The Influence of Dispositional Mindfulness on State Anxiety and Motor Choking Under Pressure

by

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Abstract

Performance pressure can promote anxiety. The accompanying increase in physiological arousal and reallocation of attentional resources can result in underperforming, known as choking under pressure. Research suggests the extent to which pressure influences motor performance may depend on individual differences in the degree to which anxiety increases while performing under pressure. Mindfulness represents a mental mode whereby attention is self-regulated in an emotionally nonreactive manner. As dispositional mindfulness can attenuate anxiety in stressful environments, it may reflect an individual difference in performers' susceptibility to choking under pressure. Specifically, individuals with high degrees of dispositional mindfulness may be less likely to experience increases in anxiety under pressure and therefore less likely to choke. The present study tested this hypothesis by having 83 participants perform a novel, closed-motor task (rolling a ball 100 cm to a target) under low- and high-pressure conditions. Self-reported state anxiety was assessed just prior to each condition, and dispositional mindfulness was indexed at the end of each data collection. Results revealed dispositional mindfulness attenuated choking under pressure, but changes in state anxiety did not mediate this relationship. This is the first experimental evidence that dispositional mindfulness attenuates choking under pressure during motor performance. Although the mechanisms underlying this relationship are still unclear, these results implicate mindfulness training as a tool that may be beneficial to alleviate choking under pressure.

Keywords: mindfulness, anxiety, motor performance, choking under pressure

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List of Abbreviations

FFMQ	Five Facet Mindfulness Questionnaire
PFC	Prefrontal cortex
fMRI	Functional magnetic resonance imaging
NA	Nucleus accumbens
ACC	Anterior cingulate cortex
EDA	Electrodermal activity
MRE	Mean radial error
SD Y	Standard deviation along Y-axis
CE Y	Constant error along Y-axis
CSAI-2R	Revised Competitive State Anxiety Inventory-Version 2
CogAnx	Cognitive anxiety
SomAnx	Somatic anxiety
SelfConf	Self-confidence
AnxComp	Composite anxiety score
Total FFMQ	Dispositional mindfulness score
HP	High-pressure
LP	Low-pressure
HRV	Heart rate variability

Skillful motor performance can be important in many contexts. Specifically, many professions require successful execution of skills like writing, typing, and speaking. As one example, accurate words typed per minute is often considered in hiring software programmers, court reporters, and medical transcriptionists. As another example, the execution quality of sport-specific actions (e.g., running, throwing, hitting, catching, etc.) is often directly related to a professional athlete's salary and potential success. Performing many of these tasks is challenging under low-pressure conditions, but performance is even more challenging in a high-stress environment where significant risks or rewards are at stake. In such conditions, performance can be highly dependent on an individual's psychological perception of and response to the added pressure (Baumeister & Showers, 1986; Gray, 2004, 2011). Failing to perform well in high stakes conditions can have drastic consequences. For example, a warfighter clearing buildings in hostile territory must breach room after room, knowing at any moment an enemy combatant could be around the next corner. Should an engagement occur, rapid decision-making combined with swift and very precise rifle manipulation is imperative. From complex ballistic actions, like quickly positioning on target, to more simple movements, like squeezing a trigger, accurately completing every component is key to survival. In such a potentially stressful and high-risk situation, the mental state in which the operator performs the highly technical motor skill can directly impact mission success and survival. Thus, it is crucial to investigate psychological factors that may predict motor performance in high-stress environments.

Routes to Choking Under Pressure

Motor performance is never the function of a "pure motor system," rather it's an interaction among social, cognitive, and affective influences on behavior, the results of which can either facilitate or disrupt performance (Lewthwaite & Wulf, 2010). The varying effects elicited by performance pressure are prime examples of this highly complex relationship. Psychological pressure is a subjective situational incentive to achieve maximal results that can paradoxically negatively affect motor performance. “Choking” describes a change in performance under pressure, specifically a decrease in performance below normal capability (Baumeister, 1984). Choking under pressure is a common phenomenon in sports, during scholastic examinations, and public speaking tasks. As a byproduct of motivation and desire to perform well, pressure in the form of competition, reward, or fear of negative social evaluation often promotes anxiety, a negative emotional state associated with feelings of worry over performance outcomes. In turn, performance anxiety increases physiological arousal, providing independent and additive mechanisms that can alter a performer’s attentional focus and can consume neural resources needed for highly skilled performance. Motor behavior research elucidating the precise mechanisms that underlie the choking effect has offered insight into individual characteristics that may predict or alter a performer’s propensity to be influenced by performance pressure.

Motor performance studies have postulated two main routes to choking under pressure (Baumeister & Showers, 1986). The first route is known as ‘explicit monitoring’ (Masters, 1992). Explicit monitoring constitutes thinking about one’s own movement production during any given task (beyond the ‘goal’ of the task that one might normally focus on). For instance, as a competitor realizes the importance of performing well, excessive anxiety and arousal may heighten conscious control of movements in an attempt to ensure successful outcomes (Wulf, 2013). Paradoxically, however, this focused attention on the mechanics of performance, instead of the outcome, often impairs motor performance in several ways (Baumeister 1984, Experiments 4 & 5; DeCaro et al., 2011, Experiment 4; Lohse, Sherwood, & Healy, 2010;

Snyder & Logan, 2013). First, explicit monitoring can take well-practiced and holistically represented movements and break them down into serial components that demand attention for initiation and completion. This serial management of sensorimotor information can slow down reaction and execution processes, essentially costing time that may be necessary for successful task performance (Snyder & Logan, 2013). Second, focusing on movement production can cause limb kinematics to become less correlated with one another, more rigid, and highly variable, resulting in a performance decline (Gray, 2011; Lohse, Jones, Healy, & Sherwood, 2014; Lohse, Sherwood, & Healy, 2010). Finally, explicit monitoring may cause more attentional resources to be consumed in initiating and completing each step, thus reducing the available pool for current task demands and potentially contributing to the choking phenomenon (DeCaro et al., 2011; Eysenck, Derakshan, Santos, & Calvo, 2007).

The second route to choking under pressure is known as 'distraction' (DeCaro et al., 2011). Specifically, heightened anxiety and worry over performance outcome can distract a performer away from task-relevant stimuli and processes (Easterbrook, 1959). Moreover, the processing of irrelevant stimuli, such as worrying about performance outcome, may consume a performer's attentional resources (DeCaro et al., 2011). Excessive consumption or reallocation of attention from the task at hand to worry-related punishments and incentives can cause choking under pressure (Beilock & Carr, 2005). This follows because many motor skills require attention. If too many attentional resources are consumed, there won't be enough to successfully execute the motor task, resulting in decreased performance (Beilock et al., 2002, Experiment 2). For example, when persons are specifically attending to their anxiety and negative emotions or the anxiety/negative emotions cause attention to be directed to other things (but are not themselves the focus of attention), they risk consuming the limited resources that are often needed for attention-demanding motor execution. The result of this activity can manifest as an increase in overall movement variability and disruption of timing among skill components (Gray, 2004). Notably, the explicit monitoring and distraction routes to choking under pressure may occur together. Specifically, the monitoring of performance production could be the irrelevant processing that consumes the attentional resources required for relevant stimuli (e.g., stimuli related to strategic decision making).

Theoretical Rationale for Mindfulness

Significant individual differences in pressure perception and response result in varying degrees to which motor performance can be affected (Baumeister & Showers, 1986). For example, personal coping styles or a predisposition to worry about performance outcomes can significantly influence arousal (Baumeister & Showers, 1986), which affects susceptibility to choking under pressure. Dispositional mindfulness may represent another individual difference predictive of pressure perception and response as they relate to motor performance. Mindfulness has been described as paying full attention to the present moment, while minimizing judgments or emotional reactions (Kabat-Zinn, 1990). A comparison of several commonly used mindfulness questionnaires revealed five facets that are consistently related to dispositional mindfulness: acting with awareness, nonjudgmentalness, nonreactivity, observing, and describing (Baer et al., 2006). These facets comprise the Five Facet Mindfulness Questionnaire (FFMQ), which attempts to quantify the extent to which individuals can recognize and accept both the environment as well as their body's current physiological and psychological state. People who score higher on the FFMQ (dispositionally mindful individuals) exhibit a mental mode whereby they tend to self-regulate attention and process stimuli in a non-judgmental and non-reactive manner (Bishop et al., 2004; Kabat-Zinn et al., 1998). Mindful attention regulation and the reduced emotional reactivity mode of stimulus processing may mitigate the choking mechanisms that normally result from psychological pressure, thus alleviating the performance decrement.

With respect to attention regulation, mindfulness may allow one to regulate attention on action goals, avoiding an internal focus of attention (explicit monitoring), which is a common consequence of high-pressure environments. Specifically, as dispositionally mindful individuals exhibit superior ability to regulate their attention (Creswell et al., 2007; Lutz et al., 2014; Taylor et al., 2011; Way et al., 2010), such individuals may be able to avoid explicit monitoring by maintaining attention to performance goals and task-relevant processes. In fact, mindfulness has been associated with self-reported adoption of external attentional focus strategies (focusing on movement goals) during motor execution (Kee et al., 2012). With respect to stimulus processing, mindfulness may prevent reactivity to the negative emotions elicited by high-pressure environments. Specifically, if one reacts to emotional stimuli, there will likely be an increase in arousal, which may cause one's attention to move internally or towards outcome-related worries (Baumeister & Showers, 1986; Beilock & Carr, 2005; DeCaro et al., 2011; Gray, 2004; Masters, 1992; Wulf, 2013). Similarly, regulating one’s attention to the present moment may prevent rumination on previous or future performance outcomes, minimizing the influence of worry-induced anxiety on current task performance.

Mindfulness and Evaluating Emotional Stimuli

Studies on dispositional mindfulness and mindful induction suggest that increased mindfulness is associated with increased attentional control and emotional regulation (Creswell et al., 2007; Lutz et al., 2014; Taylor et al., 2011; Way et al., 2010). Creswell et al. (2007) examined the relationship between dispositional mindfulness and labeling emotional stimuli.

During an affect-labeling task in which a facial expression was matched to the appropriate emotional word, participants who were more dispositionally mindful exhibited greater, widespread prefrontal cortex (PFC) activation and reduced amygdala activity. Additionally, dispositional mindfulness was positively associated with left insula activity, an area also involved in emotional awareness and regulation. After a median split in the population, the high mindful sample had several strong negative relationships between PFC and amygdala activity during affect labeling, providing evidence of prefrontal regulation correlating with a diminished limbic response in those high in dispositional mindfulness. These results indicate dispositional mindfulness modulates neural activity to emotional stimuli, which are often present in the high-pressure environments associated with choking. Moreover, the act of emotion labeling involves evaluative processing and is related to the mindfulness facets of acting with awareness, observing, and describing (Baer et al., 2006). These facets may combine to assist with modifying the coding of aversive stimuli so as to reduce emotional reactivity.

Additional support for mindfulness mitigating emotional activity comes from Way et al. (2010). During functional magnetic resonance imaging (fMRI), participants passively viewed a fixation cross. The researchers compared this condition with two goal-directed matching tasks. Comparing shape matching to facial emotion expression matching was used to assess affective reactivity to viewing negative images. At rest, dispositional mindfulness was negatively correlated with amygdala activity. During the emotion expression-matching task, those participants who were more dispositionally mindful exhibited less amygdala activity. The researchers concluded individuals with greater dispositional mindfulness possessed an intrinsic reduction in resting amygdala activity that explained the observed activity when presented with emotionally charged tasks. This study provides evidence that individuals high in dispositional mindfulness exhibit functional differences in neural reactivity to emotional stimuli. These differences in neural reactivity to emotional stimuli may translate into dispositionally mindful individuals' tendency to perceive performance pressure to a lesser degree, rendering them less likely to succumb to the choking effects caused by excessive arousal.

Evidence for mindfulness reducing emotional reactivity is also provided by neuroimaging research on the effects of mindful states. Taylor et al. (2011) induced participants into a mindful state and presented them with emotionally laden images. The induced state was successful in attenuating self-reported emotional reactivity to all conditions for participants. This reduced reactivity was concomitant with attenuated amygdala activity, and held true during both positive and negative image presentation, a fact that speaks to the broad range of emotional stability induced by mindfulness. Similarly, Lutz et al. (2014) induced mindfulness and then presented participants with positive, negative, and neutral images, sometimes cueing them prior to presenting a negative image. Compared to controls that received no induction, the mindfulness group had significantly reduced amygdala reactivity to negative images and increased PFC activation to positive and negative stimuli. When negative images were pre-cued, the reduced amygdala activity was statistically mediated by increased PFC activity. This finding supports the PFC's role in modulating emotional stimuli. Taken together these studies indicate a neural framework by which mindfulness-related increased PFC activity and diminished amygdala responsiveness attenuate emotional reactivity.

