-throw shooting, and that higher levels of anxiety are disruptive to task-relevant attention. In sum, according to the integrated model of anxiety and performance, anxiety decreases performance by decreasing task-relevant attention (Nieuwenhuys & Oudejans, 2012).

Interventions to Improve Performance Under Pressure

Interventions designed to prevent performance decrements while under pressure have largely been derived from research on the self-focus and distraction models of performance decrements under pressure (Mesagno & Beckmann, 2017). Interventions for self-focus-related performance lapses are designed to move attention from the internal processes to a more external focus, while interventions for distraction-based performance lapses have sought to bring attention from external distractions back to the task at hand. The following section includes a review of commonly tested interventions, including: dual-task interventions, pre-performance routines (PPR), and acclimatization training.

Dual-task approach to attention on motor skills. One empirically supported technique for reducing self-focus has been the use of a dual-task approach to occupy participants' attention in order to leave automatic skills unobstructed. For example, Mesagno, Marchant, and Morris (2009) tested a dual-task intervention on five choking-susceptible (four females, one male) experienced basketball players by having participants recite song lyrics while shooting free-throws in a lab setting. Choking-susceptible players were selected out of the initial 41 participants if they were in the 75th percentile or higher on two of three measures of choking susceptibility which were the: Self-Consciousness Scale (SCS; Fenigstein, Scheier, & Buss, 1975), Sport Anxiety Scale (SAS; Smith, Smoll, & Schutz, 1990), and Coping Style Inventory for Athletes (CSIA; Anshel & Kaissidis, 1997). Participants shot free-throws under four conditions (low-pressure single-task, low-pressure dual-task, high-pressure single-task, high-pressure-dual task) in a blocked, single case design. When pressure was applied via videotaping, audience presence, and a financial incentive, participants improved their number of made free-throw attempts from the low- to high-pressure conditions by performing a dual-task during the high-pressure condition. The findings of this study imply that shifting attention away from the previously automated mechanics of free-throw shooting using a dual-task may be a useful intervention for choking-susceptible athletes. This intervention may be especially effective for those who are highly self-conscious because it may foster externally focused attention, as Wilson et al (2009) found a positive relationship between external visual fixations and performance.

When comparing the outcomes for performance using a dual-task, it appears that the effects are different for experts and novices (Beilock, Carr, MacMahon, & Starkes, 2002). In a two-part study, Beilock et al (2002) found that putting with a dual-task resulted in significantly better putting performance than explicitly monitoring each putt in a sample of 21 experienced golfers (7 men, 14, women, M_{age} of 19.86). In the second part of the study, a group of experienced adult soccer players (8 women, 2 men) and novice soccer players (8 women, 2 men) completed a dribbling task on their dominant and non-dominant foot, while completing a dual-task on one trial and explicitly monitoring their dribbling on a second trial (M_{age} of 20.20). When dribbling with their dominant foot, experienced participants dribbled significantly faster while performing a dual-task. However, when dribbling with their non-dominant foot, the experienced soccer players dribbled significantly faster while consciously monitoring their foot. The novice participants were faster on both feet while explicitly monitoring their movements. The results of this experiment suggest that dual-tasks may prevent athletes from self-focus-induced skill performance decrements due to pressure on well-learned, automated skills (Beilock et al., 2002).

However, on less familiar skills, consciously paying attention to a skill may be necessary to improve performance (Beilock et al., 2002). Therefore, an ideal intervention for improving performance under pressure may be one that reduces attention on the details of a physical movement for automated skills, while increasing attention to the details of a physical movement may be more beneficial for performing new skills.

Pre-performance routine (PPR). A second type of intervention for managing performance under pressure is a PPR, or an intentional series of thoughts and actions that are performed to prepare to perform a skill (Mesagno & Beckmann, 2017). An example of a PPR is a volleyball player bouncing the ball three times and taking a deep breath before executing her serve. Mesagno and Beckmann (2017) examined the effects of a self-determined PPR that included "modification of optimal arousal levels, behavioral steps, attention control (e.g., focusing on a target), and cue words" (p. 444) on three choking-susceptible bowlers' (utilizing the same choking susceptibility criteria used by Mesagno et al., 2009) performance. Performance was measured by absolute error from the center of the lane. The results of the experiment, along with open-ended interviews, suggested that implementation of a PPR improved performance under pressure, reduced self-focus, and improved task-relevant attention (Mesagno, Marchant, & Morris, 2008). Therefore, a PPR may be an effective technique for reducing performance decrements under pressure. Another experiment was designed to investigate the effects of various types of PPRs on performance under pressure, in 60 experienced male Australian soccer players (Mesagno & Mullane-Grant, 2010). Results of the study indicated that all PPRs improved free-kick task performance under pressure (audience present and financial incentive), but an extensive PPR, involving arousal regulation strategies, attention control strategies, behavioral components, and a cue word, was the most effective type. Use of a PPR may be an effective method of reducing conscious control over automatic processes, especially when psychological and behavioral components are included in the PPR (Mesagno & Mullane-Grant, 2010). Utilizing a PPR with multiple mechanisms for increasing task-relevant focus and achieving optimal arousal appears to be effective in improving performance under pressure if it includes components that prompt optimal arousal levels and attentional stimuli.

Acclimatization training. A third research-based intervention for choking is acclimatization or self-consciousness training, which is the practice of exposing athletes to high-pressure situations in practice prior to the actual high-pressure performance situation (Mesagno & Beckmann, 2017). Several studies have reported that by practicing under pressure or simulating in-game self-consciousness, performance under pressure can be improved (Oudejans & Pijpers, 2009; Oudejans & Pijpers, 2010; Reeves, Tenenbaum, & Lidor, 2007). Acclimatization training can be conducted by either creating a high-pressure practice environment to simulate in-game anxiety levels, or by practicing explicitly monitoring skill execution to prepare for self-monitoring during high pressure situations; both methods have been shown to enhance performance under pressure (Mesagno & Beckmann, 2017; Reeves et al., 2007).

Examples of training under anxiety include a series of experiments investigating the performance of novice and expert dart players and expert basketball free-throw shooters, which indicated positive outcomes for performance after practicing under higher levels of anxiety (Oudejans & Pijpers, 2009). In one experiment, 17 male Dutch expert-level basketball players were divided into pressure training and control conditions. At posttest, a) the pressure training group exhibited a higher free-throw percentage under later situations of high pressure compared to the control group, b) the pressure training group significantly improved their free-throw percentage from pretest to a high-pressure phase, and c) the control group performed worse under high pressure situations than low pressure at both pre and post measures. These findings indicate that practicing a skill under mild levels of anxiety can improve future performance on that same skill during pressure situations. In a follow-up study, Oudejans and Pijpers (2010) utilized the same experimental design with 17 male expert dart throwers. Participants were divided into high- and low-pressure training groups and threw darts from a rock-climbing wall. High pressure tests were administered at seven meters off the ground, while low pressure tests took place at 0.32 meters off the ground. The participants who trained with higher levels of pressure maintained similar dart throwing scores between high- and low-pressure conditions at posttest, despite higher levels of anxiety during the high-pressure condition. These results suggest that while practice under pressure did not decrease anxiety levels, participants became acclimated to performing under high levels of pressure (Oudejans & Pijpers, 2010). Similar findings were also found using the same procedure with 24 (16 men, 8 women) Dutch novice dart throwers (Oudejans & Pijpers, 2010). Taken together, these studies provide evidence that by simulating pressure situations in practice, subsequent performance under pressure may be improved.

In addition to preparing for future pressure situations, acclimatization training can include practice for future instances of self-focus. Division I women's soccer players and 19 female high school students with less than three years of soccer experience, matched for competitive level across three different conditions (single task, dual-task, and self-consciousness) and two levels (penalty kicks and breakaways), participated in a self-focus-induced acclimatization experiment (Reeves et al., 2007). The single task condition essentially served as a control group. The participants in the dual-task condition were required to perform the penalty kick and breakaway tasks with simulated crowd noise and the self-consciousness group was instructed to closely monitor which part of their feet they used to kick. All participants experienced low- and high-pressure conditions (induced by performance-contingent incentives and evaluation) while they completed both simple (penalty kicks) and complex (breakaway shooting) tasks. Performance decrements under pressure only occurred on the simple task of penalty kicks, and not on the complex task of breakaway scoring. When pressure was introduced, the players who had practiced self-monitoring their feet (regardless of their skill level) improved their performance on penalty kicks, while the rest of the participants experienced decrements. These findings suggest two things, according to Reeves and colleagues (2007). First, pressure may have more of an effect on closed skills than open skills. Second, by practicing with hyperawareness of the self, consistent with the self-focus model of performance decline under pressure, an individual may acclimate to high-pressure situations in which self-consciousness tends to be higher (Baumeister, 1984; Liao & Masters, 2002). Since closed skills appear to be more affected by pressure, interventions should be tailored to closed skills.

Summary of performance under pressure interventions. Taken together, interventions for handling pressure performance are effective at improving performance or preventing decrements due to pressure by some combination of increasing task-relevant attention, decreasing self-focused attention, or regulating arousal. Dual-task interventions move attention outward to external cues, reducing self-focused attention (Mesagno et al., 2009; Mesagno & Mullane-Grant, 2010). Effective pre-performance routines address performance under pressure by facilitating task-relevant focus, thus reducing self-focus, and regulating arousal (Mesagno et al., 2008). Acclimatization interventions appear to be effective by aiding arousal regulation through exposure to anxiety (Oudejans & Pijpers, 2009; Oudejans & Pijpers, 2010).

However, there are opportunities to expand upon the current research on interventions designed to improve performance under pressure. One such opportunity is that research efforts have been focused on interventions that require repeated practice and training. For example, acclimatization and self-consciousness interventions take time and practice over several sessions for athletes to adapt and familiarize themselves with pressure. Yet, pressure situations are not always predictable, and acclimatization requires gradual exposure to anxiety, as demonstrated in the previously discussed research on soccer players, basketball players, and dart throwers (Reeves et al., 2007; Oudejans & Pijpers, 2009; Oudejans & Pijpers, 2010). Similarly, PPRs take time and repetition before they become true routines and should include attentional and arousal regulation prompts to increase their effectiveness (Mesagno & Mullane-Grant, 2010). Dual-task interventions have also been criticized for their lack of ecological validity, as they reduce task-relevant focus (Mesagno & Beckmann, 2017). In real-life pressure situations, distracting oneself intentionally may be counterproductive, as it promotes task irrelevant attention. Based on the reviewed research on interventions designed to improve performance on athletic skills under pressure, it appears that they are most effective when they promote task-relevant attention, assist with arousal regulation, decrease self-focus (for automated skills), and direct attention to external cues.

Mindfulness Terminology

Another technique that can promote task-relevant attention and decrease anxiety is mindfulness meditation (Gardner & Moore, 2004). *Mindfulness* has been defined as “intentional self-regulation of attention from moment to moment” (Kabat-Zinn, 1982, p. 34). Bishop et al (2004) expanded upon this definition, by operationally defining mindfulness as the “self-regulation of attention so that it is maintained on immediate experience, thereby allowing for increased recognition of mental events in the present moment" (p. 232). Additionally, mindfulness involves experiencing the present moment with curiosity, openness, and acceptance simultaneously (Bishop et al., 2004). Mindfulness is conceptualized as a state of being. Mindfulness can be divided into *state* and *trait* mindfulness. State mindfulness is a temporary state of present moment awareness of thoughts, emotions, and sensations, that can be induced with practice (Kiken, Garland, Bluth, Palsson, & Gaylord, 2015). Trait mindfulness has been defined as an individual's natural tendency to be attentive to the present moment in everyday life across various situations and contexts (Kiken et al., 2015). Trait (or dispositional) mindfulness has been found to be related to having clear goals, higher levels of concentration, greater sense of control, and lower self-consciousness (Gooding & Gardner, 2009). Mindfulness has also been found to be a predictor of an individual's dispositional ability to achieve flow states according to a meta-analysis (Kee & Wang, 2008). Also, a correlational study by Moore (2013) using a sample of 105 undergraduate students (64 females, 41 males, M_{age} of 20.0), found a strong relationship between trait mindfulness and an individual's propensity to achieve flow states.

As suggested by Kabat-Zinn's (1982) definition of mindfulness, the ability to intentionally regulate attention is an important component of mindfulness. Regulation of attention involves the abilities to *shift* between stimuli and *inhibit* certain attentional inputs. Attentional shifting refers to shifting attention from one attentional stimulus to another (Miyake et al., 2000). Inhibition refers to one's ability to intentionally refrain from attending to certain stimuli (Miyake et al., 2000). Eysenck and colleagues (2007) added to the definition of inhibition by including using conscious attentional control to resist the urge to attend to disruptive or irrelevant stimuli or responses. During a pressure situation in sport, athletes may be required to inhibit thoughts about the outcome of the game or the loud cheering from the crowd and focus on the relevant components of performance, and mindfulness training may help regulate their attention.

Empirical Studies on Mindfulness Training

Performance decrements in sport seem to occur due to diversion of focus away from the task at hand to either internal or external cues, consistent with the integrative model of anxiety and performance proposed by Nieuwenhuys and Oudejans (2012). Gardner and Moore (2004) propose that athletes who attend to task-relevant cues in the present moment, rather than self-focused attention, will achieve greater levels of performance. Gardner and Moore (2004) suggest that mindfulness practice may improve sport performance by enhancing present moment awareness. Due to the evidence supporting mindfulness as a mechanism fostering task-relevant attention (Bishop et al., 2004), mindfulness interventions make theoretical sense as a means of improving performance under pressure.

