DOES A BRIEF MINDFULNESS INTERVENTION IMPROVE DISTRESS TOLERANCE AMONG ATHLETES?

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The Supervisory Committee certifies that this ***disquisition*** complies with North Dakota State University's regulations and meets the accepted standards for the degree of

DOCTOR OF PHILOSOPHY

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ABSTRACT

Trait mindfulness has been found to be a beneficial characteristic of athletes. However, the research on mindfulness interventions has been limited, poorly described, and poorly designed. The current study sought to determine whether a brief mindfulness intervention improves distress tolerance among athletes. In addition, this experiment tested the impact of cultivating mindfulness on psychological variables that may be important for sport such as anxiety, happiness and capacity for stress. Athletes were randomly assigned to one of the three intervention conditions (brief mindfulness, sham mindfulness and no-intervention control). All participants completed distress tolerance measures, a motor performance measure under distressing conditions, and self-reported psychological measures. These measures were administered at pre- and post-intervention. Results indicated that the brief mindfulness intervention did not result in significant improvements in the primary outcome variables, in comparison to the sham mindfulness and no-intervention control groups. Strengths and limitations of the study, as well as future directions are provided.

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LIST OF ABBREVIATIONS

MBSR……. Mindfulness Based Stress Reduction

MTPT-C……..... Mirror Tracing Persistence Task – Computerized version

CEQ……. Credibility and Expectancy Questionnaire

DTS……... Distress Tolerance Scale

FFMQ…… Five Facet Mindfulness Questionnaire

OHQ…… Oxford Happiness Questionnaire

SAS……. Sport Anxiety Scale

TMS…… Toronto Mindfulness Scale

WSI-SF……. Weekly Stress Inventory – Short Form

ANOVA…….. Analysis of Variance

SD…… Standard Deviation

INTRODUCTION

Mindfulness is being aware of the present moment as a result of purposeful attention, while being nonjudgmental and accepting of the experience (Kabat-Zinn, 1990). Researchers have studied mindfulness as an acquired skill as well as a trait. Trait mindfulness can be thought of as naturally occurring mindfulness in one's daily life. Trait mindfulness has been found to predict lower levels of anxiety (Arch & Craske, 2010; Rasmussen & Pidgeon, 2011), act as a protective factor against stress (Bränström, Duncan, & Moskowitz, 2011) and predict less mood lability (Hill & Updegraff, 2012). It has also been found that mindful awareness, a facet of trait mindfulness, is associated with greater distress tolerance (Feldman, Dunn, Stemke, Bell, & Greeson, 2014).

Trait mindfulness has also been found to be beneficial to athletes. Among athletes, trait mindfulness has shown to be associated with benefits such as less burnout (Gustafsson et al., 2015; Menon & SulfiyaBanu, 2016; Walker, 2013; Zhang et al., 2016), lower levels of negative affect and stress (Gustafsson et al., 2015), less anxiety (Menon & SulfiyaBanu, 2016; Röthlin, Horvath, Birrer, & grosse Holtforth, 2016), fewer illnesses and injuries (Cathcart, McGregor, & Groundwater, 2014), higher levels of positive affect (Gustafsson et al., 2015), happiness (Denny & Steiner, 2009), well-being in young athletes (Nolte, Steyn, Krüger, & Fletcher, 2016), better performance in sport (Gooding & Gardner, 2009; Jones & Parker, 2016; Röthlin et al., 2016) and higher self-efficacy in sport (Pineau, Glass, Kaufman, & Bernal, 2014).