Neural Mechanisms of Mindfulness, Arousal, and Motor Behavior

Dispositional mindfulness research has demonstrated mindfulness leads to enhanced PFC control over the amygdala's response to stressors. The next pathway in the rationale for mindfulness mitigating motor choking under pressure relies on these neural mechanisms' influences on motor control. PFC activation and amygdala deactivation should enhance motor control. Specifically, skillful motor control involves significant information exchange and coordination between all components of the motor system. Based on movement intentions, the premotor cortex receives sensory information from areas like the dorsolateral PFC, then utilizes internal and external cues to mediate the selection of movement and planning in voluntary actions (Kandel et al., 2013; Miller & Cohen, 2001; Rizzolatti, Fogassi, & Gallese, 2002). The supplementary motor cortex is involved with the selection and initiation of action, before and during voluntary movement, by coordinating the execution of complex movement sequences (Goldberg, 1985; Kandel et al., 2013). The primary motor cortex controls the initiation of action commands by generating signals specific to the mechanical details and movement parameters of the musculoskeletal system, thus providing the kinematics and kinetics of voluntary actions (Biswal et al., 1995; Kandel et al., 2013). The basal ganglia contain numerous connections to areas influencing motivation, cognition, and emotion. These areas are implicated in action selection and initiation of movement through reward-based outcome monitoring (Albin, Young, & Penney, 1989; Alexander & Crutcher, 1990; Groenewegen, 2003). Constant somatosensory feedback, in the form of proprioceptive, tactile, and visual information, is required to accurately execute and coordinate voluntary movements. The cerebellum receives somatosensory input and acts as the motor system's error-correcting center by comparing the desired state of movement commands with the actual state of execution, then adjusting the parameters of current output or predicting the required upcoming command based on experience in prior movements (Middleton & Strick, 2000). The cerebellum modifies movement through direct connections with spinal motor circuits or through thalamus-mediated connections to the motor and premotor cortex.

The basal ganglia and cerebellum collectively contribute coordination and timing of movement components to motor output and are implicated in motor learning and control (Groenewegen, 2003). One of the basal ganglia structures, the nucleus accumbens (NA), receives direct input from the PFC, hippocampus, and amygdala. The NA has been implicated in the evaluative processing of emotion laden stimuli, rewarding or aversive (Kalivas & Duffy, 1995; Knutson et al., 2001), as well as encoding novel general motor programs (Mogenson, Jones, & Yim, 1980). Thus, due to its direct connections from the amygdala and other limbic forebrain structures, the NA plays a pivotal role in linking emotion with movement control (Butcher & Talbot, 1978; Groenewegen et al., 1996; Moore & Bloom, 1978; Nauta, 1958). Together these regions make up the anatomical foundation for linking motor control with appraisal and response to emotionally salient stimuli. It is plausible the functional connectivity of these regions is different in high mindful individuals. Since individuals high in dispositional mindfulness exhibit less limbic activation to stressors (Creswell et al., 2007; Way et al., 2010), and the limbic system is linked to the motor system (Nauta, 1958), it follows that mindfulness may mitigate the influence of the limbic system on performance under high-pressure conditions.

PFC and amygdala activity, their relationship to a performer's arousal, and the resulting influence on performance has demonstrated that top-down attention and emotional arousal regulation may provide a more favorable environment for reducing the impact of performance pressure on motor control. Pertaining to how an individual handles performance pressure, the mindfulness trait of frontally-mediated cognitive responses offers potential routes to control attention and minimize emotional response, thus reducing the likelihood for choking. Specific to motor execution, neuroimaging evidence supports the benefits of top-down control (Lee & Grafton, 2015; Mobbs et al., 2009). Mobbs et al. (2009) had participants play a "cat and mouse" game under high- and low-reward conditions while undergoing fMRI. In this paradigm, participants used a keypad to move their character through a maze and towards specific moving targets. Interestingly, Mobbs et al. (2009) found that PFC activity, as measured by the event-related blood-oxygenation-level-dependent signal, was positively correlated to superior performance under pressure, in that fewer motor errors occurred. This provides direct evidence that PFC-mediated activity, a mechanism common to high mindful individuals, may be one factor that protects against performance pressure-related motor choking. Additionally, participants exhibited increased activity in several cognitive reward regions as they moved closer to the high-value targets. Importantly, this elevated midbrain arousal significantly correlated with choking via motoric errors, such that the excessive motivational activity resulted in task failure. The midbrain has several significant reciprocal connections to the amygdala (Rizvi et al., 1991), and structures like the ventral tegmental area are involved in dopaminergic reward of successful motor performance, leading to motor learning (Hosp et al. 2011). Overexcitation can consume neural resources needed for skillful motor execution, a finding that describes and supports the choking under pressure theory of distraction.

Additional support for top-down control leading to superior motor performance under pressure comes from Lee and Grafton (2015). They examined activity in the motor cortex and PFC during a “snake” game, in which participants turned a scrolling wheel with one hand for forward/backward movement and the other hand for side-to-side steering. The goal was to steer their snake from one side of a screen to an apple on the other, while under tight time constraints (2 s). Difficulty was adjusted in a step-wise manner, up or down dependent on if the previous trial was a success or failure. Participants completed the task under a baseline ($0), low ($5), moderate ($10), and high ($40) reward value. In high-reward conditions, the motor cortex showed significantly increased functional connectivity to the PFC and anterior cingulate cortex (ACC), a part of the limbic system responsible for error detection and correction. This connectivity predicted performance accuracy in high reward conditions. Between the moderate and high reward conditions, participants who displayed the greatest increase in PFC connectivity choked the least. The researchers proposed that choking might be prevented with increased functional connectivity between the PFC and motor cortex, if it is an attempt to gain additional top-down attentional control resources. While this proposition may seem in conflict with the notion that explicit monitoring impairs motor performance, enhanced PFC and motor connectivity may not be reflective of consciously controlled movement production, but rather attentional resources being drawn to movement outcomes, an attentional focus that typically promotes motor performance. The PFC's structural and functional diversity also enables the utilization of resources for minimizing the attachment of thoughts and feelings, reducing the effect of perceived worry on amygdala activity and thus the downstream influence of anxiety on motor control. This claim fits with the potential mechanisms whereby mindfulness prevents motor choking under pressure. Specifically, more mindful individuals have been shown to increase PFC activity in response to stressful stimuli, and increased PFC activity can assist with mitigating the limbic response and reducing motor execution errors (Creswell et al., 2007; Lee & Grafton, 2015; Taylor et al., 2011; Way et al., 2010). It is through this top-down executive control of emotional reactivity that mindfulness could minimize motor performance decrements due to high-pressure conditions (Lee & Grafton, 2015; Mobbs et al., 2009).

The previous paragraphs have argued that dispositional mindfulness should affect PFC and amygdala activity, which are connected to motor regions and influence motor control under pressure. In the paragraphs that follow, I will provide examples supporting the argument that dispositional mindfulness reduces state anxiety under pressure, which could be a mechanism that gives rise to superior motor performance. More specifically, in mindful performers, frontally-mediated blunting of arousal may lead to minimal increases in state anxiety, and, compared to less mindful counterparts, this cumulative influence could protect motor performance under pressure.

Direct support for the proposed mindfulness mechanism that PFC activity modulates arousal comes from Zhang et al. (2014). During fMRI, their participants took part in a simple reaction time task with 25% catch trials. Additionally, electrodermal skin activity (EDA), a widely accepted index of sympathetic arousal, was recorded from the index and middle finger to examine the correlation between brain activity and arousal. PFC activity negatively correlated with skin conductance. Granger causality analysis established directional causality between PFC activity and skin conductance. This supports the notion that the PFC plays a direct and regulatory role in psychophysiological arousal. Therefore, if high mindful individuals have enhanced PFC activity when facing emotional stimuli, they may exhibit a significantly reduced arousal response.

Mindfulness modification of arousal to reduce the impact of performance pressure should be observable in reliable, downstream sympathetic responses. For instance, Brown et al. (2012) examined the relationship between dispositional mindfulness and neuroendocrine affective response. Participants completed a control condition or standardized laboratory stress task condition, the Trier Social Stress Test. During this task, participants briefly prepared and then presented a speech before critical evaluators, followed by an impromptu, continuous verbal math test. Saliva, for cortisol quantification, and self-report measures of affect and anxiety were collected before, during, and after the task. Higher measures of dispositional mindfulness significantly predicted lower cortisol responses to the stress task. Additionally, high mindful participants reported significantly lower anxiety and negative affect. This study provides self-report and physiological evidence that dispositional mindfulness mitigates the physiological and self-reported reactivity to stress.

Arch and Craske (2010) used two hyperventilation tasks to investigate the influence of dispositional mindfulness on emotional reactivity and willingness to continue the experience. Higher values of dispositional mindfulness significantly predicted lower negative self-reported affect and distress. This result provides evidence that individuals with higher values of dispositional mindfulness exhibit less self-reported arousal when presented with potentially emotional stimuli. Additionally, more mindful participants were also willing to experience hyperventilating for a significantly longer period of time, exhibiting emotional acceptance, a trait characterized by the mindfulness facets of being nonjudgmental and nonreactive.

While neural functional connectivity provides a framework for emotion regulation influencing motor performance, research on acute stress and motor behavior has provided empirical evidence of arousal negatively impacting motor execution (Noteboom et al. 2001; Sade et al., 1990; Thompson et al., 2015). Noteboom, Fleshner, and Enoka (2001) examined the effects of self-reported arousal and EDA on motor control. Participants utilized visual feedback to practice a submaximal isometric pinch task for 1 min and then performed several test trials as a baseline assessment. They then performed 10 min of verbal, paced, serial subtraction from a 4-digit number. Any errors in their calculations were punished with a brief, 60 to 120 V electric shock. This high-stress condition was immediately followed by 10 min of reassessing the pinch task. Before, during, and after the stressor, participants reported state anxiety via a questionnaire and mood using a visual analog scale. Compared to their baseline and a control group that received only verbal reprimanding for arithmetic errors, the shock group exhibited significantly higher levels of cognitive and physiological arousal, as indexed by self-report and EDA. When compared to the baseline assessment, exposure to acute shock stress reduced pinch grip steadiness such that post-stressor performance resulted in a significantly higher coefficient of variation (i.e., reduced motor control). This study provides behavioral evidence that self-report and physiological arousal impairs motor control. Therefore, if more mindful performers exhibit reduced arousal to emotional stimuli, this arousal would result in less impaired motor control and a reduced potential for performance pressure to cause motor choking.

Additional support for self-reported anxiety impairing motor execution comes from Sade et al. (1990). They had 55 highly and moderately skilled shooters compete in seven air rifle matches. State anxiety was self-reported prior to each competition. The competitions consisted of 60 standing shots at a target 10 m away. Performance, as measured by shooting accuracy, was negatively correlated with state anxiety across all competitions and skill groups. Physiological indices of anxiety have also been examined for their relationship to marksmanship performance. Thompson et al. (2015) used high-frequency heart rate variability, an accepted index of parasympathetic tone, to examine the influence of autonomic response on tactical pistol performance in a classifier competition. They found superior shooters displayed significantly less reduction in parasympathetic tone, indicating they were less aroused. In competition, performers experiencing higher levels of arousal have been shown to exhibit significantly worse motor performance, providing empirical evidence that self-report and physiological arousal significantly predict motor execution quality. Cumulatively, the reviewed literature supports the final potential mechanism for mindfulness mitigating the choking effects. Specifically, more mindful performers exhibit a neural functional difference whereby PFC resources are utilized to reduce amygdala reactivity, which minimizes physiological arousal/anxiety from performance pressure, thus reducing the negative impact on motor performance.