Mindfulness training is naturally designed to induce mindful states and may induce task-relevant attention immediately after a single training (Bishop et al., 2004). Mindfulness is often intentionally practiced in a quiet and relaxed setting, in which individuals commonly sit with their eyes closed, and attend to their breath (Bishop et al., 2004). Furthermore, mindfulness practice has been found to increase frequency and intensity of flow experiences. For example, Aherne, Moran, and Lonsdale (2011) utilized the “Guided Meditation Practices” CD by Jon Kabat-Zinn (2005) during a six-week randomized study, in which they measured the effects of regular mindfulness practice on the frequency of flow state. The participants were Irish collegiate athletes (9 male, 4 female, M_{age} of 21) from various sports, and were divided into experimental (mindfulness) and control (no treatment) groups. After six weeks of guided mindfulness meditation, the experimental group reported significantly higher flow scores. Based on the consistent link between mindfulness and flow states, mindfulness appears to be conducive to instances of superior performance through flow state. Therefore, mindfulness interventions may be a means of addressing the first discussed limitation of interventions for performance under pressure, which is that current interventions (i.e., PPR and acclimatization) require another individual train them on a skill to foster task-relevant focus under pressure, whereas mindfulness can be trained alone without a coach or instructor present.

Research on trait mindfulness in sport settings. It appears that trait mindfulness may be developed through the repeated practice of mindfulness (Baltzell & Akhtar, 2014). To investigate the relationship of regular mindfulness practice on trait mindfulness, researchers delivered an eight-week Mindfulness-Based Stress Reduction (MBSR) intervention to 235 participants from a community-based mindfulness program once per week (Kiken et al., 2015). Throughout the eight-week intervention, the researchers assessed participants' level of state mindfulness after each session with the Toronto Mindfulness Scale (TMS; Lau et al., 2006) to track changes in trait mindfulness at baseline and posttest, in addition to using the Five Facet Mindfulness Questionnaire (FFMQ; Baer, Smith, Hopkins, Krietemeyer, & Toney, 2006) at pretest and posttest. After the intervention, increases in trait mindfulness were observed for participants, but at highly variable rates. The researchers of this study concluded that repeated practice of mindfulness meditation can increase one's disposition to be mindful in everyday life (Kiken, et al., 2015). Further, a study utilizing the Mindfulness Meditation Training for Sport (MMTS) protocol on 42 intercollegiate female athletes found increases in trait mindfulness after 12, 30-minute sessions over six weeks (Baltzell & Akhtar, 2014). The intervention group displayed significant increases in dispositional mindfulness via the Mindful Attention Awareness

Scale (MAAS; Brown & Ryan, 2003) from pre to post intervention. Thus, it appears that by regular consistent mindfulness practice, individuals can increase their dispositional mindfulness.

Trait mindfulness has been found to be related to academic performance. Bellinger, DeCaro, and Ralston (2015) examined the effects of dispositional mindfulness on math performance in an ecologically valid setting. Participants were 248 (188 males, 60 females) first year undergraduate engineering students enrolled in a calculus course. Researchers monitored students' performance on homework, quizzes, and tests in addition to cognitive test anxiety (CTAS; Cassady & Johnson, 2002) and dispositional mindfulness (measured via the MAAS). Dispositional mindfulness was indirectly related performance on high-stakes assignments (i.e., quizzes and exams). The relationship between mindfulness and performance was mediated by cognitive test anxiety. Low pressure assignments (i.e., homework) were not related to mindfulness scores. The researchers concluded that mindfulness impacts cognitive performance under pressure by lowering anxiety, which in turn preserves attentional resources and allows for more working memory resources to be devoted to the task (Bellinger et al., 2015). This conclusion is in line with attentional control theory (Eysenck et al., 2007) and the integrated model of anxiety and performance (Nieuwenhuys & Oudejans, 2012).

One correlational study was conducted to investigate the relationship between trait mindfulness and performance in a sport setting. Gooding and Gardner (2009) found that dispositional levels of mindfulness (trait mindfulness) and year in school (competitive experience) of 17 Division I Men's basketball players were positively related to in-game free-throw percentage. Competitive experience may be related to free-throw percentage because more experienced players have had more repetition of shooting in high pressure situations, which would be in line with the support for acclimatization interventions for high pressure performance. Trait mindful basketball players may have higher free-throw percentages due to the previously discussed benefits of mindfulness for performance (i.e., task-focus, arousal regulation, flow). In sum, trait mindfulness can be cultivated with repeated training and trait mindfulness may predict basketball free-throw shooting percentage; therefore, increasing one's trait mindfulness may also improve free-throw shooting performance.

Effects on sport performance. Several studies have investigated the effects of multiple mindfulness trainings over the course of several weeks on sport performance. Results here indicated that four to eight-week mindfulness interventions are effective for improving performance when using standardized protocols. These protocols include Mindfulness Acceptance Commitment (Gardner & Moore, 2004), Mindfulness Sport Performance Enhancement (Kaufman, Glass, & Arnkoff, 2009), Mindfulness-based Stress Reduction (Kabat-Zinn, 2003), Mindfulness-based Cognitive Therapy (Segal, Williams, & Teesdale, 2002), and Acceptance Commitment Therapy (Hayes, Strosahl, & Wilson, 1999). These structured or semi-structured protocols typically involve meeting once or twice per week with an instructor for 30 minutes to an hour to practice mindfulness. Additionally, most of the protocols involve daily mindfulness homework between weekly or biweekly meetings. A number of studies have employed these mindfulness protocols, along with various customized mindfulness protocols, to examine their outcomes for sport performance in addition to changes in trait mindfulness. Each of these protocols will be examined in greater detail below.

Mindful acceptance commitment (MAC) approach. A handful of studies have utilized the MAC protocol to determine if it improves sport performance (e.g., Hasker, 2010; Schwanhausser, 2009; Zhang, Duan, Lyu, Keatley, & Chan, 2016). The MAC approach to mindfulness involves training the awareness of thoughts, feelings, and emotions, the acceptance of those states, and the commitment to goal-oriented action (Gardner & Moore, 2004). One case study involved a male adolescent springboard diver using an adapted version of the MAC approach to make the training age-appropriate (Schwanhausser, 2009). The training involved nine weekly sessions for about 45 minutes per session. Results indicated that, compared to pre-test scores, the diver increased his mindful attention, mindful awareness, experiential acceptance, frequency of achieving flow, and diving competition performance. Zhang and colleagues (2016) also found evidence for the effectiveness of the MAC approach as a method for enhancing performance. Their participants were 43 novice dart throwers who were first year university students from Hong Kong (M_{age} of 19.23). After an eight-week MAC intervention (one 80-90-minute session per week), the novice dart throwers had increases in trait mindfulness, experiential acceptance, flow, and dart throwing performance at posttest and at a two-week follow-up. In addition, Hasker (2010) utilized a seven-week MAC intervention to examine its effects on the performance of 19 Division II athletes (11 male, 8 female, M_{age} of 19.4) across various sports. In a non-randomized trial, the participants in the experimental condition practiced mindfulness for approximately one hour per week, while the comparison group practiced traditional mental skills. Performance was measured by subjective coach ratings of sport performance. No differences were observed between the two groups on coach ratings of performance, however the mindfulness group showed increases in experiential acceptance and non-reactivity, as measured by the Five-Facet Mindfulness Questionnaire (FFMQ; Baer et al., 2006) and Acceptance and Action Questionnaire (AAQ; Hayes et al., 2004). Overall, two of the three studies provide some evidence for the MAC approach as an effective mindfulness technique for improving performance (Schwanhausser, 2009; Zhang et al., 2016), while the other did not provide such evidence (Hasker, 2010).

Mindful cognitive therapy. An intervention containing elements of Mindfulness-Based Cognitive Therapy and Acceptance Commitment Therapy was added to a pre-existing psychological skills training regimen for seven elite young golfers (5 men, 2 women, M_{age} of 15.67) who had 4-10 years of golfing experience (Bernier, Thienot, Codron & Fournier, 2009). The intervention involved teaching various components of Mindfulness-Based Cognitive Therapy and Acceptance Commitment Therapy over four sessions during the offseason and incorporating various skills into the golfers' training during the competitive season. Participants also listened to an audiotape on their own twice per week. From pre to post intervention, all seven golfers improved their national ranking and reported subjective increases in attentional awareness, development of a non-judgmental, task-relevant focus, and behavioral flexibility. Another study involving floorball players by Kettunen and Valimaki (2014) compared the effects of a six-week ACT protocol on the performance of 24 female (M_{age} of 21.8) Finnish national league floorball players to 23 players on a control team, who received no intervention, in a non-randomized trial. Performance was measured using qualitative, subjective self-ratings and coach ratings. While the ACT experimental group showed no differences in self or coach ratings of performance, a positive relationship was found between self-rated performance and both mindfulness skills and self-confidence for the ACT experimental group. These findings suggest that a combined MBCT and ACT intervention may potentially contribute to higher levels of focus and performance. However, more research is needed with larger sample sizes, additional sport backgrounds and skills levels, and objective dependent variables on ACT and MBCT protocols to determine efficacy.

Mindfulness sport performance enhancement (MSPE). The four-week MSPE protocol developed by Kaufman and colleagues (2009), is an extension of Mindfulness-Based Stress

Reduction and Mindfulness-Based Cognitive Therapy which is condensed and designed specifically for athletes. Kaufman et al (2009) assessed the effects of MSPE training on flow states, sport performance, and psychological characteristics of 32 recreational archers and golfers (23 male, 9 female, M_{age} of 52.19) in a non-randomized study with no control group. The study lasted four weeks and involved weekly sessions lasting two and a half to three hours, along with daily mindfulness homework. The results of the study showed no significant changes in performance from pre to post-intervention, however the non-significant findings may be explained by unforeseen circumstances for the archers and lack of adherence by the golfers (Kaufman et al., 2009). While no significant changes in performance were observed, increases in dispositional mindfulness were found and increases in state flow were also positively associated with increases in mindfulness.

The same MSPE protocol was administered to 25 recreational long-distance runners (15 males, 10 females, M_{age} of 34.73) to investigate the effects of the four-week mindfulness training on running performance and psychological characteristics (De Petrillo, Kaufman, Glass, Arnkoff, 2009). Compared to a waitlist control group of 12 runners, those who received the MSPE training showed significant decreases in sport-related state anxiety, perfectionism, and significant increases in state mindfulness. Again, no significant changes in sport performance (running times) were observed during the four-week span of the intervention. One year later, Thompson, Kaufman, De Petrillo, Glass, and Arnkoff (2011) conducted a follow-up study from a sample of the distance runners, archers, and golfers from Kaufman et al (2009) and De Petrillo et al (2009). One year after the athletes had received the four-week MSPE training, significant increases were observed in ability to act with awareness, overall trait mindfulness, and running performance for the long-distance runners compared to pretest scores. These findings suggest that MSPE may produce long-term changes in mindfulness and sport performance.

While the aforementioned studies provided some evidence that MSPE may be an effective protocol for improving sport performance, Hussey (2015) found that MSPE may be an effective protocol for specifically reducing choking under pressure. Hussey (2015) tested the effects of a six-week MSPE protocol on two choking-susceptible Division I collegiate athletes. After the intervention, both athletes had reduced trait anxiety, had fewer maladaptive coping tendencies, and were less self-consciousness, which led them to no longer meet the pre-test selection criteria for choking susceptibility. In addition to the current literature largely suggesting that mindfulness is an effective performance enhancing technique, findings by Hussey (2015) indicate that mindfulness may be an effective intervention for increasing performance under pressure. However, an experimental study is needed to test whether or not mindfulness training can actually prevent performance decrements under pressure.

General mindfulness protocols. Some research on the effects of mindfulness on sport performance has been conducted utilizing non-standardized protocols. For example, John, Verma, and Khanna (2011) investigated the effects of a novel, custom mindfulness protocol on performance, by measuring pre-competition stress and performance before and after a mindfulness intervention. Of 96 male elite shooters, 48 randomly assigned participants underwent four weeks of 20-minute mindfulness meditation six-days per week, including body scans, focused breathing exercises, and yoga poses. The other 48 served as the control group. Stress levels were measured using salivary cortisol prior to competitions before and after the intervention. Posttest results indicated decreased pre-competition stress and an increase in competition shooting performance for the intervention group. Another study utilizing a different custom protocol, ACEM meditation, a type of meditation emphasizing stress-reduction and relaxation commonly used in Scandinavia, was employed in a non-randomized study of 25 (21 males, 4 females, median age of 25) elite Norwegian shooters (Solberg, Berglund, Engen, Ekberg, & Loeb, 1996). The shooters were divided into a control group (no treatment) and a meditation group that participated in a seven-week ACEM training, once per week. Participants were instructed to practice 30 minutes per day at home. The participants' shooting performance and physical tension levels (via a visual analogue scale) were monitored from the previous season to the season post-intervention. While no differences between the meditation and control groups were found immediately before and after the intervention, the meditation group showed significantly greater improvements in shooting performance from the previous season to the season following the intervention. On top of the differences in performance between groups, tension explained 18% of the variance in performance for all shooters. The authors speculated that the ACEM meditation may have been effective in improving shooting performance by reducing physical tension. Together, findings from Solberg et al (1996) and John et al (2001) findings that meditation can have a relaxing effect and can improve performance, possibly through the release of tension.