Research in this area has also focused on the mechanisms through which mindfulness promotes benefits. Negative and positive affect (Gustafsson et al., 2015) and experiential avoidance (Zhang et al., 2016) have been found to be mediators through which mindfulness predicts burnout in athletes. Since mindfulness has shown to be negatively associated with

negative behavior, Röthlin et al., (2016) hypothesized that mindfulness will predict competition anxiety which would then predict performance delivery in demanding situations. As expected it was found that cognitive competition mediated the relationship between mindfulness and self-reported performance delivery. Other research studying benefits of mindfulness has found that mindfulness moderated the relationship between gratitude and life satisfaction such that, high levels of mindfulness and high levels of gratitude predicted high levels of life satisfaction among athletes (Chen, Wu, & Chang, 2016). The authors highlighted that this study was important in researching individual differences that impacts an athlete's well-being. Röthlin et al., (2016) also found that mindfulness moderated the relationship between cognitive competition anxiety and performance delivery, that is, mindfulness acted as a protective factor against the impact of anxiety on performance. This supports findings that athletes could be anxious and still perform if they have higher levels of trait mindfulness.

Even though there have been a fair number of studies on the benefits of mindfulness for athletes, most of these studies have been correlational in nature. These studies have also focused mainly on trait mindfulness rather than mindfulness interventions used to improve mindfulness skills. Very few studies have investigated the impact of mindfulness interventions on athlete performance and other variables related to performance. Case studies (Bernier et al., 2014; Demarzo et al., 2015; Gardner & Moore, 2004; Lutkenhouse, 2007; Schwanhausser, 2009) and a qualitative study using mindfulness interventions with athletes (Baltzell, Caraballo, Chipman, & Hayden, 2014) have suggested that mindfulness training enhances sport performance and other related outcomes such as quality of life as well as decreases in anxiety and stress. One training program (Bernier et al., 2014) used metaphors related to sport in order to facilitate an understanding of the principles of mindfulness among young athletes. It has been suggested that

tailoring mindfulness training programs to the sport, population, and level of athletic proficiency may be helpful to yielding positive results.

Nonrandomized trials have indicated that training athletes in mindfulness has been studied among athletes from a variety of sports competing at different levels in their respective sports. One intervention, Mindfulness Sport Performance Enhancement (MSPE; Kaufman et al, 2009), has been reported to be positively related to factors that might influence sport performance such as level of mindfulness, flow and perfectionism. However, the results did not indicate that MSPE improves sport performance as measured by direct and objective measures of performance. The brevity of the programs, the small sample sizes, and the unknown level of commitment from the athletes may have limited the ability to see changes in objective measures of performance. In contrast to MSPE, Bernier et al. (2009) suggested that mindfulness training based on Acceptance and Commitment Therapy and Mindfulness Based Cognitive Therapy is related to improved performance. Using the Mindfulness-Acceptance Commitment based performance enhancement approach, Wolanin et al. (2010) suggested psychological functioning as an individual difference that may impact an athlete's ability to improve performance as a result of mindfulness training. It is possible that in addition to the differences among different mindfulness training programs and samples, the athlete's psychological functioning is one factor that may explain the inconsistencies in the literature on the impact of mindfulness training and sport performance. However, the results from Wolanin et al. (2010) should be interpreted with caution due to the lack of statistical results and as the coaches were not blind to the group. Haase et al. (2015) suggested that mindfulness training is associated with mindfulness skills and showed that brain regions associated with mindfulness meditation and interoceptive processing

show increased activation following mindfulness training. The authors suggested that such improvements may help athletes better adapt to stressful situations associated with sports.

There have been a few mindfulness interventions studies that have studied the effect of mindfulness training on sport performance and other related outcomes (Aherne, Moran & Lonsdale, 2011; Ivarsson, Johnson, Andersen, Fallby, & Altemyr, 2015; John, Verma, & Khanna, 2011; Moen, Abrahamsen, & Furrer, 2015; Moghadam, Sayadi, Samimifar & Moharer, 2013; Scott-Hamilton, Schutte, & Brown, 2016). Randomized trials have demonstrated that mindfulness training is related to benefits such as protection against burnout, increases in flow, and fewer injuries. Two studies have found that mindfulness enhances sport performance by objective measures (John et al., 2011; Moghadam et al., 2013) while one study did not find any evidence to support this outcome using subjective sport performance (Moen et al., 2015). It is possible that differences in measures (objective vs. subjective) used in these studies impacted the discrepancy in results. It is also possible that the athlete population influenced the results. In both John et al. (2011) and Moghadam et al. (2013), the athletes were adult athletes while the athletes in Moen et al. (2015) were junior athletes. It is likely that the adult athletes were more focused on their sport and had the ability to comprehend the principles of mindfulness and therefore were able to gain more benefits from the intervention. Furthermore, the lack of reported details about the intervention used in one study (Moghadam et al., 2013) leads to difficulty in drawing conclusion about the impact of the intervention on sport performance.