The Present Research

How performers handle pressure, the inner workings of their neural stress response structures, how they process and encode the potential reward of success and negative aspects of failure, and the extent to which these components influence arousal all act as possible contributors to choking. Cumulatively, the reviewed neuroimaging studies consistently reveal neural differences in mindfulness that may lead to enhanced regulation of attention and emotional stress reactivity. While performing an affective or emotional task, participants who are dispositionally mindful show increased prefrontal activity (Creswell, 2007; Way et al., 2010). Mindfulness and PFC regulation over amygdala response to stress leads to a decrease in physiological and self-report arousal (Brown et al., 2012; Zhang et al., 2014). Arousal impairs motor control, but PFC activity/connectivity with the motor cortex mitigates the influence of arousal and may even enhance motor performance under stress (Lee & Grafton, 2015; Mobbs et al., 2009). By preventing the initial perception of performance pressure that leads to arousal, which in turn can cause distraction or explicit monitoring, mindfulness may mitigate the potential routes to choking under pressure.

This study examined the relationship between dispositional mindfulness and motor performance under low and high psychological pressure. Using mindfulness to predict the influence pressure has on performance could be an important tool in selecting performers to undertake a given task, especially in high-stress occupations (e.g., ER surgeon, military operative, fire fighter, etc.), or suggesting interventions (mindfulness training) to facilitate performance. The present study tested the hypothesis that individuals with higher values of dispositional mindfulness will have a reduced reaction to performance pressure, and thus, less of a propensity to choke under pressure. Specifically, it was predicted that participants higher in dispositional mindfulness would experience less state anxiety under identical performance pressure manipulations and incur less of a decline in motor performance relative to lower mindfulness counterparts. To investigate this purpose, participants performed a novel, closed-motor task under low- and high-pressure conditions and had their dispositional mindfulness assessed.

Method

Prior to beginning data collection, the experimental design and analyses were registered and made public on AsPredicted.org (https://aspredicted.org/7697x.pdf).

Participants

Eighty-three participants (48 females, 21.2 ± 1.5 yrs. (*M* ± *SD*), 6 left handed; 35 males, 22.6 ± 3.0 yrs., 4 left handed) took part in this experiment. This sample size was determined using PowMed.R, a statistical R package for doing power analysis in mediation models, developed by David Kenny (davidakenny.net/cm/mediate.htm). The calculation was set to reach .80 power, with an alpha error probability of .05, and detect a moderate effect size for all mediation pathways (*r* = .30, Cohen 1988). The calculation indicated 78 participants were required, and an additional 5 were recruited to account for attrition/incomplete data. Volunteer participants were recruited by word-of-mouth, in-class announcements from a recruitment script, and by a standardized email. Potential participants with neurological impairments or a recent (3 months) musculoskeletal injury to their non-dominant hand, shoulder, arm, or lower back were excluded, as this could interfere with their performance of the task. Additionally, potential participants diagnosed with or taking medication for any psychiatric or cardiometabolic pathology were excluded as this could confound performance pressure perception and response. To avoid influencing autonomic activity, participants were instructed to avoid caffeine, nicotine, alcohol, and exercise for 2 h prior to the study.

Task

This study employed an unfamiliar ball-rolling task on a synthetic putting green (see Figure 1). Specifically, participants sat on a chair, leaned forward, and used their non-dominant hand to roll a pool cue-ball from its resting position on a piece of masking tape between their feet, with the goal of stopping the ball on a target located 100 cm away. They were instructed to set up behind the ball with their fingers extended, then, without taking a backswing, push the ball forward. The target was presented as a crosshair constructed from 2.54 cm wide masking tape that extended 7.62 cm vertically and horizontally from the origin. A thin, white strip of liquid chalk was extended 25 cm from each side of the main target and served as a reference to the experimenters to ensure measurement accuracy. After each roll, deviations from the target were measured in centimeters on the x- and y-axes. The ball was then rolled back to the participants for them to set up and push again once they felt ready. This unfamiliar task was chosen to minimize previously developed preferences that might exist in other, more familiar ballistic movements (e.g., overhand throwing, bowling).

The primary measure of motor performance was accuracy, defined as mean radial error (MRE; Hancock, Butler, & Fischman, 1995). MRE was the primary measure because participants were instructed to be as accurate as possible. Secondary measures of motor performance included precision along the Y-axis (*SD* Y) and bias along the Y-axis, defined as constant error along the Y-axis (CE Y). These measures were calculated along the Y-axis because pilot testing indicated most performance variability occurred along this axis.

Figure 1. Photograph depicting the hand starting position (left) and putting green (right). Participants sat in the chair, leaned forward, and pushed the ball with their non-dominant hand. The hand started in front of the closest piece of tape, while the cue ball started on the second.

Procedure

The University's Institutional Review Board approved all procedures. Participants reported to a research laboratory, provided written informed consent, and were fit about their sternum with a physiological monitoring device, the BioHarness 3.0 (Zephyr Technology, Annapolis, MD, USA). They completed the Edinburgh Handedness Inventory to determine non-dominant limb (Oldfield, 1971). Following the initial paperwork, participants were shown to a private, sound-attenuated room and sat undisturbed for 10 min. After the acclimation period they completed the "baseline" state anxiety assessment and were then instructed how to perform the rolling task.

The practice phase (50 trials) was meant to familiarize participants with the task. Participants were notified when they were halfway through the practice session and when they had 10 trials remaining. The length of the practice session was based on a pilot data set of 10 participants indicating performance stabilized (in terms of within-subject variance) by the 50th trial.

The second and third series consisted of 10 rolls each and were performed under conditions of either low- or high-pressure in a counter-balanced order. In the low-pressure condition, participants were instructed “do your best” to stop the ball on the target each time. Participants were notified when they had five trials left and reminded to “do your best.”

The high-pressure condition involved several manipulations common to paradigms for eliciting performance pressure in laboratory research and was meant to cause the motor choking phenomenon (DeCaro et al., 2011; Dickerson & Kemeny, 2004). Participants were presented with, read, and signed a video release form indicating the next set of 10 rolls would be recorded and critically analyzed by expert biomechanists. A video camera was removed from a nearby cabinet and placed in front of the participant. The camera’s view screen was turned so the participants could see themselves being recorded. They posed for a reference frame with their hand extended behind the ball and a tape measure, then demonstrated a roll to ensure all limb segments of interest were in view. Participants were instructed not only are these next 10 rolls being filmed and analyzed, but the combination of this analysis and their performance accuracy would be entered into a competition with the other participants in which the top five places would receive a monetary reward (1st place = $50, 2nd place = $40, 3rd place = $30, 4th place = $20, 5th place = $10). The monetary rewards were pulled from an envelope, displayed one by one to the participant, and placed along an adjacent countertop. During the high-pressure condition participants were informed when they had five remaining trials and reminded their performance was being filmed as part of a competition to win money.

Participants completed state anxiety measures just prior to the low- and high-pressure conditions. Following completion of the third series, participants completed the FFMQ (dispositional mindfulness) questionnaire and an exit survey to assess their belief regarding the pressure manipulation. They were debriefed, which involved informing them the video observation was not real, permitted to ask any questions regarding the study, and dismissed.

Subjective State Anxiety

Created specifically for application to sport performance, the Revised Competitive State Anxiety Inventory-2 (CSAI-2R) is a shortened version (containing 17 items) of the CSAI, which is a modification of the classic State-Trait Anxiety Inventory (Cox, Martens, & Russell, 2003; Martens et al., 1990; Spielberger, 1970). The CSAI-2R contains three subscales that have been structurally validated with confirmatory factor analysis: cognitive anxiety (CogAnx), somatic anxiety (SomAnx), and self-confidence (SelfConf) (Cox, Martens, & Russell, 2003). Traditionally, participants report their agreement with each item using a 4-point Likert scale with descriptions including: 1 = *not at all*, 2 = *somewhat*, 3 = *moderately so*, 4 = *very much so*. In the present study, a few modifications were made to promote a more continuous variable for statistical analysis purposes (see Appendix D). This modified CSAI-2R was treated similar to a visual analogue in that "not at all" was anchored at 0 and "very much so" at 100. Participants placed a small vertical tick mark at the location along the line corresponding with their agreement to each statement. The cognitive and somatic anxiety subscale scores were calculated based on the distance from 0 to the tick mark, relative to the length of the line. The self-confidence subscale score was reversed (measured as the distance from 100 to the tick mark). This was done so that higher reported values indicated greater anxiety and more self-confidence. Subscale scores were determined by calculating cumulative percentage. The cognitive and somatic anxiety subscales were combined to serve as the primary measure of state anxiety (AnxComp), because they were predicted to exhibit similar curvilinear relationships with performance, whereas self-confidence exhibits a different (linear) relationship with performance (Arent & Landers, 2003; Feltz, 1988).

Dispositional Mindfulness

The FFMQ was chosen to assess dispositional mindfulness (Baer et al., 2006). This questionnaire was constructed based on hierarchical confirmatory factor analysis of converging facets in the extant literature on mindfulness questionnaires. Additionally, it is the questionnaire primarily utilized to assess the impact of mindfulness treatments in a clinical setting. The questionnaire has 39 statements relevant to the mindfulness facets of acting with awareness (8), describing (8), observing (8), emotional nonreactivity (7), and nonjudgmentalness (8). Participants used a 5-point Likert scale (1 = *never or very rarely true*, 2 = *rarely true*, 3 = *sometimes true*, 4 = *often true*, 5 = *very often or always true*) to rate how often the statements are true for them in general. The scores within each facet were summed, and dispositional mindfulness was then determined by summing across the facets (FFMQ Total).

Statistical Analyses

Primary Analysis. To operationalize choking under pressure, high-pressure (HP) MRE was subtracted from low-pressure (LP) MRE, with negative values indicating a larger decrease in performance under pressure (ΔMRE = LP MRE – HP MRE). To determine changes in state anxiety, HP AnxComp was subtracted from LP AnxComp, with positive values indicating less anxiety under high pressure (ΔAnxComp = LP AnxComp – HP AnxComp).

To test the hypothesis that participants higher in dispositional mindfulness would experience less state anxiety under identical performance pressure manipulations and therefore incur less of a decline in motor performance relative to lower mindfulness counterparts, a mediational model was constructed based on Baron and Kenny (1986). In conducting the mediation, the following assumptions for linear regressions were tested and met: a linear and additive relationship between dependent and independent variables, statistical independence of errors, homoscedasticity of errors, and a normal error distribution (see Appendix A). The first step of the mediation model tests that the causal variable (FFMQ Total) will predict the outcome variable (ΔMRE) (path c in Figure 2). The second step of the mediation model tests that the causal variable (FFMQ Total) will predict the mediating variable (ΔAnxComp) (path a in Figure 2). The third step of the mediation model tests that the mediating variable ΔAnxComp will predict the outcome variable ΔMRE (path b in Figure 2). The final step of the mediation model predicts that the causal variable (FFMQ Total) will no longer predict the outcome variable (ΔMRE) when accounting for the mediating variable (ΔAnxComp) (path c' in Figure 2). Therefore, for this relationship to be considered a mediation, the regression for FFMQ Total predicting ΔMRE would have to lose strength when controlling for ΔAnxComp. If this occurs, the unstandardized beta coefficient change from unmediated c to c' is then examined for significance using Sobel's test (Sobel, 1982).

Figure 2. Primary mediation model where the change in state anxiety mediates the relationship between mindfulness and change in motor performance under conditions of low- and high-pressure.

Secondary Analyses. To assess if the relationship between mindfulness and precision or bias is mediated by the change in state anxiety, the same model was repeated testing ΔSD Y and ΔCE Y as the outcome measures. The relationship between anxiety and motor performance was tested in both the low- and high-pressure condition. Additionally, mindfulness was examined for its relationship to state anxiety in all conditions (see Appendix C).

Results

Dispositional Mindfulness

Responses to the FFMQ and facet demographics are presented in Table 1. FFMQ Total had the potential to range from 39-195, with higher values indicating greater levels of mindfulness. Participant reported values ranged from a minimum of 97 to a maximum of 174, with 122, 131, and 139 representing the 25th, 50th, and 75th percentiles, respectively. The range of each individual facet was as follows: Acting with Awareness (ActAware) (9-38), Observe (16-36), Describe (10-40), Nonemotional reactivity (NonReact) (14-29), and Nonjudmentalness (NonJudge) (10-40).