Some mindfulness protocols in past studies have simply been administered via an audio recording. One group of researchers investigated the effect of an eight-week mindfulness protocol administered via audio recording on the performance of six (2 men, 4 women, M_{age} of 20.0) national level swimmers from the United Kingdom (Mardon, Richards, & Martindale, 2016), who listened to pre-recorded mindfulness tapes once per week for 10 to 30 minutes per session. Performance times were measured, along with trait mindfulness, using the Cognitive and Affective Mindfulness Scale—Revised (CAMS-R; Feldman, Hayes, Kumar, Greerson, &

Laurenceau, 2007) and attentional efficiency using the Test of Everyday Attention (TEA; Robertson, Ward, Ridgeway, & Nimmo-Smith, 1996). At posttest, three of the six swimmers showed significant improvements in mindfulness, four showed significant improvements in attentional efficiency, and four participants recorded their season's best performance times. Five of the six swimmers improved self-rated performance. Based on these findings, it appears that even an intervention using pre-recorded, guided mindfulness may be sufficient to increase scores on mindfulness and sport performance for some athletes. Therefore, use of a pre-recorded guided mindfulness meditation, which is generally more accessible and cost-effective, may produce equitable outcomes to a course with a mindfulness instructor.

Summary of repeated mindfulness training. Collectively, research on mindfulness training in sport settings indicates efficacy for improving athletes' dispositional mindfulness (Buhlmayer, Birrer, Röthlin, Faude, & Donath, 2017; Birrer, Röthlin, & Morgan, 2012; Kiken et al., 2015; Baltzell & Akhtar, 2014). Second, the positive relationship between mindfulness and other desirable psychological variables has been documented; these variables include flow states (Kee & Wang, 2008; Moore, 2013; Aherne et al., 2011; Zhang et al., 2016), task-focused attention (Thompson et al., 2011; Mardon et al., 2016; Bernier et al., 2009; Schwanhausser, 2009), and arousal regulation (De Petrillo et al., 2009; John et al., 2011; Solberg et al.,1996).

While the number of studies that measure the direct effects of mindfulness on sport performance has recently increased, more scientifically rigorous research could enhance knowledge on this topic (Sappington & Longshore, 2017). Buhlmayer et al (2017) reported in a meta-analysis that mindfulness interventions have yielded strong effect sizes in precision sports, such as dart throwing and shooting, however high-quality randomized control trials are still needed in the literature. Sappington and Longshore (2017) echoed these concerns about the scientific rigor of the research examining the effects of mindfulness on performance. A primary concern regarding the aforementioned mindfulness interventions is the lack of randomization to the experimental and control groups. Without randomization, the findings of a study are limited by pre-existing group differences, which cannot be known. Studies that randomize participants to experimental and control groups are needed to reduce extraneous interference with the results (Sappington & Longshore, 2017). A second critique of the previously reviewed mindfulness training protocols is that most samples are small e.g., (Bernier et al., 2009; Hussey, 2015; Schwanhausser, 2009) and heterogeneous (e.g., De Petrillo et al., 2009; Hasker, 2010; Kaufman et al., 2009) including athletes from multiples sports with wide age ranges, reducing generalizability of the results. A third limitation of the extant literature on mindfulness and performance is the lack of objective measures of performance. Some studies used self-report or coach ratings of performance (e.g., Hasker, 2010; Kettunen & Valimaki, 2014), which leave performance up for interpretation. Only John et al (2011) and Solberg et al (1996) included objective measures of performance on a study investigating the effects of mindfulness on athletic performance. Future studies should include similar objective dependent variables. A final critique of these interventions is the limited real-world applicability of these protocols, given that they require consistent commitment over four to eight-week periods and coaches may not allocate such time to mental preparation. However, it remains to be determined whether an extensive protocol is required for improving performance, or if brief training is sufficient.

Brief Mindfulness Training and Performance

While many of the studies discussed above have involved implementation of a four to eight-week mindfulness training to increase trait mindfulness and performance, athletes faced with a pressure situation, may be more reliant upon their acute mental states regardless of what their dispositional characteristics may be. For example, a basketball player who must make two free-throws to win a championship game, may have high trait cognitive anxiety, and low trait mindfulness. However, the player may still make both free-throws depending on their state cognitive anxiety, state mindfulness, and how he has been performing during the game. An athlete's dispositional tendencies are helpful for understanding long-term performance, but the athlete's state immediately preceding a single, isolated performance can be influenced regardless of the athlete's dispositions (Bishop et al., 2004). Therefore, it is important to learn whether a brief mindfulness intervention can bring about a more ideal performance on the execution of an athletic skill.

It appears that brief training in mindfulness, from five to 30 minutes, may improve athletic performance amongst novice athletes in a lab setting. For example, In the physical domain, only one known study has been conducted a on the effect of a brief mindfulness intervention on sport performance. Perry, Ross, Weinstock, and Weaver (2017) divided sixty-five undergraduates (33 males, 32 females, M_{age} of 18.73) from a Midwestern university into an experimental (30-minute mindfulness session) or control group (read magazines for 30 minutes). The study measured the effects of a single 30-minute mindfulness session on objective golf putting performance, state anxiety, and flow. The mindfulness intervention was adapted from the first two sessions of the MAC protocol (Gardner & Moore, 2007). The group that received the 30-minute mindfulness intervention scored significantly higher on putting performance, flow experience, and scored significantly lower on state anxiety on the second trial compared to the control group. These findings suggest that a brief 30-minute mindfulness session can effectively improve performance and other psychological characteristics. A brief, 30-minute mindfulness training may increase athletic performance and decrease state anxiety, but it remains to be studied whether this effect persists in other closed-skills in different athletic domains, on automated skills, and under pressure. Masters (1992) found evidence that pressure can disrupt performance on automated skills.

Although the effect of brief mindfulness training on sport performance under pressure is yet to be tested, studies have shown some positive effects of brief mindfulness training on cognitive performance, despite adverse circumstances. One hundred-fifty-six psychology students (114 female, 42 male, M_{age} of 19.14) from a Canadian university were randomly assigned to an experimental group, in which they completed a 30-minute mindfulness workshop, or a waitlist control group (Imtiaz, Ji, & Vaughan-Johnston, 2018). The participants all completed an anagram task in which they were asked to solve three sets of anagram puzzles. The second of three sets consisted of highly difficult or impossible anagrams, which served as the adversity component of the study. On the third set of anagrams (post-adversity), the group that received the 30-minute mindfulness workshop performed significantly better, reported significantly higher levels of engagement, and skipped fewer items on the third set. However, the researchers found no differences between the experimental and control groups on perceived levels of stress and difficulty. The researchers suggested that brief, 30-minute mindfulness training may be effective in improving performance, engagement, and persistence on a difficult cognitive task even in stressful situations (Imtiaz et al., 2018).

A five-minute mindful eating intervention may be enough to reduce the effects of stress and improve math performance. Weger, Hooper, Meier, and Hopthrow (2012) randomly assigned a group of 71 female psychology students (M_{age} of 20.14) to either a mindfulness condition or control group. Half of the participants were exposed to stereotype threat by being told that the purpose of the experiment was to determine why males are better at math than females. The researchers found that following a 5-minute mindful eating exercise, the effects of stereotype threat on performance were significantly reduced, as the group who received a brief mindfulness training were significantly more state mindful and scored significantly better on the math test than the control group. A simple 5-minute mindful eating exercise may be sufficient to induce a more mindful state and improve performance under psychological stress (Weger et al., 2012).

Evidence for the process of the influence on mindfulness training on performance, in which mindfulness may improve performance by decreasing cognitive anxiety, can be found in a correlational study (Röthlin, Horvath, Birrer, & Grosse Holtforth, 2016). A group of elite athletes (45.9% male, 54.1% female, M_{age} of 23.68) from 23 different sports (national-level competition or higher) were questioned about their performance in pressure situations, which was measured using a three-item questionnaire with Likert-scale responses. Correlational analyses from the study indicated an indirect effect of trait mindfulness on performance under pressure, mediated by anxiety. Trait mindfulness was significantly negatively correlated with cognitive and somatic anxiety. A significant inverse relationship was found between cognitive anxiety and performance under pressure. Therefore, a higher level of trait mindfulness may make athletes less affected by anxiety, thus better able to perform under pressure. However, experimental research is still needed to test these effects.

Two additional studies provided evidence that brief mindfulness training improves cognitive performance under pressure. Brunye, et al (2013) evaluated the effect of three different brief mindful breathing interventions on performance on a time-pressured arithmetic task for North American undergraduate students with low and high math anxiety (18 male, 18 female, M_{age} of 20.8). Participants were divided into high and low math anxiety based on their scores on the Math Anxiety Rating Scale (MARS; Suinn & Winston, 2003). They were then assigned to one of three 15-minute breathing exercises (focused breathing, unfocused breathing, and a worry exercise). Participants in the focused breathing group listened to Kabat-Zinn's (2005) *Guided Meditation Practices*. Participants in the unfocused breathing condition were instructed to "simply think about whatever comes to mind. Let your mind wander freely without trying to focus on anything in particular" (Brunye et al., 2013, p. 3). Participants in the worry exercise condition were asked to consider their responses to 15 anxiety inducing questions related to death and disease. Overall, participants with low math-anxiety outperformed those with high math-anxiety on the time-pressured arithmetic task. However, this effect was attenuated for participants in the focused breathing condition, as participants high in math-anxiety, who underwent focused breathing, were significantly less anxious prior to the arithmetic task and scored higher than other high math anxiety participants. Participants with high-math anxiety, who participated in focused breathing, were able to significantly increase their test scores under pressure, however their scores were still significantly lower than participants with low math-anxiety. From the results of this study, it can be concluded that even a 15-minute mindfulness training can benefit anxious individuals' math performance while simultaneously alleviating anxiety.

Bellinger et al (2015) also tested the effects of a brief, 15-minute mindfulness training on high-pressure math testing with a sample of 112 undergraduate students (34 males, 78 females, M_{age} of 20.05). Pressure was induced by offering performance-contingent incentives. Participants were also told that they were assigned an anonymous partner, and that if both the participant and their partner could improve their problem-solving speed and accuracy from their baseline scores by 20%, their reward would double. Participants were also told that their partners had already improved their score by 20% and that the reward was dependent upon their performance. Participants either listened to a 15-minute mindful breathing audiotape or progressive muscle relaxation audiotape. The results of this study indicated that the experimental group did not score significantly higher on the math test. However, the researchers found an indirect, significantly positive effect of mindfulness on high-pressure math performance, in which the effect of mindfulness was mediated by a reduction in state anxiety. These findings indicate that brief mindfulness training can increase performance under pressure by regulating arousal.

Summary of brief mindfulness training and performance. Based on the above information, research on brief mindfulness training has indicated that it may be effective for improving performance. The experiments by Brunye et al (2013) and Bellinger et al (2015) indicate that brief mindfulness training can improve cognitive performance, while Perry et al's (2017) results demonstrate that brief mindfulness led to improved motor performance on a closed skill. Together, these trainings have all decreased state anxiety while also improving objective performance, indicating an inverse relationship between anxiety and performance. Future studies on the effects of brief mindfulness training on performance should investigate whether they are effective in other closed-skills, on well-learned skills, and in pressure situations using a true experimental design. Research is needed on experienced athletes to determine whether a brief mindfulness intervention is still efficacious for improving performance for experienced athletes. Perry et al (2017) investigated the effects of a brief mindfulness training on athletic performance on a closed skill, no known researchers have tested this the efficacy of a brief mindfulness training under pressure. Additional research is needed to determine whether a brief mindfulness intervention still improves performance during pressure situations, given that pressure situations are common in competitive sport. Second, Brunye et al (2013) utilized a quasi-experimental design, rather than a true experimental design, therefore it is unknown if the results were found due to the experimental manipulation or group differences.

The Present Study

The present study examined the effects of a brief mindfulness intervention on basketball free-throw shooting under pressure. Past studies indicate that brief mindfulness interventions reduce anxiety and improve cognitive performance under pressure as well as athletic performance in a lab setting (Bellinger et al., 2015; Brunye et al., 2013; Perry et al., 2017); thus, there is reason to expect that a brief mindfulness training may improve physical performance on a closed-skill under pressure. This study was designed to address existing limitations in the literature by examining the effect of a brief intervention using randomized experimental and control groups, an objective measure of performance, an adequate sample size, and introducing pressure. Free-throw shooting was chosen as a dependent variable for its external validity and objectivity. The purpose of this study was to answer the following questions: 1) Will participants who undergo a brief mindfulness intervention perform significantly better on basketball free-throw shooting under pressure compared to participants in a control group? Given that dispositional mindfulness has been found to be a predictor of free-throw percentage (Gooding & Gardner, 2009), will participants' dispositional mindfulness scores significantly correlate to free-throws made during the high-pressure phase? 2) Will participants who undergo a brief mindfulness training report significantly lower state anxiety, when under pressure, compared to participants in a control group? 3) Will participants who undergo a brief mindfulness training report significantly higher state mindfulness scores than the control group, when under pressure?

Introduction

Pressure situations occur often in sporting contexts at a variety of levels. For some athletes, the perceived importance of pressure situations can be physically, mentally, and emotionally stressful (Craft, Magyar, Becker, & Feltz, 2003). These heightened levels of arousal can have significant and detrimental impacts on performance (Hill, Carvell, Matthews, Weston, & Thelwell, 2017). Specifically, an athlete's ability to focus on task-relevant information in the present moment can be compromised by heightened levels of anxiety (Beilock & Barr, 2001). Closed-skills, such as basketball free-throws, that are self-paced and performed in a stable environment without interference, may be especially vulnerable to decrements under pressure (Reeves, Tenenbaum, & Lidor, 2007).