The quality of the measurements as well as the range of measurements used in the randomized studies are limited. Most measurements were subjective. Most studies measured limited direct outcomes and rarely reported on other indirect outcomes, such as overall well-being, motivation and other constructs that might be useful for performance, as a result of

mindfulness training. Most of the randomized trials included inactive control groups. The absence of active control groups limits our ability to make causal conclusions as the differences observed between the intervention and control groups may have been due to placebo effects. In summary, the research in this area is still at a very early stage and requires more experimental studies of good quality and a range of outcome variables, to continue to test the relationship between mindfulness training and performance and other outcomes in athletes.

Distress and pain experienced by athletes can negatively impact performance and engagement in sport activities. As a result, the impact of pain sensitivity on athletes from a variety of sports has been studied widely (Johnson, Stewart, Humphries, & Chamove, 2012; Raudenbush et al., 2012; Ryan & Kovacic, 1966). Research has also focused on the effectiveness of using cognitive coping skills, by athletes, to cope with pain and found mixed findings (Jaremko, Silbert, & Mann, 1981; Johnson et al., 2012).

Mindfulness skills have shown to be effective in coping with stress and pain. Clinical research shows that the Mindfulness Based Stress Reduction (MBSR) program (Kabat-Zinn, 1982) focused on training patients with chronic pain to cope with stress is effective in decreasing distress (Shapiro, Schwartz, & Bonner, 1998) and improving pain tolerance (Grant & Rainville, 2009; Jon Kabat-Zinn, Lipworth, & Burney, 1985; Kingston, Chadwick, Meron, & Skinner, 2007; Liu, Wang, Chang, Chen, & Si, 2013; Zeidan, Gordon, Merchant, & Goolkasian, 2010). Research on trait mindfulness has also shown that mindfulness skills are positively associated with persistence while experiencing distress (Evans, Baer, & Segerstrom, 2009; Feldman et al., 2014). These findings indicate that mindfulness can be effective for coping with distressing situations. There has been some speculation that for athletes, mindfulness skills may benefit persistence as a result of present-moment, nonjudgmental, awareness of sensations and improved

ability to tolerate distress (Cathcart et al., 2014). However, this has not been tested yet. Furthermore, research on the impact of mindfulness interventions on athletic performance has many methodological shortcomings, including the lack of active control groups (Aherne et al., 2011), lack of details about the control groups (John et al., 2011; Moen et al., 2015; Moghadam et al., 2013) and failure to describe the intervention in detail (Moghadam et al., 2013). These limit our ability to draw meaningful and causal conclusions about the impact of the intervention on sport performance.

The primary purpose of the current experiment was to investigate whether training athletes using a brief mindfulness intervention impacts persistence and performance, while enduring distress. Secondly, this experiment tested the impact of cultivating mindfulness on psychological variables that may be important for sport, such as competition anxiety as well as variables like stress and well-being which are indicative of overall functioning. Athletes were randomly assigned to one of the three intervention conditions (brief mindfulness, sham mindfulness and no-intervention control) and tested on three distress tolerance measures, a motor performance measure under distressing conditions and six self-report psychological measures. These measures were administered both before and after the intervention. It was hypothesized that athletes undergoing the brief mindfulness intervention would show significant improvements in distress tolerance, motor performance and psychological measures, following the intervention. I expected the improvements shown by the athletes in the brief mindfulness intervention group to be significantly greater in comparison to the differences shown by the athletes in the two control groups.