Table 1.
Dispositional Mindfulness Demographics

	M	*SD*
FFMQ Total	130.2	14.4
ActAware	26.9	5.8
Observe	26.9	4.2
Describe	27.3	5.6
NonReact	22.6	3.0
NonJudge	26.5	6.4

Motor Performance

Motor performance data are presented in Table 2. Paired sample *t*-tests indicated there was a significant difference in MRE between the LP and HP conditions (*t*(82) = -2.17, *p* = .033, *d* = -.262), with MRE increasing (i.e., worse performance) in HP. This indicates participants on average choked under pressure. Notably, there was a significant bias to undershoot the target under HP relative to LP (CE Y: *t*(82) = 2.48, *p* = .015, *d* = 0.336).

Table 2.
Motor Accuracy, Precision, and Bias by Condition

Measure	Condition LP	 HP
MRE	16.99 ± 5.54	18.53 ± 6.09
SD Y	18.96 ± 6.99	20.56 ± 6.90
CE Y	-2.05 ± 6.51	-4.21 ± 6.40

Note. Distance from target presented in cm as *M* ± *SD*.
Negative CE Y value reflects undershooting the target

State Anxiety

CSAI-2R questionnaire response data are presented in Table 3. A paired sample *t*-test indicated significantly greater AnxComp under HP relative to LP. This result indicates the pressure manipulations were effective in eliciting greater anxiety in the HP condition. Notably, paired sample *t*-tests indicated the other measures of anxiety/self-confidence exhibited the expected changes in HP relative to LP.

Table 3.
Competitive State Anxiety Inventory-2R by Condition

	Condition		Paired samples t-test		
Measure	LP	HP	*t*-score	Cohen *d*	Sig. (2-tailed)
SomAnx	0.472 ± 0.618	0.819 ± 0.981	-4.95	-0.367	$p < .001$
CogAnx	0.794 ± 0.940	1.16 ± 1.09	-5.39	-0.350	$p < .001$
AnxComp	1.27 ± 1.44	1.98 ± 1.93	-6.17	-0.379	$p < .001$
SelfConf	3.27 ± 1.28	3.09 ± 1.39	-2.56	-0.125	$p = 0.010$

CSAI Total	3.00 ± 2.25	3.89 ± 2.64	-6.54	-0.346	$p < .001$

Note. CSAI-2R data presented as $M \pm SD$.

Primary Mediation Model

The mediation model is depicted in Figure 3. The first step of the mediation model regressed FFMQ Total with ΔMRE and revealed a significant relationship ($t(81) = 4.33$, $p < .001$, $\beta = 0.194$, $CI_{95\%}$ [0.105, 0.283], which explained a moderate amount of the variance in ΔMRE ($R^2 = .188$, $F(1,81) = 18.7$, $p < .001$, see Figure 4). The second step of the mediation model regressed FFMQ Total with ΔAnxComp and revealed a nonsignificant relationship ($p = .451$). The third step of the mediation model regressed ΔAnxComp with ΔMRE and revealed a nonsignificant relationship ($p = .594$). The final step of the mediation model regressed FFMQ Total with ΔMRE accounting for ΔAnxComp and revealed a significant relationship between FFMQ Total and ΔMRE ($t(81) = 4.27$, $p < .001$, $\beta = 0.194$, $CI_{95\%}$ [0.103, 0.283] but not between ΔAnxComp and ΔMRE ($p = .819$). As a set, FFMQ Total and ΔAnxComp explained a moderate amount of the variance in ΔMRE ($R^2 = .188$, $F(2,80) = 9.27$, $p < .001$). The bivariate relationships between mediation variables are presented as scatterplots in Figure 5 and Figure 6.

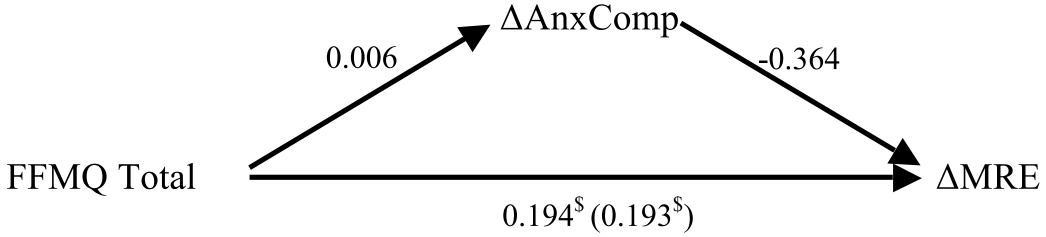

Figure 3. Unstandardized regression coefficients for the relationship between mindfulness and ΔMRE as mediated by ΔAnxComp. The unstandardized regression coefficient between mindfulness and ΔMRE, controlling for AnxComp, is in parentheses. $^{\$}$ $p < .001$.

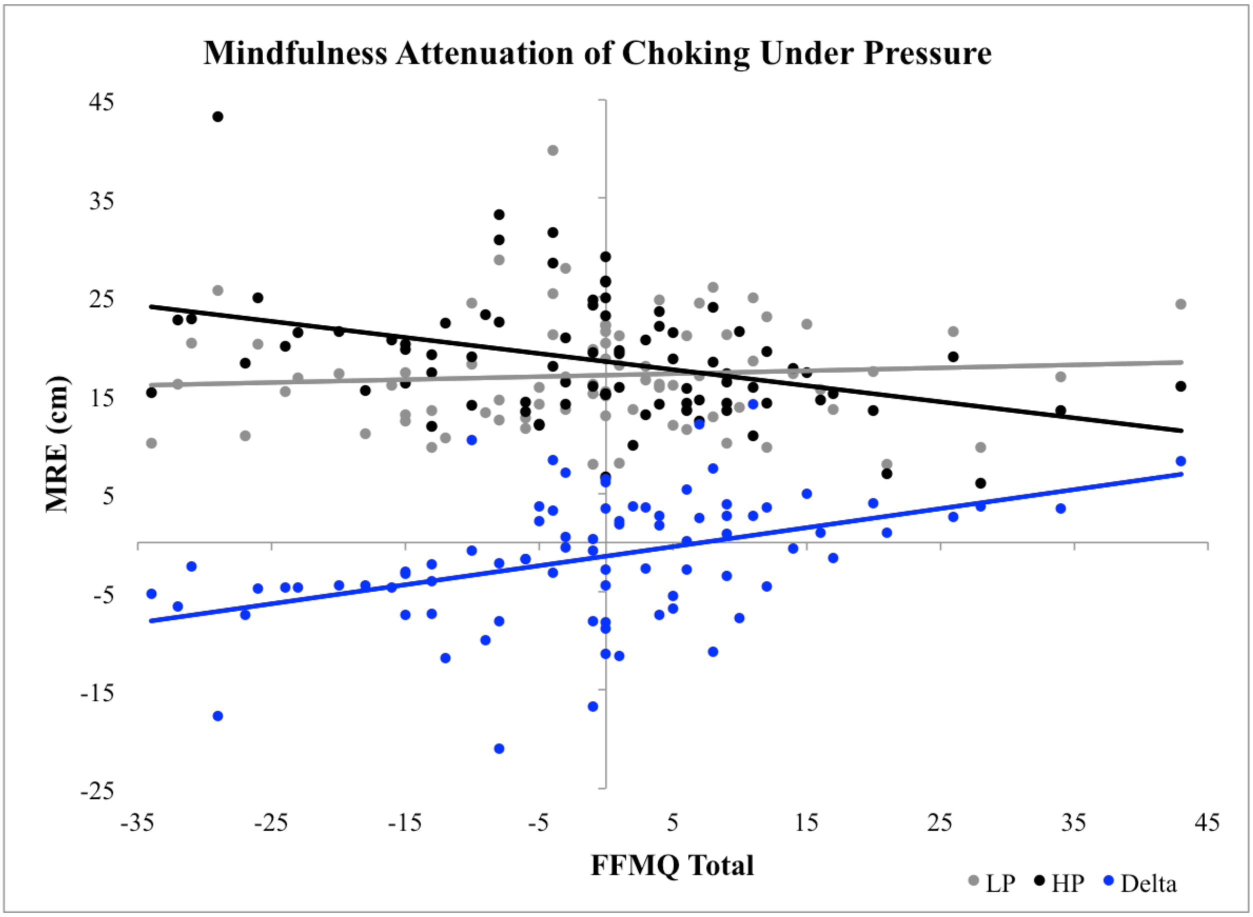

Figure 4. FFMQ Total is centered on the median score of 131. Low-pressure (LP) motor accuracy data are presented as gray circles, high-pressure (HP) data are presented in black, and delta scores (LP-HP) are presented in blue. Therefore, lower values indicate better performance in the LP and HP datasets, but worse performance/greater choking under pressure in the delta dataset. The choking effect is eliminated when mindfulness is about 5 points higher than the median value.

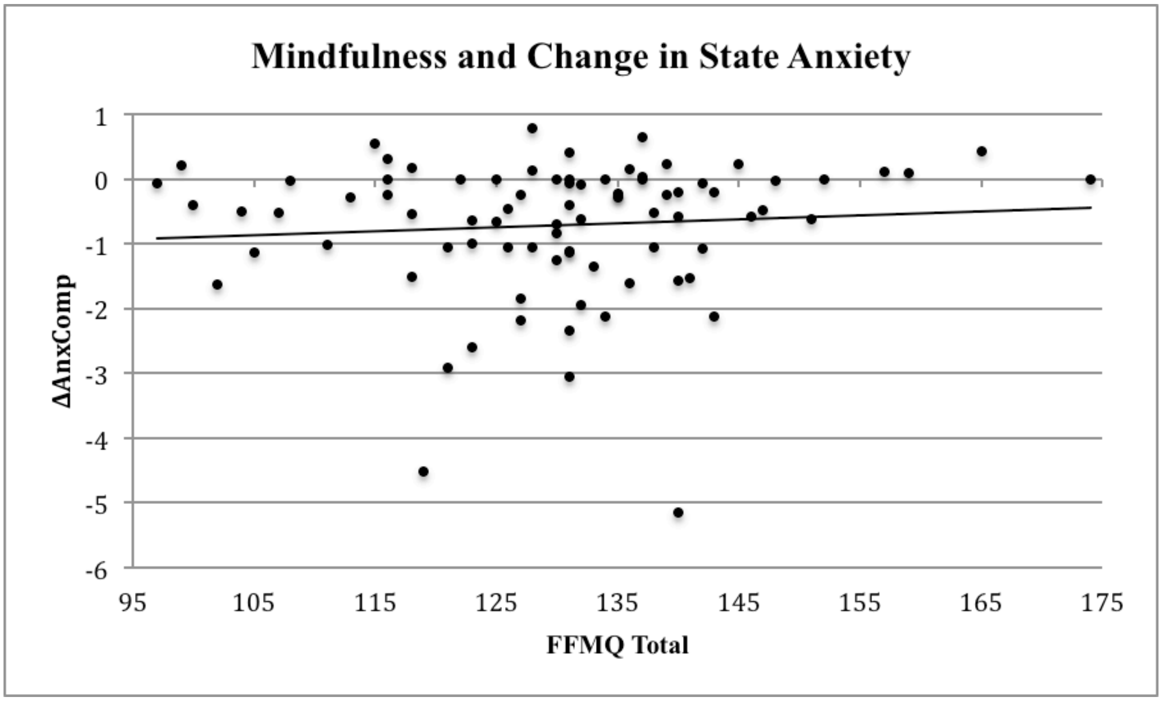

Figure 5. The bivariate relationship between FFMQ Total and ΔAnxComp. Delta calculations were made by subtracting high- from low-pressure (LP-HP), therefor negative values represent an increase in state anxiety.