Several models have been developed to explain the relationship between anxiety and performance, including the inverted-U model (Yerkes & Dodson, 1908), the catastrophe model (Hardy, 1996), and the individual zones of optimal functioning model (Hanin, 1997). Each model includes slightly different assumptions about how much anxiety is optimal for performance. Proponents of the catastrophe model argue that when an athlete's *somatic anxiety* (i.e., physical anxiety) levels are high and the athlete has elevated *cognitive anxiety* (i.e., mental anxiety) a rapid (catastrophic) decline in performance occurs. This model is supported by Röthlin, Horvath, Birrer, and Grosse Holtforth (2016), who found that athletes' cognitive competition anxiety was significantly negatively associated with their ability to perform under pressure, while somatic anxiety was not. Therefore, managing cognitive anxiety may be more critical to performing under pressure than managing physical anxiety.

Currently, there are three published models that explain why and how high levels of anxiety contribute to poor performance under pressure (e.g., distraction model, self-focus model, integrated model). First, the distraction model is based on the idea that an abatement in performance during pressure scenarios is caused by athletes attending to irrelevant external stimuli instead of task-relevant information (Eysenck & Calvo, 1992). A second model, the self-focus (or self-monitoring) model (Baumeister, 1984), is based upon evidence that turning attention internally during pressure situations interferes with the execution of well-learned skills (Beilock & Carr, 2001), likely because these skills were encoded to be performed without conscious attention (Masters, 1992). Finally, Nieuwenhuys and Oudejans' (2012) model integrated both distraction and self-focus concepts. According to the authors' model, heightened levels of cognitive anxiety can result in poor performance due to distraction (i.e., attending to task-irrelevant stimuli) or self-focus (i.e., fixation on internal stimuli), but that these sources of disruption may not be mutually exclusive. Nieuwenhuys and Oudejans (2012) stated that the distraction model is more accurate in explaining anxiety-induced performance decrements, but they believe that self-focus may be a form of distraction, especially for well-learned skills. Therefore, the authors posited that an individual performs increasingly less effectively as he or she is less attentive to the task at hand, whether the distraction is an internal or external stimulus. Oudejans, Kuijpers, Kooijman, and Bakker (2011) found that both self-focus and distraction negatively affected performance under pressure, but distraction (e.g., worry) was the more common cause of performance decrements. Therefore, performance may be improved by improving one's ability to focus on task-relevant information in the present moment while managing anxiety.

Accordingly, researchers have tested various techniques for improving performance under pressure to inform the work of sport psychology practitioners. Examples of current interventions for improving sport performance under pressure include practicing dual-tasks

(Beilock, Carr, MacMahon, & Starkes, 2002; Mesagno, Marchant, & Morris, 2009), creating pre-performance routines (PPR; Mesagno, Marchant, & Morris, 2008; Mesagno & Mullane-Grant, 2010), and participating in pressure acclimatization training (Oudejans & Pijpers, 2009, 2010; Reeves, et al., 2007). Although these three interventions appear to be effective for improving performance under pressure in some circumstances, interventions are not always specifically designed to alleviate cognitive anxiety, which may underlie performance decrements under pressure in some cases (Röthlin et al., 2016).

Mindfulness practice, which is the cognitive process of consciously paying attention to one's thoughts, emotions, and physical sensations with non-judgmental awareness (Kabat-Zinn, 1982), may improve sport performance by enhancing present-moment awareness (Gardner & Moore, 2004). Mindfulness may be an effective technique for specifically improving performance under pressure because its primary aim is to train attention and task-relevant focus (Bishop et al., 2004). The practice of mindfulness typically involves intentionally attending to one's thoughts, emotions, and sensations (Bishop et al., 2004). Mindfulness can be conceptualized as having both *state* and *trait* components (Kiken, Garland, Bluth, Palsson, & Gaylord, 2015). *State mindfulness* is the degree to which one is aware of one's thoughts, emotions, and sensations in the present moment, which can be induced with practice (Kiken et al., 2015). *Trait mindfulness* has been defined as an individual's natural tendency to be attentive to the present moment in everyday life across various contexts (Kiken et al., 2015). Dispositional or trait mindfulness can be developed with repeated practice and has been found to be associated with enhanced athletic performance and resilience to stress (Arch & Craske, 2010; Baltzell & Akhtar, 2014; Gooding & Gardner, 2009). Röthlin et al (2016) found that an individual's disposition to be mindful, even despite a highly activated physical state, was associated with better sport performance in pressure situations, and athletes with higher trait mindfulness experienced less cognitive and somatic anxiety (Röthlin et al., 2016).

Several studies have been designed to test the effects of several weeks of mindfulness training (usually four to eight weeks) on athletic performance. For example, Bernier, Thienot, Codron, and Fournier (2009) found that seven elite youth golfers' national rankings improved after completing mindfulness training over the course of several months; the training included a combination of Acceptance and Commitment Therapy (ACT; Hayes, Strosahl, & Wilson, 1999) and Mindfulness-Based Cognitive Therapy (MBCT; Segal, Williams, & Teesdale, 2002). The golfers also subjectively reported increases in task-relevant attention, attentional awareness, and behavioral flexibility. However, only seven golfers were included in the study and performance was measured by national ranking and subjective goals, which may not have been directly attributable to the mindfulness intervention.

In contrast to the research described above, studies conducted on four weeks of Mindfulness Sport Performance Enhancement (MSPE; Kaufman et al., 2009) training in 21 recreational golfers and 11 recreational archers (Kaufman et al., 2009) and 25 recreational long-distance runners (De Petrillo et al., 2009), revealed no immediate effects on sport performance compared to a waitlist control group. However, a one-year follow-up (Thompson, Kaufman, De Petrillo, Glass, & Arnkoff, 2011) on a subset of athletes from Kaufman et al's (2009) and De Petrillo et al's (2009) studies indicated that the runners had statistically significantly improved their mile times. Additionally, the golfers, archers, and runners from Kaufman et al (2009) and De Petrillo et al (2009) had significant decreases in task-irrelevant thoughts and task-relevant worries, as well as increases in trait mindfulness. However, a limitation of these three studies is that there were no randomized experimental and control groups, the follow-up did not include participants from the control group, and improvements in performance at follow-up could be a result of factors other than the MSPE training.

In addition to the Mindfulness Sport Performance Enhancement (MSPE) protocol, the Mindfulness Acceptance and Commitment (MAC; Gardner & Moore, 2004) program has been used to investigate the effects of mindfulness on sport performance, as well. The results of a case study involving a male adolescent springboard diver who completed a nine-week adapted version of the MAC program, indicated that the diver had increased his mindful attention, mindful awareness, experiential acceptance, frequency of achieving flow, and diving competition scores (Schwanhausser, 2009). Further evidence for the effectiveness of a MAC intervention was found in a study of the effect of an eight-week program on the performance of 43 novice dart-throwers, who were randomly assigned to a mindfulness or control group (Zhang, Duan, Lyu, Keatley, & Chan, 2016). Following the intervention, participants had statistically significantly greater increases in trait mindfulness, experiential acceptance, flow, and dart throwing performance at posttest and at a two-week follow-up compared to the control group. Although these studies provide useful information about the effects of mindfulness training, research that uses randomized experimental and control groups is still needed on more experienced athletes who undergo mindfulness training.

Overall, literature regarding multi-session mindfulness training indicates positive effects on sport performance; however, further methodologically rigorous research is needed on this topic (Sappington & Longshore, 2017). Buhlmayer et al (2017) conducted a meta-analysis and found that mindfulness interventions yielded strong effect sizes on performance in precision sports, such as dart throwing and shooting, yet they stated that high-quality randomized control trials are still needed. Studies on mindfulness interventions for sport performance should also include larger and more homogeneous samples, as well as objective measures of performance.

Almost all known studies in sport settings on mindfulness have taken place over several weeks and involved many sessions of guided instruction (e.g., Kaufman et al., 2009; Zhang, et al., 2016). Research on shorter mindfulness trainings would be beneficial to sport psychology practitioners because brief trainings are easier to implement in applied settings with time constraints and may be more attractive to sport coaches who want to maximize practice time. Yet, there is only one known study on the effects of a brief mindfulness training on sport performance (Perry, Ross, Weinstock, & Weaver, 2017). In Perry et al (2017)'s study, after a pretest, 65 physically active undergraduate students (33 males, 32 females) were divided into an experimental (30-minute mindfulness session adapted from the MAC protocol) or control group (read magazines for 30 minutes). After a single 30-minute mindfulness session, the researchers measured objective golf putting performance, state anxiety, and flow. The group who received the mindfulness intervention scored higher on golf putting performance, and flow experience, and scored lower on state anxiety on the second trial compared to the control group. These findings suggest that a brief 30-minute mindfulness session can effectively improve athletic performance and other psychological variables. However, no known research has been published on the effects of brief mindfulness training on athletic performance under pressure. Practitioners would benefit from research on brief mindfulness interventions, because pressure situations often arise in sport and athletes are arguably more likely to request assistance from practitioners regarding managing pressure situations. However, thus far, the only studies that have included a measurement of the effects of a brief mindfulness training on performance under pressure have been conducted on cognitive performance (e.g., Brunye et al., 2013; Bellinger et al., 2015).

The effects of three different brief breathing interventions on a time-pressured arithmetic task, was investigated using a sample of college students (Brunye et al., 2013). Overall, college students with low math anxiety outperformed those with high math anxiety on the arithmetic task. However, participants with high math anxiety, who participated in mindful breathing (instead of unfocused breathing or a worry exercise), were able to significantly increase their test scores under pressure and significantly decrease their anxiety. In a similar manner, Bellinger et al (2015) tested the effects of a brief mindfulness training on high-pressure math testing with a sample of 112 undergraduate students. Participants either listened to a 15-minute mindful breathing or a progressive muscle relaxation audiotape. Participants were told that they could receive additional compensation depending on their performance. The results indicated that while mindfulness did not have a direct effect on high working memory math performance, an indirect, positive effect of mindfulness on high-pressure math performance was found. On difficult math problems, increases in mindfulness were then related to decreases in state anxiety, which were related to increased math performance. In a third study on math test performance under pressure, 71 female college students were assigned to one of four conditions in a 2 (mindfulness vs no mindfulness) x 2 (stereotype threat vs no threat) experimental design (Weger et al., 2012). Half of the participants were primed to stereotype threat, when the researchers stated that the test was to investigate why men are better at math. In a second condition, half of the participants completed a five-minute mindful eating exercise prior to the math test, while the other half was told to simply eat two raisins. The results indicated that for participants who completed the mindfulness exercise, the effects of stereotype threat were eliminated on their math performance; therefore, the findings suggest that mindfulness training can improve performance by increasing task-relevant attention and decreasing the load of cognitive anxiety on working memory. Taken together, these findings imply that brief mindfulness training enhances performance under pressure.

In summary, several research studies have demonstrated that four to eight-week mindfulness training programs are effective at improving athletic performance (Bernier et al., 2009; De Petrillo et al., 2009; Kaufman et al., 2009; Schwanhausser, 2009; Thompson et al., 2011; Zhang et al., 2016). These trainings also increased trait mindfulness (De Petrillo et al., 2009; Kaufman et al., 2009; Thompson et al., 2009); however, athletes faced with a pressure situation in a specific competition, may be more reliant upon their acute mental states than their dispositions. Several other studies have found that brief mindfulness training improves cognitive performance (Imtiaz et al., 2018), including cognitive performance under pressure (Bellinger et al., 2015; Brunye et al., 2013; Weger et al., 2012), and golfing performance (Perry et al., 2017), Based upon the evidence that a single mindfulness training may be sufficient for inducing a more mindful state (Bishop et al., 2004), a single training may also be sufficient to improve sport performance under pressure. Also, Carmody and Baer (2009) found no statistically significant correlation between number of class hours in mindfulness training and reduction of psychological stress. However, there are still no known studies that have tested the effects of a brief mindfulness training on sport performance under high pressure. In addition, research is still needed to determine whether brief mindfulness training can improve sport performance in multiple domains and competence levels, as the only study to date to test the effect of a brief mindfulness training on sport performance used a sample of novice golfers (Perry et al., 2017). Coaches, especially in competitive sport, may be interested to know whether mindfulness training can improve sport performance in pressure situations. Additionally, coaches may be interested in whether a brief training is sufficient to improve performance because of the minimal time commitment and cost associated with a brief guided meditation audio recording.

The present study was designed to examine the effects of a brief mindfulness training intervention on experienced basketball players' free-throw shooting performance under pressure. This study's methodology attempted to address limitations of past research on mindfulness by using random assignment to experimental and control groups, including an objective measure of performance, recruiting a larger sample size, and introducing a high-pressure situation. First, it was hypothesized that participants who underwent a brief mindfulness intervention would perform significantly better on basketball free-throw shooting under pressure compared to participants in a control group, and that participants' dispositional mindfulness scores would be positively correlated with free-throws during a high-pressure situation, given that dispositional mindfulness has been found to be a predictor of free-throw percentage (Gooding & Gardner, 2009). Next, it was hypothesized that the mindfulness group would report significantly lower state anxiety when under pressure compared to the control group. The final hypothesis was that the mindfulness group would report significantly higher state mindfulness scores than the control group, when under pressure.