METHOD

Participants

A statistical power analysis was performed for sample size estimation. With an effect size of .25, an alpha = .05 and power = 0.80, the projected sample size needed with this effect size (GPower 3.1) was approximately N = 90. Due to time constraints, sixty-nine students involved in varsity sports or club sports at the North Dakota State University were recruited for the study. Participants were recruited via an email inviting athletes interested in learning skills to cope with competition distress to participate in the study. Potential participants were informed that participants will be taught skills to help improve concentration, eliminate distraction and cope with pain and distress during performance. Participants were randomly assigned to one of the intervention conditions, brief mindfulness, sham mindfulness or no intervention condition. Eleven participants dropped-out mid-way of the study due to scheduling conflicts, resulting in missing data. Therefore, the final participants sample consisted of 59 participants (Male=32, Female =27). The mean age was 19.12 years (*SD* = 1.13). Eighty-one percent of the participants identified themselves as White. The brief mindfulness condition and the sham mindfulness condition each consisted of 20 participants and the no-intervention condition consisted of 19 participants. Table 1 shows that athletes from 15 different sports participated in this study, with three athletes identifying as participating in two sports.

Table 1

Number of participants in each sport

Sport	Number of participants
Football	11
Golf	2
Track & Field	14
Basketball	5
Volleyball	3
Soccer	2
Softball	3
Track & Field and Cross Country	3
Lacrosse	1
Baseball	3
Wrestling	4
Cheer team	3
Ultimate frisbee club	1
Equestrian Team	2
Hockey	2

Measures

Distress Tolerance Tasks

Distress tolerance was measured via three different tasks. These included a pain tolerance task, a task with a motor component, and task with a cognitive component. The three tasks are described below.

Pain Task. This task measured pain tolerance. Heat stimuli were administered via a Medoc Thermal Sensory Analyzer 2001 (Ramat-Yishai, Israel) and presented to the non-dominant forearm. The Medoc TSA has been used in previous studies to successfully measure pain tolerance and threshold in a variety of populations (Bresin & Gordon, 2013; Bresin, Gordon, Bender, Gordon, & Joiner, 2010; Fillingim et al., 2004; Paungmali, Sitilertpisan, Taneyhill, Pirunsan, & Uthaikhup, 2012). Participants were first exposed to a temperature of 35° C for 30 seconds. During the first trial, the temperature was started at 35° C then increased by 1°

C every second, until it reached the target temperature of 40° C. The temperature remained at this level for five seconds. The temperature was then decreased by 1°C every second until the temperature was 35° C. The temperature remained at this level for 30 seconds. This procedure was then repeated for trials with target temperatures of 43° C, 45° C and 48° C. At the end of each trial, participants rated their heat sensation on a scale of 0 (no heat sensation at all) to 100 (intolerable heat sensation). If the heat sensation was intolerable and the participant wanted the heat exposure to be terminated, participants were instructed to say "stop" to terminate the task. None of the participants requested for the heat administration to be stopped due to discomfort. Heat sensation rating at 48°C was considered as the pain tolerance rating for this study.

Mirror Tracing Persistence Task – Computerized Version (MTPT-C; Feldman et al., 2014). This task measured distress tolerance with a motor component. This task has been previously used as a behavioral distress tolerance task (Bornovalova, Gratz, Daughters, Hunt, & Lejuez, 2012; Ellis, Fischer, & Beevers, 2010; Feldman et al., 2014). Three different geometric shapes were presented on a computer. Participants were required to move a dot using a computer mouse to trace the lines of the shapes. To simulate tracing the image on a mirror, the dot moved in the opposite direction of movement. If participants made an error by moving the dot away from the lines or pause responding for two seconds or more, a loud buzzer sounded and participants were required to start tracing the lines from the beginning. Two relatively easy shapes, a line and an L-shape, were presented first. Participants were given 60 seconds to complete each trial. Following this, a message on the screen appeared instructing that the third shape will be a difficult star shape and that they will be given the option to discontinue if they find it too difficult to complete. However, participants were asked to persist for as long as they can, as terminating early would negatively affect the score. If participants did not terminate after

five minutes, the program terminated by itself. Persistence under distressing conditions was measured by the time spent on the star shape until termination.