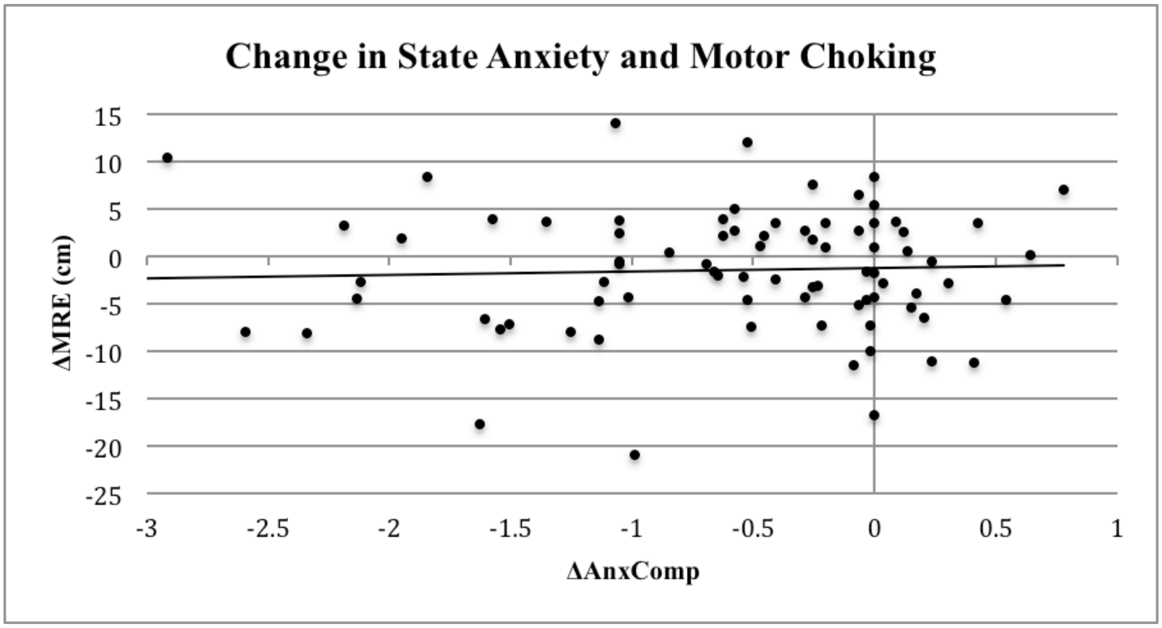

Figure 6. The bivariate relationship between FFMQ Total and ΔMRE. Delta calculations were made by subtracting high- from low-pressure (LP-HP), therefore negative values represent an increase in state anxiety and greater choking.

The results of the mediation analysis suggest dispositional mindfulness attenuates choking under pressure, but not because mindfulness reduces elevations in state anxiety under high-pressure. This follows because dispositional mindfulness predicted choking, even after accounting for changes in state anxiety. Notably, changes in state anxiety were not related to dispositional mindfulness or choking. The mediation analysis was also rerun by removing participants who did not believe one or more aspects of the pressure manipulation (*n* = 30), but this did not change the results in terms of statistical significance (see Appendix B).

Secondary Analyses

The secondary mediations are presented as Figures 7 and 8. FFMQ Total predicting ΔSD Y was the only leg of either mediation that reached statistical significance. The first step of the mediation model in Figure 5 regressed FFMQ Total with ΔSD Y and revealed a significant relationship ($t(81) = 4.00$, $p < .001$, $\beta= 0.221$), which explained a moderate amount of the variance in ΔSD Y ($R^2 = .165$, $F(1,81) = 16.0$, $p < .001$). The second step of the mediation model regressed FFMQ Total with ΔAnxComp and revealed a nonsignificant relationship ($p = .451$). The third step of the mediation model regressed ΔAnxComp with ΔSD Y and revealed a nonsignificant relationship ($p = .593$). The final step of the mediation model regressed FFMQ Total with ΔSD Y accounting for ΔAnxComp and revealed a significant relationship between FFMQ Total and ΔSD Y ($t(81) = 3.94$, $p < .001$, $\beta = 0.220$) but not between ΔAnxComp and ΔMRE ($p = .804$). As a set, FFMQ Total and ΔAnxComp explained a moderate amount of the variance in ΔSD Y ($R^2 = .165$, $F(2,80) = 7.93$, $p < .001$).

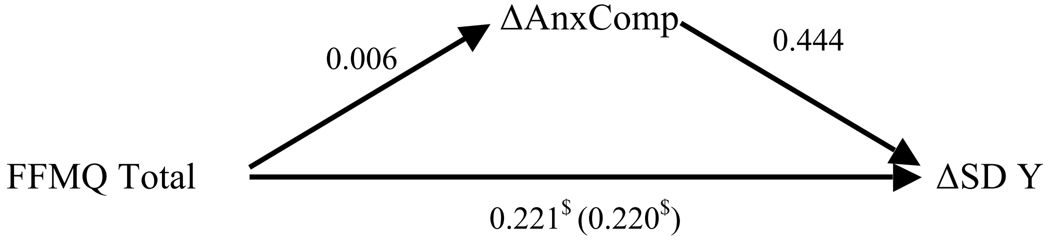

Figure 7. Unstandardized regression coefficients for the relationship between mindfulness and ΔSD Y as mediated by ΔAnxComp. The unstandardized regression coefficient between mindfulness and ΔSD Y, controlling for AnxComp, is in parentheses. $^{\$}$ p < .001.

The first step of the mediation model in Figure 8 regressed FFMQ Total with ΔCE Y and revealed a nonsignificant relationship (*p* = .513). The second step of the mediation model regressed FFMQ Total with ΔAnxComp and revealed a nonsignificant relationship (*p* = .451). The third step of the mediation model regressed ΔAnxComp with ΔCE Y and revealed a nonsignificant relationship (*p* = .519). The final step of the mediation model regressed FFMQ Total with ΔCE Y accounting for ΔAnxComp and revealed a nonsignificant relationship between FFMQ Total and ΔCE Y (*p* = .549) and a nonsignificant relationship between ΔAnxComp and ΔCE Y (*p* = .556).

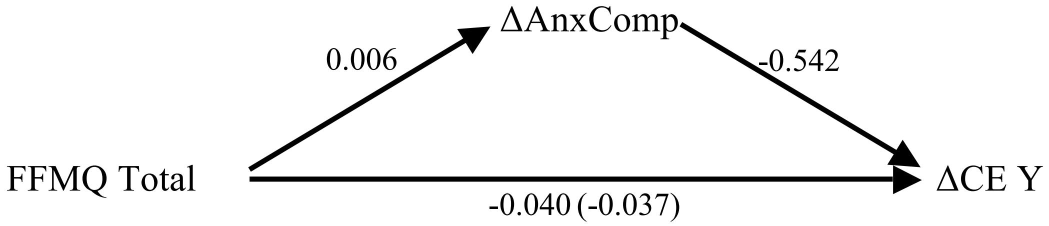

Figure 8. Unstandardized regression coefficients for the relationship between mindfulness and ΔCE Y as mediated by ΔAnxComp. The unstandardized regression coefficient between mindfulness and ΔCE Y, controlling for AnxComp, is in parentheses.

The relationships between anxiety and motor performance data in low- and high-pressure conditions are presented in Table 5 and Table 6, respectively. Scatterplots of MRE by condition are presented in Figure 9 and Figure 10. These data indicate several significant relationships between anxiety and motor performance, in both conditions. While baseline and low-pressure state CogAnx was the only CSAI-2R measure to significantly predict accuracy in the low-pressure condition, several other measures indicated participants with higher baseline and performance state anxiety had a tendency to under roll the target, suggesting difficulty with inserting the correct force parameter. In the high-pressure condition, baseline and performance state anxiety significantly predicted accuracy and precision, such that performers reporting more state anxiety and less self-confidence had significantly worse motor performance.

Table 5.
LP Correlations: CSAI-2R and Motor Performance

Measure	MRE	SD Y	CE Y
Baseline			
SomAnx	.075	-.022	-.266*
CogAnx	.239*	.143	-.351$
AnxComp	.176	.070	-.349$
SelfConf	.125	.153	.163
CSAI Total	.052	-.038	-.332**
Low-pressure			
SomAnx	.076	.038	-.209^
CogAnx	.214^	.137	-.323**
AnxComp	.173	.106	-.302**
SelfConf	.079	.142	.234*
CSAI Total	.066	-.012	-.324**

Note. *Pearson correlation is significant at the 0.05 level (2-tailed). **at the 0.01 level (2-tailed). $at the 0.001 level (2-tailed). ^*p* < .08 (2-tailed).

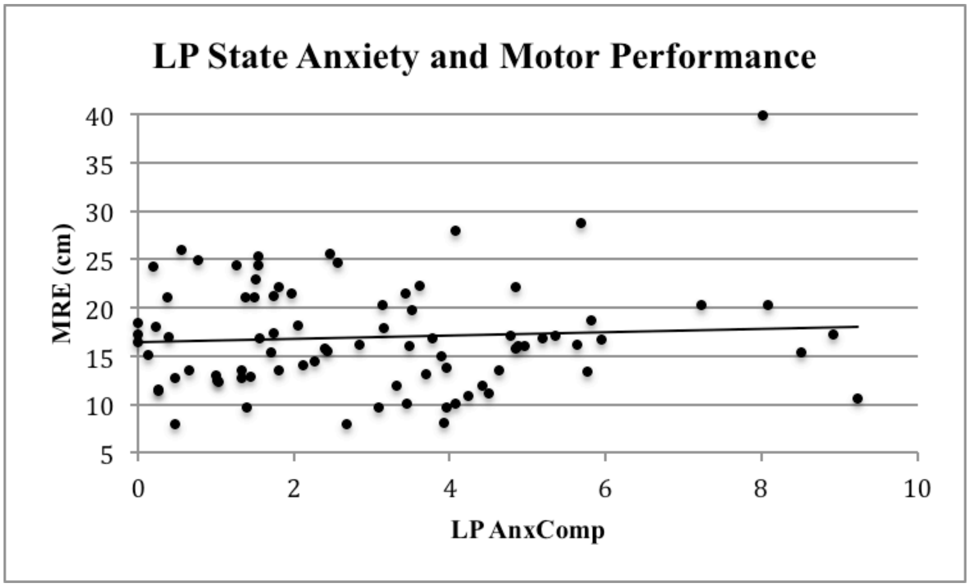

Figure 9. The bivariate relationship between AnxComp and MRE in the low-pressure condition.

Table 6.

HP Correlations: CSAI-2R and Motor Performance

Measure	MRE	SD Y	CE Y
Baseline			
SomAnx	.148	.197	-.012
CogAnx	.270*	.276*	-.025
AnxComp	.233*	.263*	-.021
SelfConf	-.090	-.092	.027
CSAI Total	.212^	.233*	-.029
High-pressure			
SomAnx	.218*	.222*	-.158
CogAnx	.271*	.250*	-.104
AnxComp	.264*	.254*	-.139
SelfConf	-.134	-.110	.121
CSAI Total	.263*	.243*	-.166

Note. *Pearson correlation is significant at the 0.05 level (2-tailed). ^*p* < .08 (2-tailed).

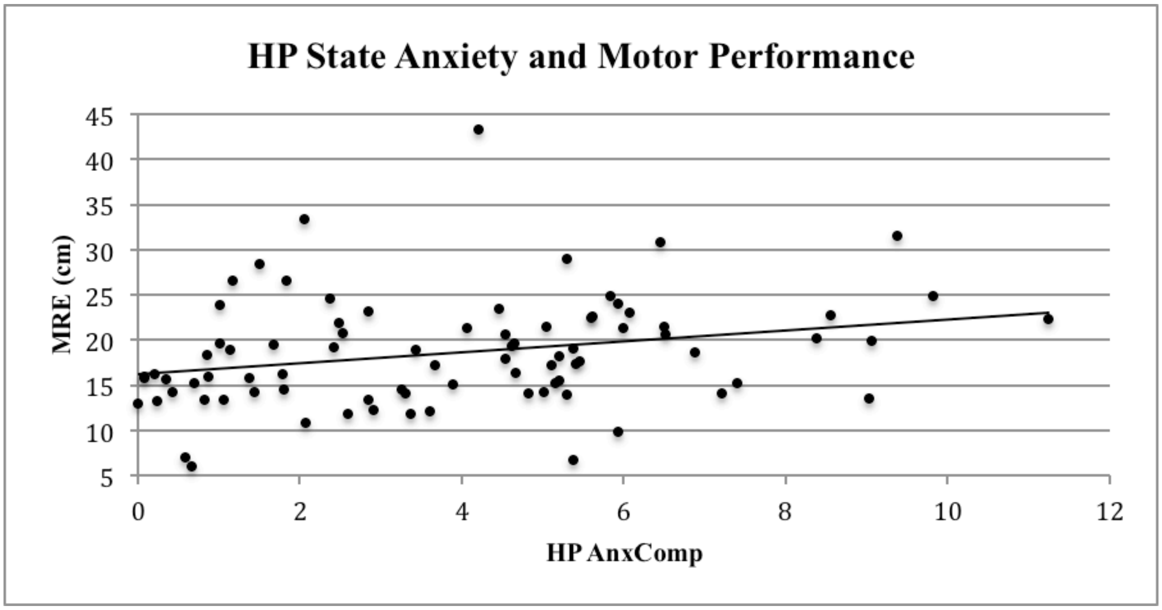

Figure 10. The bivariate relationship between AnxComp and MRE in the low-pressure condition.