Methods

Participants

Participants were 32 male recreational basketball players (mean age 21.22 years, SD = 2.01) who attended a university in the northwestern United States. The sample was 53.1% White, 15.6% Black, 12.5% Asian, 12.5% Multiracial, and 6.3% Latino. The sample's average years of basketball playing experience was 8.19 (SD = 3.75). Participants reported that their highest level of competition experience was junior college basketball (n = 1, 3.1%), collegiate club (n =1, 3.1%), high school varsity (n =18, 56.3%), high school club (n = 3, 9.4%), college intramural (n

= 4, 12.5%), high school non-varsity (n = 4, 12.5%), or middle school (n = 1, 3.1%). The mindfulness group (n = 16) had a mean age of 21.5 (SD = 1.79) and an average of 8.06 (SD = 4.12) years of playing experience. The control group (n = 16) participants had a mean age of 20.94 (SD = 2.24) and an average of 8.31 (SD = 3.48) years of experience. Twelve participants reported having some form of experience practicing mindfulness prior to the experiment, six of whom were in the mindfulness group and six were in the control group.

Measures

Competitive Sport Anxiety Inventory-II revised (CSAI-2R). The CSAI-2R (Cox, Martens, & Russell, 2003) was designed to assess competitive cognitive state anxiety, somatic state anxiety, and self-confidence. The revised version contains 17 items measured on a 4-point Likert scale, ranging from 1 *very untrue* to 4 *very true*. Seven questions are included in the somatic state anxiety subscale. There are five items in the self-confidence subscale. Each subscale score is calculated by summing all items, dividing by number of items, and multiplying by 10. Scores range from 10 to 40 for each subscale (Cox et al., 2003). Higher scores represent higher levels of anxiety and higher levels of confidence. In past studies, reliability for all three subscales (cognitive anxiety, somatic anxiety, and self-confidence) were determined to have Cronbach's alpha values above .80, and sound construct and internal validity (Cox, et al., 2003). In the current study, Crohbach's alpha was .78 for the cognitive anxiety subscale, .76 for the somatic anxiety subscale, and .77 for the confidence subscale.

In the current study, a second version of the CSAI-2R was also given to participants, which was modified to assess trait competitive anxiety by changing the wording of the questions to include words such as, "typically," "commonly," or "usually." For example, the somatic item, "My body feels tense" was changed to "My body typically feels tense." The difference between participants' scores on the original CSAI-2R and on the modified trait version of the CSAI-2R was one measure of the participants' anxiety level during each phase of the study, which was recommended by one of the authors of the CSAI-2 (D. Burton, personal communication, April 21, 2018). Cronbach's alphas for this modified trait version were .83 for the cognitive subscale, .81 for the somatic subscale, and .60 for the confidence subscale. In the current study, subscale scores were used to calculate anxiety.

Toronto Mindfulness Scale (TMS). The TMS includes 13 questions that assess state levels of mindfulness (Lau et al., 2006). The TMS contains two subscales: curiosity (six items) and decentering (seven items). Each item is rated on a 5-point Likert scale from 0 (*not at all*) to 4 (*very much*). Scores range from 0 to 24 on the curiosity subscale and 0 to 28 on the decentering subscale. Scores on the TMS range from 0 to 52; a higher score indicates higher state mindfulness. Lau et al (2006) found an alpha coefficient of .93 for the curiosity subscale and .91 for the decentering subscale. Further, strong internal consistency, convergent validity, and discriminant validity was found in past studies (Lau et al., 2006). In the current study, Cronbach's alphas were .77 for the decentering subscale and .88 for the curiosity subscale.

Mindful Attention Awareness Scale (MAAS). The MAAS assesses a person's dispositional (trait) mindfulness, using 15-items (Brown & Ryan, 2003). Each item is rated on a 6-point Likert-scale from 1 *almost always* to 6 *almost never*. The score on the 15 items is averaged; higher scores indicate greater dispositional mindfulness. Cronbach's alpha was found to be 0.89 and there is evidence of strong convergent and divergent validity (MacKillop & Anderson, 2007). For the current sample, the MAAS had a Cronbach's alpha of .81.

Basketball free-throw shooting performance. There were two measures of free throw shooting performance in the current study. First, each shot was coded as a "make" if it went through the basket, or a "miss" if it did not, which allowed the researchers to determine the number of successful free throws made out of 20 for each participant. In addition, the scoring system used by Pates, Cummings, and Maynard (2002) was implemented to rate each attempt's shot quality, which provided a more sensitive measure of shooting performance. The following scoring system was used: "1 for the ball hitting the backboard then hitting the rim and coming out, or the ball hitting the backboard and coming out, or a complete miss (air-ball); 2 for the ball hitting the rim and coming out; 3 for the ball hitting the backboard and then going in; 4 for the ball hitting the rim and then going in; and 5 for a clean basket (swish)" (Pates et al., 2002, p. 4). Shot quality was recorded by summing scores of 20 attempts during the low- and high-pressure conditions. Possible scores on shot quality could range from 20 to 100.

Procedure

The study was approved by the university internal review board prior to recruitment and data collection. Participants were recruited via convenience sampling by posting and handing out fliers in a university campus recreation center near several basketball courts. Participants were offered a $20 gift card for their participation in all phases of the study. In order to be included, participants were required to have had at least three years of competitive playing experience of organized basketball to ensure their familiarity with in-game free-throw shooting. The researchers elected not to study elite players (e.g., college varsity players), because they may not be affected by a simulated pressure situation in a lab setting. In addition, novice participants were excluded from the current sample because of the potential of practice effects and because the current study examined the effect of a brief mindfulness training on well-learned skills. Participants were excluded if they had current injuries that would interfere with their free-throw performance or if they had a diagnosed anxiety disorder. No participants were excluded.

For both phases of the study, participants came to a regulation basketball court, which was reserved solely for the study and had locked doors to prevent disturbance. A regulation game men's basketball was used for both phases. During data collection, two researchers were stationed near the basket to record free throw shooting results. All raters were trained prior to data collection on the five-point rating system (Pates et al., 2002). Once participants all participants finished both phases, they were debriefed and given a $20 gift card for their participation.

Thirty-five participants contacted the researcher and completed phase one of the study. However, three participants (2 control group, 1 mindfulness group; free-throw percentage during phase one = 68%) did not respond to multiple reminders for phase two of the study. Thus, these three participants' data were excluded from the study's analyses.

Data Collection Protocol

Low pressure phase. Once the participants arrived for their first individual session, they completed the modified trait version of the CSAI-2R, the MAAS, and the CSAI-2R. Then, participants were read the protocol instructions, were allowed two minutes to warm up any way they liked, shot 20 free-throws, and completed the TMS.

To control for free throw shooting ability, once all participants had completed the low-pressure phase of the experiment, they were pair-matched by free-throw percentage and randomly assigned to the mindfulness or control conditions. For example, participants with the first- and second-best free-throw percentages were matched and randomly assigned to the experimental and control conditions and so on.

High pressure phase. Participants returned two to three weeks later for the high-pressure phase of the study. Participants who were assigned to the experimental condition listened to the first 15 minutes of a guided mindfulness meditation recording from Kabat-Zinn's (2005) Guided Mindfulness Meditation practice CDs (disc 3, Sitting Meditation). This audio recording has been used by others (e.g., Aherne et al., 2011; Brunye et al., 2013; Mardon et al., 2016) as a protocol for mindfulness training in experiments on cognitive performance and flow experience for athletes. Participants in the control condition listened to a 15-minute audio recording of a lecture on the history of basketball. Both groups were told that listening to their respective recordings may help them to attain a better performance mindset. Fifteen minutes was selected for the length of the intervention based on Brunye et al's (2013) study.

In order to induce pressure, once the participants had listened to their audio recordings, they were told that in this session their free throws would be videotaped because motor control and physical education professors needed video footage of successful basketball shots for their teaching material. They were told to try to make as many shots as possible so that the professors would have usable footage. They were also offered a monetary incentive ($20 additional gift card) if they were the participant with the most made free-throws during session two. Numerous past studies have used video recording (e.g., Beilock & Carr, 2001; Otten, 2009) and monetary incentives (e.g., Bellinger et al., 2015; Mullen, Hardy, & Tattersall, 2005) to induce pressure.

Participants then completed the CSAI-2R and began their two-minute warm-up. A video camera was positioned behind the participant near the half court line and participants believed it was turned on immediately after their warm up; however, participants were not actually recorded. The participants shot 20 consecutive scored free-throws and then completed the TMS.

Manipulation check. A three-question manipulation check questionnaire was administered after the high-pressure phase. The first question asked participants to rate the degree to which they found the mindfulness training or history of basketball lecture to be of value to their free-throw shooting performance. Next, participants rated the degree to which they actively listened to the mindfulness recording or history recording. A third question asked participants to rate the degree to which their anxiety or nervousness increased when they were told that they would be recorded, evaluated, and could win more money. Participants responded to all questions using a scale from 1 (*strongly disagree)* to 7 (*strongly agree).*

Data Analysis

Two separate ANCOVAs were performed to examine differences between groups (intervention vs. control) on free-throws made and shot quality during the high-pressure phase. Trait mindfulness was chosen as a covariate, given its past association with free throw shooting performance (Gooding & Gardner, 2009). If trait mindfulness was not found to be a significant covariate, two separate, 2 (intervention vs. control) x 2 (low pressure vs. high pressure) mixed between-within subjects ANOVAs were used to determine whether any change in free throw shooting performance or shot quality rating was a result of an interaction between the between-subjects factor of group assignment (mindfulness versus control) and the within subjects factor of pressure (low pressure versus high pressure).

Measures of both trait and state anxiety were used to determine whether the pressure manipulation resulted in a difference between participants' competitive trait anxiety and their state anxiety during the experiment. Difference scores were created by subtracting their reported state anxiety during the low- and high-pressure phases from their reported trait scores. Three mixed ANOVAs were run to determine if there were interaction effects between group and pressure level on the difference within each group's reported trait and state anxiety scores. Finally, three independent samples t-tests were run to determine if there were any significant differences between the groups on the three subscales of state anxiety during the high-pressure phase. These analyses determined whether or not mindfulness training possibly buffered against state anxiety in the high-pressure phase.

Finally, two mixed between-within subjects ANOVAs were run on the decentering and curiosity state mindfulness subscales to determine possible interaction effects between group assignment and pressure on state mindfulness.

IBM SPSS was used to calculate significance and effect sizes. For all analyses, the significance cutoff was set at $p \leq 0.05$. Effect size was calculated using partial eta squared (.01 small, .09 medium, .25 large; Cohen, 1973).

Results

During the low-pressure phase, the mindfulness group made an average of 12.81 (SD = 3.21) free-throws out of 20 (64.06%) and the control group made an average of 12.44 (SD = 3.43) out of 20 (62.19%). During the high-pressure phase, the mindfulness group made 14.13 (SD = 3.72) free-throws out of 20 (70.63%) and the control group made 12.31 (SD = 3.63) free-throws out of 20 (61.56%). See Table 1 for all descriptive statistics.

Results of the first ANCOVA revealed no statistically significant differences between groups on number of made free-throws during the high-pressure phase, while controlling for trait mindfulness, F (1, 29) = 2.33, p = .14; η_p^2 = .07, with a small effect size. Additionally, there was no significant relationship between trait mindfulness and free throws made, F (1, 29) = 2.08, p = .16; ηp^2 = .07, indicating that trait mindfulness was not a meaningful covariate. A second ANCOVA revealed that, while the mindfulness group scored higher in shot quality, there were no significant differences between groups on shot quality during the high-pressure phase, while controlling for trait mindfulness, F (1, 29) = 4.16, p = .051. However, this finding approached significance and had a medium effect size (η_p^2 = .13). Once again, trait mindfulness F (1, 29) = 1.75, p = .20; ηp^2 = .06 was not a significant covariate.

A mixed ANOVA indicated no statistically significant interaction between group and pressure level on free-throws made, with a small effect size, F (1, 30) = 1.23, p = .28; Wilk's Λ = .961; ηp^2 = .04. Main effects of pressure F (1, 30) = .84, p = .37; Wilk's Λ = .973; ηp^2 = .03 and group F (1, 30) = 1.08, p = .31; ηp^2 = .04 were also not significant. No interaction between group and pressure were found on shot quality scores with a small effect size, F (1, 30) = 1.32, p = .26; Wilk's Λ = .958; ηp^2 = .04. There were also no significant main effects for pressure level F (1, 30) = .61, p = .44; Wilk's Λ = .980; ηp^2 = .02 or group F (1, 30) = 2.69, p = .11, ηp^2 = .08.

Three mixed ANOVAs were performed to examine possible interaction effects of group and pressure on the differences scores of participants' reported trait anxiety and their reported state anxiety on each subscale on the CSAI-2R. The first mixed ANOVA on participants' somatic subscale difference scores revealed no significant interaction effect F (1, 30) = 1.32, p = .26; Wilk's Λ = .958; ηp^2 = .04. Main effects of pressure F (1, 30) = .38, p = .54; Wilk's Λ = .987; ηp^2 = .01 and group F (1, 30) = 1.05, p = .31; ηp^2 = .03 were also not significant. A mixed ANOVA on the cognitive subscale revealed no significant interaction between group and pressure F (1, 30) = 1.34, p = .26; Wilk's Λ = .957; ηp^2 = .04. The main effects of pressure F (1, 30) = .03, p = .86; Wilk's Λ = .999; ηp^2 = .00 and group F (1, 30) = 1.89, p = .18; ηp^2 = .06 were non-significant. A final mixed ANOVA was performed on the confidence subscale. No significant interaction between groups across pressure levels was found F (1, 30) = .19, p = .67; Wilk's Λ = .994; ηp^2 = .01. The main effects of pressure F (1, 30) = .42, p = .52; Wilk's Λ = .986; ηp^2 = .01 and group F (1, 30) = 3.70, p = .06; ηp^2 = .11 were both non-significant; although main effects of group approached significance, with a medium effect size.