Anagram solving task (Evans et al., 2009). The task was presented on a computer. At the beginning of the task, participants were instructed to rearrange the letters to make a meaningful English word. Two easy practice trials were presented at the beginning of the task to ensure that the participants understood the task. Eleven anagrams were then be presented on a computer screen. Participants were instructed to solve the anagrams in their minds as quickly and as accurately as possible, without the aid of paper and pencil, and type in the answer. Following this, participants were instructed to press the spacebar to move on to the next item. The first anagram was unsolvable and participants were given five minutes to work on the anagram. At the end of the five minutes, if the participant had not moved on, the individual was instructed to press the spacebar and move on to the next item. The remaining 10 anagrams were mild to moderate in difficulty. Participants were given 90s to solve each of the 10 anagrams. The same method was followed in the post-intervention with the exception of a new set of 11 anagrams. The number of anagrams accurately solved and the total time spent on solving the 10 anagrams were recorded. To ensure that persistence as measured by time was a result of mindfulness rather than success, for the analyses, the number of anagrams accurately solved was controlled for.

Motor Performance Task

Dart throwing. Dart Throwing was used as a measure of motor performance and was conducted under two conditions; low stress and high stress. In the low stress condition, a dart board was located at six feet high and seven feet from a target line (Raalte et al., 1995). The dart board consisted of four rings. The smallest ring in the center (bull's-eye) was worth 50 points.

The remaining rings were worth 35, 10 and 5 points each, with points decreasing, the farther the rings get from the bull's-eye. If the dart missed the board completely, no points were awarded. Each participant was instructed to throw the darts toward the bull's-eye. Participants were given three practice attempts. Following the practice attempts, two blocks of five test trials, i.e. ten trials in total were given to each participant. At the end of each block, the total points were recorded. Participants then self-reported their stress perception.

For the high stress condition, a dart board was located at six feet high and nine feet from a target line. Following three practice attempts, two blocks of five test trials, i.e. ten trials in total were given to each participant. In this condition, participants were timed and instructed that they have 10 seconds to throw five darts for each block. Participants were also informed that most participants gain hundred and eighty points per five dart throws. They were told that their performance will be ranked with the rest of the participants. At the end of each block, the total number of points was recorded. Participants then self-reported their stress perception. The low stress condition was always presented before the high stress condition.

Self-report Measures

Credibility and Expectancy Questionnaire (CEQ; Devilly & Borkovec, 2000). The CEQ is a measure of intervention credibility and treatment expectancy. The participants were required to rate to what extent they believe and feel that the therapy that they received was successful in reducing their psychological symptoms. This questionnaire is focused on measuring credibility of treatments focused on reducing depressive and anxiety symptoms. For this study, the items on this questionnaire were modified to measure the credibility and expectancy of the two intervention conditions on reducing distress and improving performance. The modified questionnaire consists of 10 items divided in two sets; the 6 items in set I measure what

participants "think" and the 4 questions in set II measure what participants "feel" about the intervention. Participants rate their responses to items 1, 2, 3, 4, 7, and 8 on a scale of 1 to 9 (different descriptors for each item). The remaining four items measure one's symptom improvement on a 11-point scale, ranging from 0% to 100%. The scores from these four items were recorded in a manner to correspond to the 1-9 point scale used in the other items, such that the scores from 40-60% were collapsed to 50% (Nock, Ferriter, & Holmberg, 2007). Credibility is measured by the first 4 items and expectancy is measured by the 6 remaining items. The original article reported the internal consistency for the expectancy factor between .79 and .90, for the credibility factor between .81 and .86 and for the whole scale between .84 and .85. In this sample, the internal consistency for the expectancy factor was .94, for the credibility factor was .96 and for the full scale it was .96.