The relationship between mindfulness and state anxiety in the low- and high-pressure conditions are displayed in Figure 11. Mindfulness was negatively correlated with anxiety in both pressure conditions (LP, $r = -.367$, $p < .001$; HP, $r = -.319$, $p < .010$). Additional relationships between dispositional mindfulness, state anxiety, and motor performance under low- and high-pressure are shown in Tables 7 – 9 of Appendix C.

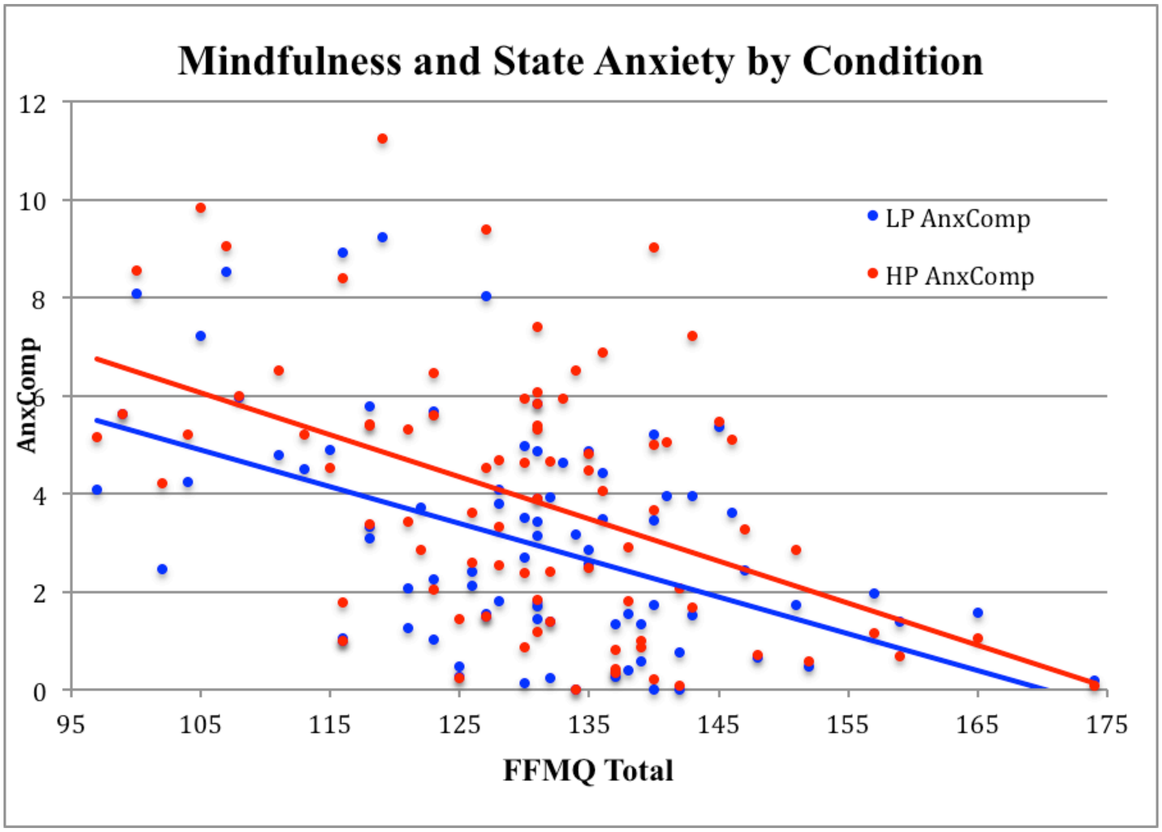

Figure 11. The bivariate relationship between FFMQ Total and AnxComp in the low-pressure condition is presented as blue circles (r = -.367, $p < .001$). The bivariate relationship between FFMQ Total and AnxComp in the high-pressure condition is presented as red circles (r = -.319, $p < .010$).

Discussion

This study examined the relationship between dispositional mindfulness, self-reported state anxiety, and motor performance under conditions of low- and high-pressure. It hypothesized mindfulness would be significantly related to choking under pressure and that changes in state anxiety would mediate this effect. Results revealed mindfulness did predict choking under pressure, in that more mindful participants had less of a decrease in motor performance between pressure conditions; however, this relationship was not mediated by the change in state anxiety. This is the first experimental evidence that mindfulness attenuates choking under pressure during motor performance of a simple, closed motor skill.

Prior to postulating explanations for the present findings, it is important to note the current sample reported FFMQ Total and individual subscale scores that are similar to other studies of comparable samples (Bruyné et al., 2013; Fisak & Von Lehe, 2012). In a study on 400 undergraduate students from a southeastern university, Fisak and Von Lehe (2012) reported the following subscale scores: ActAware (29.98 ± 6.12), Observe (27.99 ± 5.94), Describe (27.22 ± 6.46), NonReact (22.16 ± 5.04), NonJudge (25.83 ± 7.72). In a much smaller sample, 36 undergraduate students, Bruyné et al. (2013) also reported subscale values with mean and *SD* values similar to the current study's results. Since the current sample was neither more nor less mindful than data collected on other college students, this helps to rule out extreme mindfulness values as a possible justification for the current results. More importantly, these results likely generalize to other, similar populations.

There are a few possible explanations for why change in state anxiety was not associated with choking under pressure or dispositional mindfulness. An explanation for the absence of a relationship between changes in state anxiety and choking under pressure (change in performance) has to do with the nature of the anxiety/arousal-performance relationship. According to the dynamic and individualized nature with which performers handle the adaptation of psychological and physiological resources required to perform under pressure, increases in anxiety can improve or hinder performance, depending on the individual and where the initial anxiety level is (Hancock & Warm, 2003). It is possible that participants who reported very low levels of anxiety on the low-pressure condition improved with the additional pressure, while others who reported moderate to high levels of anxiety under the low-pressure condition choked under pressure. As such, there would be no reliable relationship between the change in a participant's anxiety and the change in performance (i.e., more anxiety does not necessarily mean worse performance).

A second explanation for the absence of a relationship between change in anxiety and choking under pressure also may explain the absence of a relationship between change in anxiety and dispositional mindfulness. Specifically, there may have been too little variability in change in anxiety. A measure with little variability (change in state anxiety) will not have much variance to be explained by a predictor variable (dispositional mindfulness). Additionally, a measure with little variability (change in state anxiety) will not be able to predict much variance in an outcome variable (choking under pressure). The data suggest that change in state anxiety had relatively little variability ($SD = 1.05$) compared to the variability in state anxiety during the low- and high-pressure conditions ($SD = 1.44$ and 1.93, respectively). The lack of variability in the change in state anxiety is likely due to the high correlation between state anxiety in the low- and high-pressure conditions ($r = .843$, $p < .001$). While change in state anxiety did not predict choking, it is noteworthy that elevated low-pressure state anxiety (AnxComp) was associated with under rolling the target (CE Y, $r = .264$, $p < .050$), while high-pressure state anxiety (AnxComp) was significantly related to reduced accuracy (MRE, $r = .264$, $p < .050$) and precision (SD Y, $r = .254$, $p < .050$). Collectively these data suggest self-reported state anxiety, as opposed to the change score, was more predictive of performance under the low- and high-pressure conditions. Participants who reported moderate to high levels of state anxiety performed less accurately and precisely, but only in the high-pressure condition.

Secondary analyses on mindfulness revealed that the FFMQ was negatively correlated with state anxiety (CSAI Total) under low- ($r = -.482$, $p < .001$) and high-pressure ($r = -.469$, $p < .001$) (see Appendix C, Table 7 and Table 8). In this study, more mindful performers had significantly lower anxiety and higher self-confidence across all conditions, but the relationship between mindfulness and anxiety weakened (generally became nonsignificant) when assessed as the change between conditions, and only remained significant for the facet of nonjudgmentalness.

Participants' anxiety increased similarly from low- to high-pressure, as indicated by the high correlation between state anxiety (AnxComp) in LP and HP ($r = .843$, $p < .001$). Mathematically this severely limits the amount of variance in delta state anxiety for the FFMQ to explain. Some of these findings are in line with other studies that have found more mindful participants exhibit significant reductions in resting state and induced high-stress amygdala activity (Creswell et al., 2007; Way et al., 2010). Additionally, they give credence to the idea that more mindful performers are better suited, with respect to psychological and physiological resource allocation, to adapt to changes in anxiety and thereby mitigate its negative impact on performance.

Potential Cognitive Mechanisms

Nonetheless, state anxiety did not mediate the relationship between dispositional mindfulness and choking under pressure; therefore, we have to consider what does underlie the relationship between mindfulness and choking. While self-reported state anxiety was related to motor performance, and the ability of mindfulness to reduce emotional reactivity was advocated as a rationale for mindfulness attenuating choking, this study failed to support this hypothesis. It is possible other facets of mindfulness may be responsible for the attenuation of choking. In particular, more mindful participants may have benefited from their superior ability to regulate their attention (Creswell et al., 2007; Lutz et al., 2014; Taylor et al., 2011; Way et al., 2010). For example, perhaps mindful participants still felt more anxiety under high-pressure, but they were able to maintain their focus on the task at hand (e.g., by increasing PFC-motor cortex connectivity [Lee & Grafton, 2015]). Such focus may prevent processing of task-irrelevant stimuli, like worrying about the outcome of the task, which can consume resources or cause distraction, thereby impairing performance (Beilock et al., 2002; DeCaro et al., 2011; Easterbrook, 1959). Additionally, the same moment-to-moment focus may prevent performers from explicitly monitoring their movements, allowing them to adopt an adaptive external focus of attention (Kee & Liu, 2011). Thus, attention regulation may provide the mechanism by which mindfulness mitigates the multiple routes to skill failure under pressure (Bishop et al., 2004; Gray, 2004; Kabat-Zinn et al., 1998; Lohse et al., 2014).

Limitations

The lack of mediation could also be explained by several experimental limitations. This was a laboratory-based study during which performance pressure was manipulated. Motor behavior and questionnaire data indicate the manipulations were effective in producing anxiety and choking under pressure, but the effects were modest in terms of effect sizes. Eliciting performance anxiety in a laboratory setting can be difficult and one could postulate the current findings would hold true and potentially strengthen in a real-world setting where anxiety may be significantly higher and more variable. Additionally, the task utilized in this study involved pushing a ball 100 cm; thus it required very few degrees of freedom. Complex movements with more moving components to control may produce a greater choking effect as performers attempt to explicitly monitor movement production, potentially strengthening the relationship between mindfulness and choking. To enhance external validity and practical applicability, future research should expand paradigms investigating the mindful mitigation of choking to more complex, ecologically-valid tasks.

Another explanation for why change in state anxiety may have not been related to dispositional mindfulness or choking under pressure has to do with the limitation of how state anxiety was measured (by self-report). It is possible a physiological index of state anxiety would have been more sensitive to changes from low- to high-pressure. Future research should collect autonomic measures, like cardiovascular inter-beat intervals for determining HRV, and then analyze the calculated change scores between all conditions. While self-report state anxiety did not mediate the relationship between mindfulness and choking, HRV may exhibit a different outcome. This analysis is promising given that delta HRV has been shown to significantly predict motor performance under pressure (Thompson et al., 2015). Additionally, the CSAI-2R responses occurred after the pressure condition manipulation and prior to motor execution. Accordingly, there was a temporal disconnect between when participants reported their anxiety and what their anxiety levels actually were during performance. Online physiological measures (e.g., HRV) could address this shortcoming. By addressing the limitations of this study, future research may help to further explain the relationship between mindfulness, change in state anxiety, and choking under pressure.