A statistically significant difference was found between the mindfulness (M = 15.00, SD = 3.86) and control (M = 17.88, SD = 4.03) groups on the cognitive anxiety subscale of the

CSAI-2R during the high pressure phase, *t (31)* = 2.06, *p* = .048; additionally, there was a statistically significant difference between the mindfulness group (M = 14.20, SD = 2.97) and control group (M = 18.57, SD = 5.86) on the somatic anxiety subscale, *t (31)* = 2.67, *p* = .01. These results indicate that the mindfulness group experienced significantly less cognitive and somatic anxiety than the control group during the high-pressure phase. However, no statistically significant difference between the mindfulness (M = 31.19, SD = 4.12) and control (M = 31.50, SD = 3.97) groups was observed for the confidence subscale *t (31)* = 1.48, *p* = .15.

Another mixed ANOVA was performed to investigate possible interaction effects of group and pressure level on the curiosity state mindfulness subscale of the TMS; no statistically significant interaction was found F (1, 30) = .14, p = .71; Wilk's Λ = .995; ηp^2 = .01. There were statistically significant main effects of pressure F (1, 30) = 6.05, p = .02; Wilk's Λ = .832; ηp^2 = .17 and group F (1, 30) = 4.32, p = .046; ηp^2 = .13, both with medium effect sizes and a stronger effect of pressure. A fourth mixed ANOVA assessed possible interaction effects of group and pressure on the decentering subscale of the TMS. No statistically significant interaction was found F (1, 30) = .01, p = .92; Wilk's Λ = .999; ηp^2 = .00. There were no significant main for pressure F (1, 30) = .13, p = .72; Wilk's Λ = .996; ηp^2 = .00 or group F (1, 30) = .01, p = .92, ηp^2 = .00.

When asked during the manipulation check whether they found the audio recording to be of value, the mindfulness group reported an average response that fell between *neutral* and *somewhat agree* (*M* = 4.81, *SD* = 1.87) and the control group reported an average response between *disagree* and *somewhat disagree* (*M* = 2.88, *SD* = 2.03). When asked if they listened closely to the recording, the mindfulness group reported an average between *somewhat agree* and *agree* (*M* = 5.81, *SD* = 1.28) and the control group's average was between *somewhat agree* and *agree* (*M* = 5.25, *SD* = 1.00). When asked if their anxiety level increased after they were told that they would be recorded, evaluated, and could win more money, the mindfulness group reported an average between *somewhat disagree* and *neutral* (*M* = 3.44, *SD* = 1.90); the control group's average was between *neutral* and *somewhat agree* (*M* = 4.13, *SD* = 1.67).

Table 1

Descriptive Statistics for Mindfulness Group and Control Group

	Mindfulness Group		Control Group	
Variable	Low-Pressure Phase *M (SD)*	High-Pressure Phase *M (SD)*	Low-Pressure Phase *M (SD)*	High-Pressure Phase *M (SD)*
Free-throws Made (20 attempts)	12.81 (3.21)	14.13 (3.72)	12.44 (3.43)	12.31 (3.63)
Shot Quality Score (20-100)	70.50 (8.01)	73.44 (9.67)	67.94 (8.50)	67.38 (8.12)
CSAI2R: Somatic Anxiety	14.73 (4.91)	14.20 (2.97)	16.79 (5.10)	18.57 (5.86)
CSAI2R: Cognitive Anxiety	15.91 (5.62)	15.00 (3.86)	16.63 (5.78)	17.88 (4.03)
CSAI2: Self-Confidence	30.63 (5.10)	31.25 (4.55)	33.75 (4.25)	33.88 (5.44)
TMS: Decentering	13.50 (4.38)	13.38 (4.91)	13.81 (4.90)	13.38 (5.41)
TMS: Curiosity	10.75 (5.66)	12.50 (6.25)	6.75 (5.07)	9.13 (5.14)

Note. Mean (*M*) and Standard Deviation (*SD*) are reported for all dependent variables.

Discussion

This is the first known study to test the effects of a brief mindfulness intervention on sport performance under pressure. The main research hypothesis, that participants who underwent a brief mindfulness training would perform statistically significantly better under pressure than the control group, was tested using two measures of basketball shooting performance. Overall, the hypothesis was not supported by the results. Although the mindfulness group made more free-throws on average than the control group during the high-pressure phase of the study, inferential analyses indicated that the number of free-throws made by the two groups did not statistically significantly differ. The findings that there were no significant effects of mindfulness training on performance in the current experiment are congruent with those from studies conducted by Hasker (2010) and Kaufman et al (2009), in which no immediate improvements to sport performance were found following a mindfulness training. However, the findings of the current study contrast with those of previous studies involving longer protocols, which have found improvements in performance after several sessions of a mindfulness intervention (e.g., Bernier et al., 2009; Solberg et al., 1996), possibly because the present study involved less training time and examined performance under pressure. The current findings also contrast with previous research on novice golfers. A group of novice golfers who received one brief 30-minute mindfulness intervention performed statistically significantly better compared to a control group (Perry et al., 2017); however, Perry et al (2017) may have found different results than the present experiment due to the fact that their sample was larger, their participants were novices, and their participants were not introduced to a pressure situation.

However, regarding the current study's main hypothesis, it is important to note that the difference between the mindfulness and control groups in shot quality rating in the high-pressure phase approached statistical significance ($p = .051$) with a moderate effect size, when controlling for trait mindfulness. One explanation for this moderate effect size could be that shot quality rating was a more sensitive dependent variable measure than free-throws made; thus, it was likely better able to detect subtle group differences in performance and may provide a more accurate representation of the effect of the mindfulness training on performance than free-throws made. Less accurate shots, which may have more negative consequences in an actual basketball game, were more accurately detected with the shot quality rating system than simply keeping track of the number of made free-throws. For example, several participants shot an “airball” on a free-throw attempt during the high-pressure phase, which is an automatic turnover in an actual basketball game. A more accurate shot, even if the shot is a miss, still gives the shooter’s team a chance to rebound the ball. Therefore, the current study’s findings on shot quality under pressure, has practical significance for coaches, athletes, and practitioners. It is possible that the groups’ scores would have statistically significantly differed with a larger sample size.

In the current study, trait mindfulness was not found to be a significant predictor of free-throws made or shot quality. This finding counters the study’s hypothesis and conflicts with the findings of Gooding and Gardner (2009), who found a significant positive correlation between trait mindfulness scores on the Mindful Attention Awareness Scale and in-game free-throw percentage for Division I men’s collegiate basketball players. Since the present sample was recreational competitive college-aged males, and trait mindfulness was not significantly related to performance, it is possible that trait mindfulness serves as a better indicator of free-throw shooting ability for higher level performers. Additionally, Gooding and Gardner’s (2009) study was not specifically on high-pressure free-throws. Free-throws for elite players, especially when the score is not close, would not be considered a pressure situation. Therefore, more research is needed to determine whether trait mindfulness is a significant predictor of free-throw shooting ability for elite basketball players in high-pressure situations and for recreational basketball players in low-pressure situations.

Analyses on the current samples' data were also run without controlling for trait mindfulness, given that trait mindfulness was not a statistically significant covariate. These analyses also indicated that the brief mindfulness training for the experimental group did not result in statistically significantly better free-throw shooting performance under pressure than the control group. It is possible that the sample size was not sufficient to detect differences between the mindfulness and control groups, as the variance within each group was substantial. Another possible explanation for the lack of significant findings could be that the 15-minute training was not long enough to produce detectable effects. Given that Perry et al (2017) found significant effects of one 30-minute training, it is possible that a slightly longer mindfulness protocol could have similarly led to significantly enhanced performance under pressure. Additionally, previous researchers that have measured the impacts of mindfulness on sport performance have not always observed immediate, direct performance enhancing effects (e.g., De Petrillo et al., 2009; Kaufman et al., 2009). Instead, they have reported an indirect relationship to cognitive performance mediated by cognitive anxiety (e.g., Bellinger et al., 2015; Röthlin et al., 2016) or delayed improvement in sport performance during long-term follow up (Thompson et al., 2011). Given that the current study did not include a follow-up phase, the long-term effects of one mindfulness intervention on sport performance under pressure remain to be tested.

During the high-pressure phase in the current study, some individual participants performed better than they had in the low-pressure phase and some performed worse. Therefore, the individual zones of optimal functioning model seems to most accurately describe the effects of anxiety on performance in the current experiment, although performance was only assessed in two environments with no moderate pressure condition (Hanin, 1997). The catastrophe model (Hardy, 1996) may have explained some outcomes in the present study, as several airballs occurred during the high-pressure phase, and only one occurred in the low-pressure phase. An abundance of research findings indicate that anxiety can be disruptive to cognitive and athletic performance on well-learned skills (Beilock & Carr, 2001; Eysenck et al., 2007; Hill et al., 2011; Mesagno & Beckmann, 2017), as anxiety can induce distraction or self-focus, decreasing task-relevant attention (Nieuwenhuys & Oudejans, 2012). The present study did not include any measures of attentional focus, so it is difficult to discern whether individual participants' performance in the high-pressure phase was affected by external distraction or excessive self-focus. Anxious performers distracted by external stimuli, internal self-focus, or both, are less likely to perform well as their attention becomes increasingly divided (Nieuwenhuys & Oudejans, 2012). Previous researchers have found that mindfulness may indirectly influence performance by regulating anxiety (Bellinger et al., 2015; Brunye et al., 2013; Röthlin et al., 2016; Solberg et al., 1996). Notably, Mesagno et al (2009) found that a dual-task intervention improved free-throw shooting performance during a high-pressure situation for choking-susceptible athletes, which suggests that attention-based interventions may be appropriate for addressing free-throw shooting performance under pressure.

There is some evidence in the current study that the pressure manipulation was effective at increasing participants' anxiety during the high-pressure phase. The mindfulness training was expected to buffer against anxiety for the experimental group, therefore, the control group's state anxiety scores between phases served as a main indication of the effect of the manipulation. The control group participants reported higher mean cognitive state anxiety and somatic state anxiety scores during the high-pressure phase compared to their scores during the low-pressure phase of the study; however, none of those increases was statistically significant. By contrast, the mindfulness group reported slightly lower levels of cognitive and somatic anxiety during the high-pressure phase; though these changes were not statistically significant from their low-pressure levels. Therefore, the second hypothesis was not supported by this data; though trends in the groups' anxiety data from low to high pressure phases were in the direction of the study's third hypothesis. One possibility for this finding is that in addition to the relaxing quality of the mindfulness treatment, the control group's treatment of listening to a basketball history lecture may not have been completely neutral, as they may have found it to be relaxing. However, the mindfulness group reported statistically significantly lower levels of cognitive and somatic anxiety during the high-pressure phase of the study compared to the control group, which supports the study's second hypothesis. These significant findings indicate that merely 15-minutes of mindfulness training leads to meaningful differences in anxiety in sport settings, which may have implications for performance given previous research (Bellinger et al., 2015; Solberg et al., 1996). A mindfulness protocol requiring only a 15-minute time commitment, which can be administered via an audio recording, is more efficient in terms of time and cost than longer protocols spanning multiple weeks with many hours spent with a guided meditation instructor. The brief mindfulness intervention may increase athletes' emotional well-being by decreasing anxiety, which is usually perceived as a negative experience. However, additional studies are necessary to determine whether this effect can be reproduced.

Inconsistent with the second hypothesis, both the mindfulness and control groups reported being significantly less cognitively and somatically state anxious during the high-pressure phase than their reported trait levels of competitive cognitive and somatic anxiety. The control group also reported significantly higher confidence during phase two of the study than their reported trait confidence levels, which ran contrary to the initial hypotheses. However, the trait measure, which was administered during the low-pressure phase, was a modified version of the CSAI-2R (Cox et al., 2003), a state measure of anxiety. In the current study, the phrasing of the questions was changed from this measure to ask about general tendencies, rather than states. Although this procedure was recommended by one of the CSAI-2's authors, this modified measure has not been validated and thus may not have accurately detected differences between trait and state anxiety after the pressure manipulation.