Distress Tolerance Scale (DTS; Simons & Gaher, 2005) is a self-report measure of perceived capacity to tolerate distress. It consist of 15 items that are rated on a five-point scale (1 = strongly agree and 5 = strongly disagree). The scale consists of the four subscales, tolerance, absorption, appraisal and regulation. Subscale scores are the mean of the items and the total DTS scores is computed by the four subscale means. The internal consistency of the subscales have been reported to range between .72 to .84 (Simons & Gaher, 2005). In this sample, internal consistencies of the subscales were found to be between .63 and .84.

Five Facet Mindfulness Questionnaire (FFMQ; Baer, Smith, Hopkins, Krietemeyer, & Toney, 2006). The FFMQ is a self-report questionnaire measuring trait mindfulness. It consists of 39 items belonging to the five factors, observing, describing, acting with awareness, non-judging of inner experiences, and non-reactivity to inner experiences. Participants are required to respond on a five-point scale ranging from 1 (never or very rarely true) to 5 (very often or

always true). Participants can score between 39 and 195 with higher scores indicating high levels of mindfulness. The internal consistency for the facets of the FFMQ has been reported ranging from .67 to .92 (Baer et al., 2008). In this sample, the alpha coefficient ranged between .60 and .87.

Homework log sheets. Log sheets required participants to record the date and time of practice, the audio clip used (breathing or body scan, described below in "Interventions") and duration of practice for each day. Participants were also be encouraged to note any other comments related to their experience.

Oxford Happiness Questionnaire (OHQ; Hills & Argyle, 2002). The OHQ is a measure of well-being that consists of 29 items. Participants are required to rate to what extent they agree or disagree with each statement on a scale ranging from 1 (strongly disagree) to 6 (strongly agree). The scores range from 29 to 174 with higher scores reflecting greater happiness. The alpha coefficient has been found to be .91 (Hills & Argyle, 2002) and in this sample it was found to be .88 and .89.

Sport Anxiety Scale (SAS; Smith, Smoll, & Schutz, 1990), The SAS is a 21-item measure of cognitive and somatic anxiety specific to sports. It consists of three subscales belonging to somatic anxiety, worry and concentration disruption. Participants rate their responses on a 4 point scale (1 = not at all and 4 = very much so) indicating the extent to which they experience each symptom before or during competition. The internal consistency has been found to range between .74 to .92 (Smith et al., 1990). In this sample it was found to be .88 and .91.

Toronto Mindfulness Scale (TMS; Lau et al., 2006). The TMS is a 13-item measure of state mindfulness including two factors curiosity and decentering. Participants report on a 5-point scale (0 = not at all and 4 = very much) to what extent each statement explain their

experience in practicing mindfulness. The scores range between 0 and 52 with higher scores indicating higher state mindfulness. The internal consistency of the two subscales have been reported as .91 and .93 (Lau et al., 2006). In this sample the internal consistency of the subscale decentering was found to be .30 and .75 and the internal consistency of the subscale curiosity was found to be .83 and .85.

Visual Analog Scale for Stress (Creswell, Pacilio, Lindsay, & Brown, 2014). A 140mm line ranging from 0 (not at all) to 140 (highly) was marked at every centimeter, to measure the participant's level of stress for both dart throwing conditions. A higher number of centimeters reflect higher levels of stress perception.

Weekly Stress Inventory – Short Form (WSI-SF; Brantley et al., 2007) is a self-report measure of occurrences of minor stressors in a week. Respondents respond on an eight-point scale ranging from 0 (did not occur) to 7 (extremely stressful). Two scores are obtained: an event score which corresponds to the number of events endorsed (WSI-SFE) and impact score (WSI-SFI) which is the total score for the events endorsed as stressful. Alpha coefficients for WSI-SFE and WSI-SFI have been reported as .92 and .91 respectively (Brantley et al., 2007). In this sample, the internal consistency for WSI-SFI was found to be .94.