Conclusions

The main conclusion of this study is that dispositional mindfulness mitigates choking under pressure, through mechanisms other than reduced self-report state anxiety. This finding has important practical implications. Specifically, there are numerous programs designed to enhance dispositional mindfulness (e.g., Mindfulness-Based Stress Reduction), so mindfulness training may be one route to enhancing performance under pressure and reducing the choking effect. Indeed, the present results indicate that moving individuals beyond ‘average’ levels of mindfulness may be necessary to attenuate choking under pressure. Specifically, the participant with average mindfulness in the current study still choked under pressure, and it wasn’t until mindfulness levels increased by the equivalent of one point per mindfulness facet (5 points total) that choking was prevented. Thus, performers, especially in high-stress occupations, may significantly benefit from mindfulness training. Future research should investigate whether mindfulness training for these performers can mitigate the propensity to choke under pressure.

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Appendix A

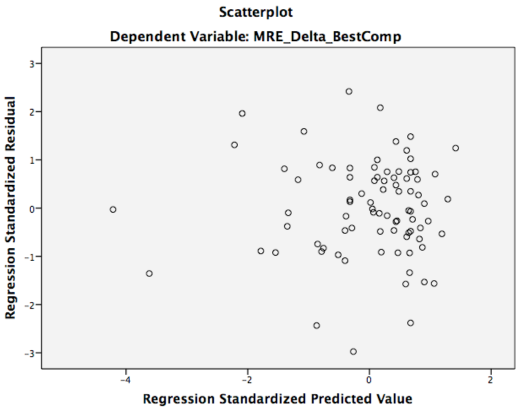
Table 11.

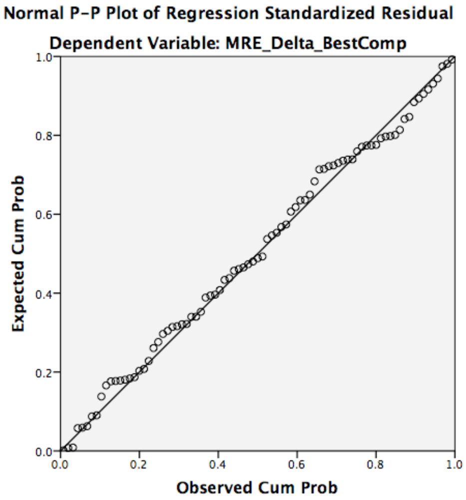
Primary Regression Diagnostics

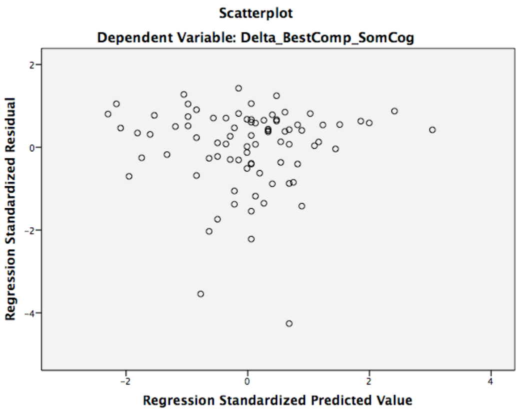
Measure	Cook's Distance	Centered Leverage Value
ΔMRE	.014 ± .032	.012 ± .030
ΔAnxComp	.010 ± .024	.012 ± .020

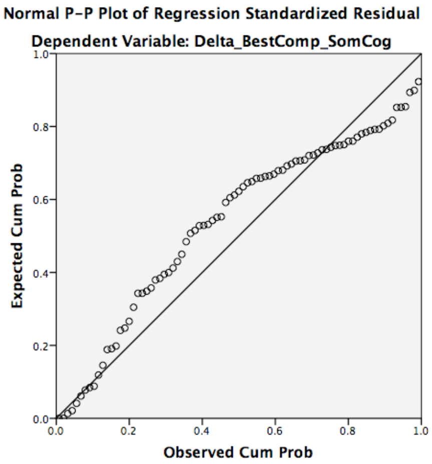
Note. Data are presented as *M* ± *SD* and suggested

The following plots of observed residuals versus expected values indicate the absence of linearity violations. Visual inspection of residual scatterplots appears to be randomly and symmetrically centered around zero, and therefore indicate the absence of independence violations. Additionally, visual inspection of observed residuals versus predicted values indicates no violations of homoscedasticity. The normal P-P plots of regression-standardized residuals indicate no violations of normality.









Appendix B

The first step of the mediation model containing only participants who believed both aspects of the pressure manipulation ($n = 53$) regressed FFMQ Total with ΔMRE and revealed a significant relationship ($t(51) = 2.94$, $p < .010$, $\beta_{\text{unstandardized}} = 0.159$, $CI_{95\%}$ [0.050, 0.267], which explained a moderate amount of the variance in ΔMRE ($R^2 = .145$, $F(1,51) = 8.66$, $p < .010$). The second step of the mediation model regressed FFMQ Total with ΔAnxComp and revealed a nonsignificant relationship ($p = .451$). The third step of the mediation model regressed ΔAnxComp with ΔMRE and revealed a nonsignificant relationship ($p = .598$). The final step of the mediation model regressed FFMQ Total with ΔMRE accounting for ΔAnxComp and revealed a significant relationship between FFMQ Total and ΔMRE ($t(51) = 3.09$, $p < .010$, $\beta_{\text{unstandardized}} = 0.168$, $CI_{95\%}$ [0.059, 0.278] but not between ΔAnxComp and ΔMRE ($p = .851$). As a set, FFMQ Total and ΔAnxComp explained a moderate amount of the variance in ΔMRE ($R^2 = .164$, $F(2,50) = 4.92$, $p = .011$).

Appendix C

Table 7.
LP Correlations to Mindfulness: Motor Performance and CSAI-2R

		Subscales				
Measure	FFMQ Total	ActAware	Observe	Describe	NonReact	NonJudge
Motor Performance						
MRE	.078	.003	.132	.091	-.086	.051
SD Y	.125	.066	.119	.142	-.039	.041
CE Y	.009	.047	-.076	.131	-.043	-.067
CSAI-2R Scores						
SomAnx	-.342**	-.273*	.048	-.249*	-.237*	-.227*
CogAnx	-.336**	-.327**	.102	-.146	-.215	-.302**
AnxComp	-.367$^{\$}$	-.332**	.087	-.203	-.242*	-.295$^{\$}$
SelfConf	.441$^{\$}$	.410$^{\$}$	.048	.377$^{\$}$	.380$^{\$}$	.152
CSAI Total	-.482$^{\$}$	-.442$^{\$}$	.083	-.342**	-.368$^{\$}$	-.274*

Note. *Pearson correlation is significant at the 0.05 level (2-tailed). **at the 0.01 level (2-tailed). $^{\$}$at the 0.001 level (2-tailed).

Table 8.
HP Correlations to Mindfulness: Motor Performance and CSAI-2R

		Subscales				
Measure	FFMQ Total	ActAware	Observe	Describe	NonReact	NonJudge
Motor Performance						
MRE	-.388$^{\$}$	-.320**	-.173	-.175	-.265*	-.195
SD Y	-.336**	-.313**	-.150	-.110	-.292**	-.144
CE Y	.099	.041	-.017	.169	-.058	.078
CSAI-2R Scores						
SomAnx	-.258*	-.208	.045	-.074	-.120	-.304**
CogAnx	-.332**	-.262*	.150	-.135	-.181	-.409$^{\$}$

AnxComp	-.319**	-.254*	.108	-.114	-.163	-.386$^{\$}$
SelfConf	.447$^{\$}$	.386$^{\$}$	.112	.421$^{\$}$	.353$^{\$}$	.204
CSAI Total	-.469$^{\$}$	-.389$^{\$}$	.138	-.305**	-.305**	-.389$^{\$}$

Note. *Pearson correlation is significant at the 0.05 level (2-tailed). **at the 0.01 level (2-tailed). $^{\$}$at the 0.001 level (2-tailed).

Table 9.
ΔLPHP Correlations to Mindfulness: Motor Performance and CSAI-2R

		Subscales				
Measure	FFMQ Total	ActAware	Observe	Describe	NonReact	NonJudge
Motor Performance						
MRE	.433$^{\$}$	.304**	.277*	.243*	.176	.228*
SD Y	.406$^{\$}$	.333**	.237*	.223*	.222*	.163
CE Y	-.073	.006	-.048	-.029	.011	-.117
CSAI-2R Scores						
SomAnx	.059	.160	-.128	-.162	-.048	.235*
CogAnx	.074	-.035	-.111	.016	-.007	.262*
AnxComp	.084	.012	-.079	-.068	-.031	.304**
SelfConf	-.104	-.029	.157	-.177	-.015	-.152
CSAI Total	.122	.025	-.144	.028	-.019	.333*

Note. *Pearson correlation is significant at the 0.05 level (2-tailed). **at the 0.01 level (2-tailed). $^{\$}$at the 0.001 level (2-tailed).

Table 10.
ΔLPHP Correlations: CSAI-2R and Motor Performance

Measure	*Δ*MRE	*Δ*SD Y	*Δ*CE Y
*Δ*SomAnx	-.012	-.021	-.150
*Δ*CogAnx	-.026	-.020	-.035
*Δ*AnxComp	.059	.059	-.072
*Δ*SelfConf	-.081	-.079	.043
*Δ*CSAI Total	.011	.012	-.082

Appendix D

Edinburgh Handedness Inventory

Please circle Left or Right to show your preferences in the use of hands in the following activities.

If you are really indifferent, circle "Either".

Where the preference is so strong that you would never try to use the other hand select "No".

	Which hand do you prefer?			**Do you ever use the other hand?**	
Writing:	Left	Right	Either	Yes	No
Drawing:	Left	Right	Either	Yes	No
Throwing:	Left	Right	Either	Yes	No
Using Scissors:	Left	Right	Either	Yes	No
Using a Toothbrush:	Left	Right	Either	Yes	No
Using a Knife (without fork):	Left	Right	Either	Yes	No
Using a Spoon:	Left	Right	Either	Yes	No
Using a Broom (upper hand):	Left	Right	Either	Yes	No
Striking a Match:	Left	Right	Either	Yes	No
Opening a Box (lid):	Left	Right	Either	Yes	No

Participant Demographics

Age ________ Gender_________

Number of Years in Competitive throwing and catching sports _________

Number of competitive throwing and catching sports __________

CSAI-2R

Directions: A number of statements that athletes have used to describe their feelings before competition are given below. Read each statement and then the appropriate location and write the self-determined associated 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 that describes your feelings right now.

Not At All   Somewhat   Moderately So   Very Much So

1. I feel jittery. (0……………………………….......100) ____
2. I am concerned that I may not do as well in this competition as I could. (0……………………………….......100) ____
3. I feel self-confident. (0……………………………….......100) ____
4. My body feels tense. (0……………………………….......100) ____
5. I am concerned about losing. (0……………………………….......100) ____
6. I feel tense in my stomach. (0……………………………….......100) ____
7. I'm confident I can meet the challenge. (0……………………………….......100) ____
8. I am concerned about choking under pressure. (0……………………………….......100) ____
9. My heart is racing. (0……………………………….......100) ____
10. I'm confident about performing well. (0……………………………….......100) ____
11. I'm concerned about performing poorly. (0……………………………….......100) ____
12. I feel my stomach sinking. (0……………………………….......100) ____
13. I'm confident because I mentally picture myself reaching my goal. (0……………………………….......100) ____
14. I'm concerned that others will be disappointed with my performance. (0……………………………….......100) ____
15. My hands are clammy. (0……………………………….......100) ____
16. I'm confident of coming through under pressure. (0……………………………….......100) ____
17. My body feels tight. (0……………………………….......100) ____

Five Facet Questionnaire

Instructions:
Please rate each of the following statements using the scale provided. Write the number in the blank that best describes your own opinion of what is generally true for you.