The mindfulness group did not statistically significantly increase their reported curiosity compared to the control group on the study's state mindfulness measure as the researchers predicted in the study's third hypothesis; however, the mindfulness group reported significantly higher curiosity scores during phase one compared to the control group, which was unexpected given that the groups were randomly assigned. Both groups also increased their curiosity scores from the low-pressure phase to the high-pressure phase, which could have been due to several reasons, including: familiarity with the questionnaire from taking it twice, the fact that both the mindfulness and control recordings required participants to sit without distraction before shooting free-throws, a placebo effect from both groups being told that their performances may be improved, or good-subject bias from control participants. This finding that both the mindfulness and control groups increased their curiosity scores from the low-pressure to high-pressure phase indicates no significant effect of the mindfulness intervention on curiosity. There were also no significant differences between groups on the decentering scale during the high-pressure phase, possibly because some participants had difficulty understanding the decentering questions about separating oneself from their thoughts and emotions. Anecdotally, many participants asked questions about items on the decentering scale, which indicated confusion with the wording and may indicate that their answers are not an accurate representation of their state mindfulness. Previous researchers have found no significant correlation between number and length of mindfulness class sessions and positive psychological outcomes (Carmody & Baer, 2009). However, the present results suggest a single 15-minute mindfulness training session may not be enough to increase state mindfulness, which contrasts with previous findings that a single mindfulness training can increase state mindfulness while performing cognitive tasks (Bishop et al., 2004; Weger et al., 2012). A 15-minute intervention may not bring about significant changes in state mindfulness, which could explain why no statistically significant differences in sport performance were observed in the current study. Perry et al (2017) implemented a 30-minute intervention, which may be the necessary length of brief mindfulness training to increase performance on physical skills.

Although no statistically significant differences in state mindfulness were found between the mindfulness and control groups, mindfulness participants' responses on the manipulation check questions indicated that they found their treatment to be of more value than the control group. Additionally, when asked if they were more anxious following the pressure manipulation, participants in the mindfulness group reported *somewhat disagree* on average, yet the control group participants responded *neutral* on average. Overall, the participants who received a brief mindfulness session found it to be valuable and subjectively felt less anxious, which should be noted by coaches and sport psychology practitioners, as athletes who practice mindfulness may find it beneficial and be more relaxed under pressure.

Limitations

Although the study had several strengths, including the use of a true experimental design and pair-matched random assignment, several limitations of the current study should also be considered. A primary limitation of the present study was the sample size. A larger sample would have provided more statistical power. Next, because the experiment required that participants return to the lab for a second session, there was attrition (n = 3) between phases. Additionally, participants were not explicitly prohibited from practicing free-throws in the two- to three-week period between the low- and high-pressure phases. If some participants practiced their free-throws before returning for the high-pressure phase, the results of the study could have been affected. An additional limitation is that participants had varying levels of experience with mindfulness; however, the 12 participants who had experience with mindfulness were evenly spread between the experimental (n = 6) and control conditions (n = 6).

Conclusions and Future Directions

The present study is the first to examine the effects of a brief mindfulness training on athletic performance under pressure. Previous studies have indicated that mindfulness training may be an effective technique for reducing anxiety (Bellinger et al., 2015; Solberg et al., 1996), increasing task-relevant attention (Bishop et al., 2004; Gardner & Moore, 2004), and improving sport performance (Kaufman et al., 2009; De Petrillo et al., 2009; Thompson et al., 2011). The present study's results do not align with these previous findings, as the mindfulness group did not statistically significantly outperform the control group in free-throws made or shot quality under pressure. However, when controlling for trait mindfulness, the mindfulness group's shot quality score under pressure was nearly statistically significantly higher (p = .051) than the control group, with a medium effect size, after just 15 minutes of mindfulness meditation. There is practical significance in this result, as more accurate shots can translate into meaningful differences in actual game performance. In addition, the findings of the current study indicate that a single mindfulness training results in significantly lower cognitive and somatic anxiety for athletes faced with a high-pressure performance situation. Therefore, the implementation of a 15-

minute mindfulness training would be worthwhile for an athlete prior to a pressure performance, with little cost and time required, as a way to enhance their subjective experiences in sport.

Future researchers investigating the effects of a brief mindfulness training on athletic performance under pressure should explore other variables and take into consideration the aforementioned limitations when designing future experiments. Both fear of negative evaluation and self-consciousness have been found to be predictors of performance decrements under pressure and are often positively related to heightened cognitive and somatic anxiety (Leary, 1992; Liao & Masters, 2002; Mesagno, Harvey, & Janelle, 2012), therefore inclusion of the Brief Fear of Negative Evaluation Scale (BFNE-II; Carlton, McCreary, Norton, & Asmundson, 2006) and Self-Consciousness Scale (SCS; Fenigstein et al., 1975) in future studies may provide a clearer representation of how cognitive and somatic anxiety translates into performance. Future research should also attempt to recruit a larger sample for more statistical power to detect group differences. Furthermore, studies should instruct participants not to practice free-throws between sessions, if possible. Additionally, future studies should attempt to recruit participants with similar levels of experience with mindfulness. Finally, examining various types of mindfulness scripts and protocols, various instructors and recordings, various time lengths, and varying numbers of sessions on different sport skills and ability levels are worthy of further study on sport performance under pressure.

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Appendix A

Journal of Applied Sport Psychology Submission Guidelines

Guidelines can be found using the following link:

https://www.tandfonline.com/action/authorSubmission?journalCode=uasp20&page=instructions

Appendix B

Western Washington University Internal Review Board Notification

19-012 Human Subjects Application Approved

WWU Research Compliance
Mon 12/17/2018 4:26 PM
To:

Nate Wolch <wolchn@wwu.edu>

Cc:

Jessyca Arthur-Cameselle <arthurj2@wwu.edu>

Hi Nate,

Your application needed to be assigned a new protocol number. Going forward, your application can be referred to as protocol #19-012.

Your application #19-012 "The Effect of a Brief Mindfulness Intervention on Free-throw Shooting Performance Under Pressure" is approved. You may begin recruitment and data collection.

Applications should be closed when all interaction and intervention with human subjects or their identifiable data is complete.

If any adverse events or issues occur during your research, please tell us as soon as possible. If you need to request any changes to your research, please submit a modification form.

Attached is your approval packet. Please be sure to only use the text of the stamped approved consent form for all subject consenting. Please also store this application packet and signed consent forms for the duration of your research and according to the University's retention guidelines.

Feel free to call or email if you have any questions.

Best,

Stephanie Richey
Research Compliance Officer
Research & Sponsored Programs|Western Washington University
www.wwu.edu/compliance

compliance@wwu.edu
360.650.2146

Appendix C

Consent Form
Mental States and Free-throw Shooting Performance
Western Washington University

Researchers:
Principle Investigator: Nate Wolch
Faculty Advisor: Dr. Jessyca Arthur-Cameselle
Western Washington University
Phone: 360-650-7269

We are asking you to be in a research study. Participation is voluntary. The purpose of this form is to give you the information you will need to help you decide whether to participate. Please read the form carefully. You may ask questions about anything that is not clear. When we have answered all of your questions, you can decide if you want to be in the study or not. This process is called "informed consent." We will give you a copy of this form for your records.

Purpose of the Study

Research in the field of sport psychology is often designed to investigate various performance enhancing techniques. The purpose of this experiment is to investigate the way that psychological factors, in other words mental states, influence performance on free-throw shooting.

Study Procedures

This study requires that you participate on two separate days.

On day 1 you will:

- Take four brief psychological surveys and one demographic survey (~ 15-20 minutes). The surveys will ask you about your thoughts and experiences. A sample question includes: "I generally feel self-confident"
- Warm up and shoot basketball free-throws (~ 7-9 minutes)

On day 2 (scheduled several days after day 1), you will:

- Listen to an audio recording (15 minutes)
- Take three more psychological surveys (~ 10-15 minutes)
- Warm up and shoot basketball free-throws (~ 7-9 minutes)

For all surveys, you may skip any question that you are not comfortable answering.

ALL RESEARCH SESSIONS WILL BE IN CARVER GYMNASIUM, GYM D

Risks of Participation

Potential risks of participation in this study include:

- Experiencing stress and anxiety
- There are no anticipated lasting risks

Benefits

Potential benefits of participation in this study include:

- Increased free-throw shooting performance
- Heightened levels of self-awareness

Compensation

Participants who complete both phases of the study will receive a $20 gift card as compensation for their time and effort.

Data Security, and Protections

We will protect the privacy of your data by keeping all completed survey materials in a locked file cabinet inside of a locked room, in Carver 202D, after your participation.

We take every precaution to protect your information, though no guarantee of security can be absolute. We believe the chances of you being identified are low due to the protections in place for your privacy. Only researchers and research assistants will be able to access your responses. You will be given an ID number for this study, which will be used to label your data. The link between this ID number and your name and other identifying information will be stored separately. The link between your ID number and contact information will be kept by the researchers through the end of the study. There are times where studies are reviewed by Western Washington University to make sure that they are being conducted safely. In the event that this occurs, the reviewers will be responsible for protecting your privacy.

Withdrawal

You are free to withdraw from this study at any time without penalty. If you withdraw the study, we will keep your data unless you request to withdraw your data. If you choose to withdraw after only completing phase one of the study, you will receive a pro-rated compensation of $5. You can submit a request to **wolchn@wwu.edu or jessyca.arthur-cameselle@wwu.edu** to withdraw your data up until the study ends.

Research Participant Rights

This research was approved by Western Washington University's Human Subjects Committee. If you have concerns or questions about this research study, please contact Nate Wolch at 253-306-4817 or wolchn@wwu.edu or Dr. Jessyca Arthur-Cameselle at jessyca.arthur-cameselle@wwu.edu. If you have questions about your rights as a research participant, contact the Western Washington University Office of Research and Sponsored Programs (RSP) at compliance@wwu.edu or (360) 650-2146.

Consent

By signing below, you are saying that you have read this form, that you have had your questions answered, that you understand the tasks involved, and volunteer to take part in this research. You understand that we will contact you by email to schedule your second day for participation.

Participant's Statement: This study has been explained to me. I volunteer to take part in this research. I have had a chance to ask questions. I will receive a copy of this consent form.

____________________________ _______________________________ _____________

Full Name Signature Date

Appendix D

Competitive State Anxiety Inventory–2 Revised (Cox, Martens, & Russell, 2003)

Directions: A number of statements that athletes have used to describe their feelings before competition are given below. Read each statement and then circle the appropriate number to the right of the statement to indicate how you feel right now – at this moment. There are no right or wrong answers. Do not spend too much time on any one statement but choose the answer which describes your feelings right now.

	Very Untrue **1**	**Somewhat Untrue** **2**	**Somewhat True** **3**	**Very True** **4**
1. I feel jittery	**1**	**2**	**3**	**4**
2. I am concerned that I may not do as well in this competition as I could	**1**	**2**	**3**	**4**
3. I feel self-confident	**1**	**2**	**3**	**4**
4. My body feels tense	**1**	**2**	**3**	**4**
5. I am concerned about losing	**1**	**2**	**3**	**4**
6. I feel tense in my stomach	**1**	**2**	**3**	**4**
7. I'm confident that I can meet the challenge	**1**	**2**	**3**	**4**
8. I am concerned about choking under pressure	**1**	**2**	**3**	**4**
9. My heart is racing	**1**	**2**	**3**	**4**

	Very Untrue 1	Somewhat Untrue 2	Somewhat True 3	Very True 4
10. I'm confident about performing well	**1**	**2**	**3**	**4**
11. I'm concerned about performing poorly	**1**	**2**	**3**	**4**
12. I feel my stomach sinking	**1**	**2**	**3**	**4**
13. I'm confident because I mentally picture myself reaching my goal	**1**	**2**	**3**	**4**
14. I'm concerned that others will be disappointed in my performance	**1**	**2**	**3**	**4**
15. My hands are clammy	**1**	**2**	**3**	**4**
16. I'm confident of coming through under pressure	**1**	**2**	**3**	**4**
17. My body feels tight	**1**	**2**	**3**	**4**

Scoring key:

Somatic anxiety: 1, 4, 6, 9, 12, 15, 17
Cognitive anxiety: 2, 5, 8, 11, 14
Self-confidence: 3, 7, 10, 13, 16

Subscale score is obtained by summing, dividing by number of items, and multiplying by 10. Score range is 10 to 40 for each subscale. If an athlete fails to respond to an item, merely sum and divide by items answered.

Appendix E

Modified Competitive State Anxiety Inventory–2 Revised (Cox, Martens, & Russell, 2003)

Directions: A number of statements that athletes have used to describe their feelings before competition are given below. Read each statement and then circle the appropriate number to the right of the statement to **indicate how you typically feel before a competition**. There are no right or wrong answers. Do not spend too much time on any one statement but choose the answer which describes your usual feelings.

	Very Untrue **1**	**Somewhat Untrue** **2**	**Somewhat True** **3**	**Very True** **4**
1. I usually feel jittery	**1**	**2**	**3**	**4**
2. I am usually concerned that I may not do as well in this competition as I could	**1**	**2**	**3**	**4**
3. I typically feel self-confident	**1**	**2**	**3**	**4**
4. My body usually feels tense	**1**	**2**	**3**	**4**
5. I am typically concerned about losing	**1**	**2**	**3**	**4**
6. I usually feel tense in my stomach	**1**	**2**	**3**	**4**
7. I'm typically confident that I can meet the challenge	**1**	**2**	**3**	**4**
8. I am typically concerned about choking under pressure	**1**	**2**	**3**	**4**

	Very Untrue 1	Somewhat Untrue 2	Somewhat True 3	Very True 4
9. My heart is usually racing	**1**	**2**	**3**	**4**
10. I'm usually confident about performing well	**1**	**2**	**3**	**4**
11. I'm usually concerned about performing poorly	**1**	**2**	**3**	**4**
12. I typically feel my stomach sinking	**1**	**2**	**3**	**4**
13. I'm usually confident because I mentally picture myself reaching my goal	**1**	**2**	**3**	**4**
14. I'm typically concerned that others will be disappointed in my performance	**1**	**2**	**3**	**4**
15. My hands are usually clammy	**1**	**2**	**3**	**4**
16. I'm typically confident of coming through under pressure	**1**	**2**	**3**	**4**
17. My body usually feels tight	**1**	**2**	**3**	**4**

Scoring key:
Somatic anxiety: 1, 4, 6, 9, 12, 15, 17
Cognitive anxiety: 2, 5, 8, 11, 14
Self-confidence: 3, 7, 10, 13, 16

Subscale score is obtained by summing, dividing by number of items, and multiplying by 10. Score range is 10 to 40 for each subscale. If an athlete fails to respond to an item, merely sum and divide by items answered.

Appendix F

Toronto Mindfulness Scale (Lau et al., 2006)

Directions: We are interested **in what you just experienced**. Below is a list of things that people sometimes experience. Please read each statement. Next to each statement are five choices: "not at all," "a little," "moderately," "quite a bit," and "very much." Please indicate the extent to which you agree with each statement. In other words, how well does the statement describe what you just experienced, just now? Mark the box that best represents your experience.

	Not at all **0**	**A little** **1**	**Moderately** **2**	**Quite a bit** **3**	**Very much** **4**
1. I experienced myself as separate from my changing thoughts and feelings.	**0**	**1**	**2**	**3**	**4**
2. I was more concerned with being open to my experiences than controlling or changing them	**0**	**1**	**2**	**3**	**4**
3. I was curious about what I might learn about myself by taking notice of how I react to certain thoughts, feelings or sensations.	**0**	**1**	**2**	**3**	**4**
4. I experienced my thoughts more as events in my mind than as a necessarily accurate reflection of the way things 'really' are.	**0**	**1**	**2**	**3**	**4**
5. I was curious to see what my mind was up to from moment to moment.	**0**	**1**	**2**	**3**	**4**
6. I was curious about each of the thoughts and feelings that I was having.	**0**	**1**	**2**	**3**	**4**

	Not at all 0	A little 1	Moderately 2	Quite a bit 3	Very much 4
7. I was receptive to observing unpleasant thoughts and feelings without interfering with them.	**0**	**1**	**2**	**3**	**4**
8. I was more invested in just watching my experiences as they arose, than in figuring out what they could mean.	**0**	**1**	**2**	**3**	**4**
9. I approached each experience by trying to accept it, no matter whether it was pleasant or unpleasant.	**0**	**1**	**2**	**3**	**4**
10. I remained curious about the nature of each experience as it arose.	**0**	**1**	**2**	**3**	**4**
11. I was aware of my thoughts and feelings without overidentifying with them.	**0**	**1**	**2**	**3**	**4**
12. I was curious about my reactions to things.	**0**	**1**	**2**	**3**	**4**
13. I was curious about what I might learn about myself by just taking notice of what my attention gets drawn to.	**0**	**1**	**2**	**3**	**4**

Scoring:
All items were written in the positively keyed direction, so no reverse scoring is required.
Curiosity score: The following items are summed: 3, 5, 6, 10, 12, 13
Decentering score: The following items are summed: 1, 2, 4, 7, 8, 9, 11

Appendix G

Mindful Attention Awareness Scale (MAAS) (Brown & Ryan, 2003)

Directions: Below is a collection of **statements about your everyday experience**. Using the 1-6 scale below, please indicate how frequently or infrequently you currently have each experience. Please check the **box according to what really reflects your experience** rather than what you think your experience should be. Please treat each item separately from every other item.

	Almost Always 1	**Very Frequently 2**	**Somewhat Frequently 3**	**Somewhat Infrequently 4**	**Very Infrequently 5**	**Almost Never 6**
1. I could be experiencing some emotion and not be conscious of it until some time later.	**1**	**2**	**3**	**4**	**5**	**6**
2. I break or spill things because of carelessness, not paying attention, or thinking of something else.	**1**	**2**	**3**	**4**	**5**	**6**
3. I find it difficult to stay focused on what's happening in the present.	**1**	**2**	**3**	**4**	**5**	**6**
4. I tend to walk quickly to where I'm going without paying attention along the way.	**1**	**2**	**3**	**4**	**5**	**6**
5. I tend not to notice feelings of physical tension or discomfort until they really grab my attention.	**1**	**2**	**3**	**4**	**5**	**6**
6. I forget a person's name almost as soon as I've been told it for the first time.	**1**	**2**	**3**	**4**	**5**	**6**

	Almost Always 1	Very Frequently 2	Somewhat Frequently 3	Somewhat Infrequently 4	Very Infrequently 5	Almost Never 6
7. It seems I'm "running on automatic" without much awareness of what I'm doing.	**1**	**2**	**3**	**4**	**5**	**6**
8. I rush through activities without being really attentive to them.	**1**	**2**	**3**	**4**	**5**	**6**
9. I get so focused on the goal I want to achieve that I lost touch with what I am doing right now to get there.	**1**	**2**	**3**	**4**	**5**	**6**
10. I do jobs or tasks automatically, without being aware of what I'm doing.	**1**	**2**	**3**	**4**	**5**	**6**
11. I find myself listening to someone with one ear, doing something else at the same time.	**1**	**2**	**3**	**4**	**5**	**6**
12. I drive places on "automatic pilot" and then wonder why I went there.	**1**	**2**	**3**	**4**	**5**	**6**
13. I find myself preoccupied with the future or the past.	**1**	**2**	**3**	**4**	**5**	**6**
14. I find myself doing things without paying attention.	**1**	**2**	**3**	**4**	**5**	**6**
15. I snack without being aware that I'm eating.	**1**	**2**	**3**	**4**	**5**	**6**

Scoring:
Items are all asked in the negatively keyed direction, so no reverse scoring is needed. Sum each item, and divide by 15. The score should be between 1 and 6.

Appendix H

Debrief Script

Thank you for your participation in our study. Now that we have finished taking our measures, I would like to take a moment to explain exactly what we were studying. The purpose of this study was to see the effects of a brief mindfulness training on participants' ability to shoot free-throws under pressure. In order to study this, we divided all participants into two groups. We had the experimental group listen to a mindfulness recording, and had the control group listen to an NBA basketball history lecture. Some studies have shown that mindfulness training can improve performance on athletic skills, and other studies have shown that mindfulness can improve cognitive performance under pressure. Previous research has indicated that mindfulness training may improve athletes' ability to remain attentive to a sport task. In this study, we wanted to see if mindfulness would have an effect on free-throw shooting, despite the presence of a simulated pressure situation.

In our study, it was necessary for us to withhold certain information from you as a participant. The video cameras that we said would be recording your form to be evaluated by our motor control professors were actually turned off. By telling you and other participants that the cameras were recording, and by offering an incentive to the top performer, we were hoping to make you and other participants more nervous and self-aware. Researchers often use similar strategies in research studies to make participants more nervous. We want you to be aware that no footage was actually taken of your free-throw shooting. We were interested in whether practicing mindfulness for just 15 minutes was more or less helpful than listening to a generic audio tape about basketball on free-throw shooting performance under pressure. But, we will be giving a gift card to the top performer. We will contact you within a week if you were the top performer.

Now that we have gone over the purpose of this study, do you have any questions?

Now that I've explained all the details of the study to you, do you agree to allow us to use the data that you provided in our study?

Please do not discuss the details of this study with anyone else who may participate until after he quarter is over, when all of the data has been collected. Thank you for your discretion.

Appendix I

Researcher Script

Phase 1:
Hi! Welcome to the study. Before we get started please read over this consent form and let us know if you have any questions.

Written measures

We will begin by having you complete three written survey measures, then once you complete the surveys, you will be allowed two minutes to warm up, and finally you will shoot 20 free-throws. After you complete your free-throw attempts we have two more surveys for you to complete. The purpose of these surveys is to get an idea of how you feel. Each survey is between 13 and 17 questions. This phase of the study should take about 20 to 30 minutes to complete. Please be sure to read the instructions for each separate survey and answer as honestly as you can. There are no right or wrong answers, and your identity will not be indicated on the survey. You will be assigned to a participant number on all of these documents. So, please do not write your name on the surveys.

CSAI-2R-Trait (Survey 1)

We will begin with a survey assessing how you typically feel before a competition. Make sure to read the instructions carefully and let us know if you have any questions.

MAAS (Survey 2)

Now we ask you some questions about your everyday experience. Once again, please make sure to read the instructions carefully and let us know if you find anything confusing.

CSAI-2R-State (Survey 3)

Next we will be asking you about your experience right now at this very moment. Once again, please make sure to read the instructions carefully and let us know if you find anything confusing.

Warm-up

You will have two minutes to warm up in any way that you would like before we begin keeping score.

Do you have any questions before you begin your warm up?

Free-throw shooting

Your two-minute warm-up is now complete. Now we will begin keeping track of your free-throw shooting performance on 20 official free-throws (Gather scoresheet and pen). Do you have any questions before we get started?

TMS

Now that you have finished your free-throw attempts, we will have you complete a brief survey asking about your experience while shooting the free-throws. Please read the instructions and let us know if you have any questions.

Demographic

Finally, we have a brief demographic questionnaire for you to fill out.

Once finished…

Thank you for completing phase one of our study. Would you like to know your free-throw score? You will be compensated after completing phase two of the study. We will be in touch to schedule your follow-up session (Try to schedule participant right there).

Phase 2:

For the experimental group: Thank you for joining us for part two of the study. Today, you will be listening to a 15-minute recording of mindfulness meditation prior to shooting 20 free-throws. Mindfulness meditation may help you to get into a better performance mindset while you shoot your free-throws and improve your performance. Please listen closely to the recording and follow along. My voice will prompt you to open your eyes when the recording is finished. Do you have any questions?

For the control group: Thank you for joining us for part two of the study. Today, you will be listening to an audio recording of 15-minute NBA history lecture prior to shooting your free-throws. This lecture may help you to get into a better performance mindset while you shoot your free-throws and improve your performance. Please listen closely and follow along. Do you have any questions?

Pressure manipulation

- This time we will be videotaping your free-throws. Our motor control and P.E. professors need video footage of made basketball shots.
- Because we were already having you come for the study, we thought it would be easy to just tape you rather than recruiting other participants. These professors may show these videos in class as teaching material.
- While your identity will be kept anonymous by recording you from behind, it is important that you take this session very seriously and try to make as many shots as possible so that the professors have usable footage of made free-throws.
- In order to get everyone to try their best on this second session, we also decided to add an incentive. So, in this second phase of the experiment, the participant with the best shooting performance, the highest percentage made, will be awarded an additional $20 bonus.
- Before you shoot, you will fill out one of the same surveys as last time and then we will get started. Once again, you will have two minutes to warm up and way you would like, and you will shoot 20 free-throws that will be evaluated and recorded.
- Do you have any questions?

CSAI-2R-State (Survey 3)

First, we will be asking you about your experience right now at this very moment. Once again, please make sure to read the instructions carefully and let us know if you find anything confusing.

Warm up

You will have two minutes to warm up in any way that you would like. Do you have any questions before you begin your warm up?

Free-throw shooting

Now we will begin keeping track of your free-throw shooting performance (Turn on camera). Do you have any questions before we get started?

TMS (Survey 4)

(Turn off camera) Now that you have finished your free-throw attempts, we will have you complete a brief survey asking about your experience while shooting the free-throws. Please read the instructions and let us know if you have any questions.

Manipulation check

Before we give you your compensation and debrief you, we have a few more questions for you.

Debrief

Appendix J

Manipulation Check

Experimental Group:

Instructions: Please rate the degree to which you agree or disagree with the following statements.

	Strongly Disagree 1	**Disagree 2**	**Somewhat Disagree 3**	**Neutral 4**	**Somewhat Agree 5**	**Agree 6**	**Strongly Agree 7**
1. I found the mindfulness meditation to be of value to my free-throw shooting performance.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
2. I actively listened and participated in the meditation.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
3. When I was told I would be recorded, evaluated, and could win more money, my anxiety/nervousness increased.	**1**	**2**	**3**	**4**	**5**	**6**	**7**

Have you ever practiced mindfulness/meditation?

____Yes   ______No

If yes, please describe the type of mindfulness or meditation practice you have engaged in and your frequency of practice below:

Control Group:

Instructions: Please rate the degree to which you agree or disagree with the following statements.

	Strongly Disagree 1	**Disagree 2**	**Somewhat Disagree 3**	**Neutral 4**	**Somewhat Agree 5**	**Agree 6**	**Strongly Agree 7**
1. I found the basketball history lecture to be of value to my free-throw shooting performance.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
2. I listened closely to the recording.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
3. When I was told I would be recorded, evaluated, and could win more money, my anxiety/nervousness increased.	**1**	**2**	**3**	**4**	**5**	**6**	**7**

Have you ever practiced mindfulness/meditation?

____Yes ______No

If yes, please describe the type of mindfulness or meditation practice you have engaged in and your frequency of practice below:

Appendix K

Demographic Questionnaire

Age: _________

Biological sex assigned at birth (Circle one): M / F

Years of experience playing competitive basketball in which games were refereed: _________

Ethnicity (Check all that apply):

- ☐ American Indian or Alaska Native
- ☐ Asian (including Indian subcontinent and Philippines)
- ☐ Black or African American (including Africa and Caribbean)
- ☐ Hispanic or Latino (including Spain)
- ☐ Native Hawaiian and Other Pacific Islander
- ☐ White (including Middle Eastern)
- ☐ Other________________
- ☐ Prefer to not respond

Highest level of competition (e.g., HS varsity, HS club, collegiate NCAA DIII):

____