1	2	3	4	5
never or very rarely true	rarely true	sometimes true	often true	very often or always true

_____ 1. When I'm walking, I deliberately notice the sensations of my body moving.
_____ 2. I'm good at finding words to describe my feelings.
_____ 3. I criticize myself for having irrational or inappropriate emotions.
_____ 4. I perceive my feelings and emotions without having to react to them.
_____ 5. When I do things, my mind wanders off and I'm easily distracted.
_____ 6. When I take a shower or bath, I stay alert to the sensations of water on my body.
_____ 7. I can easily put my beliefs, opinions, and expectations into words.
_____ 8. I don't pay attention to what I'm doing because I'm daydreaming, worrying, or otherwise distracted.
_____ 9. I watch my feelings without getting lost in them.
_____ 10. I tell myself I shouldn't be feeling the way I'm feeling.
_____ 11. I notice how foods and drinks affect my thoughts, bodily sensations, and emotions.
_____ 12. It's hard for me to find the words to describe what I'm thinking.
_____ 13. I am easily distracted.
_____ 14. I believe some of my thoughts are abnormal or bad and I shouldn't think that way.
_____ 15. I pay attention to sensations, such as the wind in my hair or sun on my face.
_____ 16. I have trouble thinking of the right words to express how I feel about things
_____ 17. I make judgments about whether my thoughts are good or bad.
_____ 18. I find it difficult to stay focused on what's happening in the present.
_____ 19. When I have distressing thoughts or images, I "step back" and am aware of the thought or image without getting taken over by it.
_____ 20. I pay attention to sounds, such as clocks ticking, birds chirping, or cars passing.
_____ 21. In difficult situations, I can pause without immediately reacting.
_____ 22. When I have a sensation in my body, it's difficult for me to describe it because I can't find the right words.
_____ 23. It seems I am "running on automatic" without much awareness of what I'm doing.
_____24. When I have distressing thoughts or images, I feel calm soon after.
_____ 25. I tell myself that I shouldn't be thinking the way I'm thinking.
_____ 26. I notice the smells and aromas of things.

Instructions:
Please rate each of the following statements using the scale provided. Write the number in the blank that best describes your own opinion of what is generally true for you.

1	2	3	4	5
never or very rarely true	rarely true	sometimes true	often true	very often or always true

_____ 27. Even when I'm feeling terribly upset, I can find a way to put it into words.
_____ 28. I rush through activities without being really attentive to them.
_____ 29. When I have distressing thoughts or images I am able just to notice them without reacting.
_____ 30. I think some of my emotions are bad or inappropriate and I shouldn't feel them.
_____ 31. I notice visual elements in art or nature, such as colors, shapes, textures, or patterns of light and shadow.
_____ 32. My natural tendency is to put my experiences into words.
_____ 33. When I have distressing thoughts or images, I just notice them and let them go.
_____ 34. I do jobs or tasks automatically without being aware of what I'm doing.
_____ 35. When I have distressing thoughts or images, I judge myself as good or bad, depending what the thought/image is about.
_____ 36. I pay attention to how my emotions affect my thoughts and behavior.
_____ 37. I can usually describe how I feel at the moment in considerable detail.
_____ 38. I find myself doing things without paying attention.
_____ 39. I disapprove of myself when I have irrational ideas

Exit Questionnaire

Remember back to each series of the study. Think about what you paid attention to during your rolls in that phase.
Think of the 10 rolls in the competition series.
In as few of words as possible, what were you focused on during each roll of this phase?

____

Think of the 10 rolls in the “do your best” series
In as few of words as possible, what were you focused on during each roll of this phase?

____

Think of the 50 rolls in the first series you completed (practice).
In as few of words as possible, what were you focused on during each roll of this phase?

____

Now think about your participation throughout the entire study.

Did you notice anything different between your best and worst rolls?

Circle one: Yes / No Why or why not? ______________________________

During your best rolls, what were you focusing on?

____

During your worst rolls, what were you focusing on?

____

Did you believe that you were in competition for money? Circle one: Yes / No

Did you believe your videotape would be analyzed and used for teaching purposes?

Circle one: Yes / No

Appendix E

RECRUITMENT SCRIPT (verbal, in person)

I am Andrew G Thompson, a graduate student in the School of Kinesiology. I would like to invite you to participate in my research study examining motor performance. You may participate if you are between 18 and 35, do not take medication for or have been diagnosed with any psychiatric or cardiometabolic disease, and are not currently suffering from any musculoskeletal injury to your lower back, or non-dominant shoulder, arm, or hand.

As a participant, you will be asked to meet on one day for approximately 1 hour. You will complete several questionnaires and perform 70 trials of rolling a pool cue ball approximately 100 cm. During this task you will wear a heart rate monitor around your sternum.

Participants could experience mild discomfort from sitting for approximately one hour. The risk of this event is very low in individuals who pass the participant inclusion criteria.

You may benefit by having your motor performance analyzed. Each participant will receive his or her own individual results and an explanation of their importance and relevance of the values. Kinesiology students in participating classes may receive extra credit. Check with your instructor to see if and how extra credit will be applied. To protect the participants' identities, study results will be presented in the aggregate form only.

If you would like to participate in this research study, please print your name and Auburn University email on the signup sheet that is circulating the room. You will be contacted through the provided email to set up a meeting with one of the investigators.

Thank you for your time and consideration

E-MAIL INVITATION FOR EXPERIMENT

I am Andrew G Thompson, a graduate student in the School of Kinesiology. I would like to invite you to participate in my research study to examining motor performance. You may participate if you are between 18 and 35, do not take medication for or have been diagnosed with any psychiatric or cardiometabolic disease, and are not currently suffering from any musculoskeletal injury to your lower back, or non-dominant shoulder, arm, or hand.

As a participant, you will be asked to meet on one day for approximately 1 hour. You will complete several questionnaires and perform 70 trials of rolling a pool cue ball approximately 100 cm. During this task you will wear a heart rate monitor around your sternum.

Participants could experience mild discomfort from sitting for approximately one hour and continuously rolling a ball. The risk of this event is very low in individuals who pass the participant inclusion criteria.

You may benefit by having your motor performance analyzed. Each participant will receive his or her own individual results and an explanation of their importance and relevance of the values. Kinesiology students in participating classes may receive extra credit. Check with your instructor to see if and how extra credit will be applied. To protect the participants' identities, study results will be presented in the aggregate form only.

If you would like to participate in this research study, or if you have questions, please contact me at AGT0006@auburn.edu or you may contact my advisor, Dr. Miller, at MWM0024@auburn.edu.

Thank you for your time and consideration,

Andrew G. Thompson

Appendix F

LETTERHEAD

(NOTE: DO NOT SIGN THIS DOCUMENT UNLESS AN IRB APPROVAL STAMP WITH CURRENT DATES HAS BEEN APPLIED TO THIS DOCUMENT.)

INFORMED CONSENT
for a Research Study entitled
"Questionnaire and Motor Performance"

You are invited to participate in a research study that is examining motor performance. The study is being conducted by Andrew Thompson, doctoral student, under the direction of Dr. Matthew Miller, Professor in the Auburn University School of Kinesiology. You were selected as a possible participant because you are age 18-35, do not take medication for or have not been diagnosed with any psychiatric or cardiometabolic disease, and are not currently suffering from any musculoskeletal injury to your lower back, or non-dominant shoulder, arm, or hand.

What will be involved if you participate? As a participant, you will be asked to meet for 1 hour. You will complete several questionnaires and perform 70 trials of rolling a pool cue ball approximately 100 cm. During this task you will wear a heart rate monitor around your sternum.

Are there any risks or discomforts? If you decide to participate in this study, then you may face a risk of mild discomfort from sitting for approximately 60 minutes and continuously rolling a ball. As such, at any point in time you will be given the opportunity to decline to proceed with the study. Finally, as with any research, there is some possibility that you may be subject to risks that have not yet been identified. You are responsible for any costs associated with medical treatment.

Are there any benefits to yourself or others? You may benefit by having your motor performance analyzed. Each participant will receive his or her own individual results and an explanation of their importance and relevance of the values.

Will you receive compensation for participating? While we cannot offer monetary payment for your time, Kinesiology students may receive extra credit towards one participating course. Check with your instructor to see if and how extra credit will be applied. Alternative means of extra credit are available. You do not have to participate in this study in order to obtain such credit.

If you change your mind about participating, you can withdraw at any time during the study. Your participation is completely voluntary. If you choose to withdraw, your data can be withdrawn as long as it is identifiable. Your decision about whether or not to participate or to stop participating will not jeopardize your future relations with Auburn University, the School of Kinesiology or any of the investigators.

Your privacy will be protected. Any information obtained in connection with this study will remain confidential. This Informed Consent document will be the only study-related items with your name. All other data will be coded using participant numbers. All identifying information will be kept in a locked laboratory, separate from data forms containing participant identification numbers. As approved by the Auburn University Institutional Review Board, the Informed Consent documents will be shredded after three years. Information obtained through your participation may be used to fulfill an educational requirement, published in a professional journal, presented at a professional meeting, but will be void of identifying information and used in the aggregate form only. At any time you may request a copy of your results in this study.

If you have questions about this study, *please ask them now or* contact Andrew Thompson at 757-535-3112 or Dr. Matthew Miller at 334-844-4483. A copy of this document will be given to you to keep. Please do not mention any portion of this study's procedures to fellow students.

If you have questions about your rights as a research participant, you may contact the Auburn University Office of Human Subjects Research or the Institutional Review Board by phone (334)-844-5966 or e-mail at hsubjec@auburn.edu or IRBChair@auburn.edu.

HAVING READ THE INFORMATION PROVIDED, YOU MUST DECIDE WHETHER OR NOT YOU WISH TO PARTICIPATE IN THIS RESEARCH STUDY. YOUR SIGNATURE INDICATES YOUR WILLINGNESS TO PARTICIPATE.

______________________________ ___________________
Participant's signature Date

____
Printed Name

______________________________ ___________________
Investigator obtaining consent Date

____
Printed Name

DeBriefing Form
For the Study entitled: “Questionnaire and Motor Performance”

Dear Participant;

During this study, you were asked to perform three series of a ball-rolling task. You were told a video recording of your performance would be analyzed by professional biomechanist and used as teaching tools in Biomechanics and Motor Learning classes. No video was actually recorded.

We deceived you about video recording and neglected to tell you about the monetary reward portion of this study because it was necessary to elicit performance pressure. Creating such an environment was essential to test the true effects stress may have on motor performance.

The monetary reward was real. Should you have scored well enough on the task to receive an award, you will be contacted by email following completion of the study. At this point you will be required to come pick up the cash in person and provide your email as proof of identity.

You are reminded that your original consent document included the following information: If you change your mind about participating, you can withdraw at any time during the study. Your participation is completely voluntary. If you choose to withdraw, your data can be withdrawn as long as it is identifiable. Your decision about whether or not to participate or to stop participating will not jeopardize your future relations with Auburn University, the School of Kinesiology, or any of the investigators. If you have any concerns about your participation or the data you provided in light of this disclosure, please discuss this with us. We will be happy to provide any information we can to help answer questions you have about this study.

If your concerns are such that you would now like to have your data withdrawn, and the data is identifiable, we will do so. If you have questions about your participation in the study, please contact me at (*agt0006@auburn.edu*), or my faculty advisor, (*Dr. Miller, mwm0024@auburn.edu*). If you have questions about your rights as a research participant, you may contact the Office of Human Subject Research (334-844-5966, hsubjec@auburn.edu) or Auburn University’s Institutional Review Board (IRBChair@auburn.edu). If you have experiences distress as a result of your participation in this study, a referral list of mental health providers is attached to this document for your use. (Please remember that any cost in seeking medical assistance is at your own expense.)

Please again accept our appreciation for your participation in this study. Please refrain from mentioning methods or details about this study to anyone, as it could corrupt the results.

Name ______________________________ Date___________________

Referral List

Mental Health Providers in Auburn/Opelika

Provider	Services	Phone No.	Cost/Hour
Crisis Center	**Phone Counseling**	**334-821-8600**	**No charge**
Student Counseling Services at Auburn University	**Individual and Group Therapy**	**334-844-5123**	**No charge**
Auburn University Psychological Services Center	**Marriage, Family, and Individual Therapy**	**334-844-4889**	**$75, Intake $5-55 based on income**
Clinical Psychologists	**Individual and Group Therapy**	**334-821-3350**	**$120, Intake $100, Treatment, per**
East Alabama Mental Health Center	**Individual and Group Therapy**	**334-742-2700 334-742-2877 (after hours)**	**$8-80 based on income**
Safe Harbor at Auburn University	**Counseling for victims and friends of victims of rape and dating violence**	**334-844-5123**	**No charge**
Auburn Family Therapy		**334-821-3631**	**$50-100 per hour**
Psychological Associates, LLC 1915 Professional Circle		**334-826-1699**	**$120, Intake $100, Treatment per**
East Alabama Psychiatric Services (Medication referrals only)		**334-821-0238**	
Auburn-Opelika Psychology Clinic		**334-742-9555**	