Interventions

Brief mindfulness intervention

A 45-minute workshop was conducted with one to five participants at a sitting. Participants were provided with an introduction to mindfulness, including the benefits of mindfulness training related to well-being as well as sport performance. Participants were then given two opportunities to practice mindfulness with the use of two audio-recorded guided mindfulness exercises (mindful breathing and body scan), each lasting for ten minutes.

Following each practice exercise, the group facilitator gave the participants a chance to reflect on their experience and ask questions. Please see appendix A for the detailed instructions of the guided mindfulness exercises.

Sham Mindfulness Intervention

The purpose of the sham mindfulness intervention was to serve as a control for the potential benefits of attention, practice and expectancies for performance. Having participants engage in a task similar to that of the mindfulness intervention, but without formally being instructed to practice components specific to mindfulness interventions, help us rule out placebo effects. This workshop was also conducted in groups with one to five participants and lasted for 45 minutes. Participants were provided with an introduction indicating that taking time to sit and think, to reflect on the past, and to plan, are beneficial to mental health well-being and sport performance. Participants were then given two opportunities to practice controlling their attention with the use of two audio-recorded guided exercises (breathing and body scan), each lasting for ten minutes. Following each practice exercise, the group facilitator gave the participants a chance to reflect on their experience and ask questions. Please see appendix B for the detailed instructions of the attention control exercises.

Participants in both intervention conditions filled out the TMS reflecting on the practice sessions completed during the workshop. At the end of the workshop, based on the intervention group, participants were instructed to practice mindfulness or attention control at home by listening to the two audio-recorded exercises provided to them. Participants were given the option to use both or either audio file for practice. Participants were required to practice once a day for five days before they returned to the lab for post-intervention measures. Participants were asked to not practice more than once a day, log the date, time, and length of practice and fill out

a TMS immediately following the final practice session. Participants were also asked to not engage in any other meditation practice during the period of the study.

No Intervention: Participants in this group completed the pre-intervention measures (distress tolerance, motor performance and self-report measures). They then returned to the lab to complete post- intervention measures at a time that matched the time between pre- and post-intervention measures for the two active intervention groups.

Procedure

Participants were recruited via an email invitation for the study. Participants were randomly allocated to one of the three groups; brief mindfulness intervention, sham mindfulness intervention, or a no-intervention control group. Participants first arrived at the "Attention and Emotion" laboratory located in the Psychology Department and completed pre-intervention measures, in the order of, anagram solving task, dart throwing tasks, MTPT-C, pain task, DTS, FFMQ, OHQ, SAS and WSI-SF. Participants assigned to the brief mindfulness and sham mindfulness intervention conditions then attended the workshop between 1 and 10 days following the pre-intervention measures. Participants filled out a measure of TMS and were asked to complete the homework log and a measure of TMS following the final practice session at home. These participants then practiced the interventions at home, for five days, once a day, before returning to the laboratory to complete post-intervention measures in the order of, CEQ, anagram solving task, dart throwing tasks, MTPT-C, pain task, DTS, FFMQ, OHQ, SAS, WSI-SF. The duration between the workshop and post-intervention measures varied between 6 and 13 days. Participants in the no-intervention control condition also returned to the laboratory during this time to complete the post-intervention measures. The time duration between the pre-intervention and post-intervention measures for participants in the no-intervention condition

varied between 7 and 18 days. Participants were compensated for participation by offering course credit and entering them into a draw for a chance to win one of four, $50 gift cards. Following the post-intervention measures, participants in the sham mindfulness and no intervention conditions were given access to the mindfulness meditation recordings so that these participants also benefitted from participating in the study.

RESULTS

Data were tested for normality and sphericity. In all the analyses reported below, data met the statistical assumptions. Data from the primary outcome measures were also tested for between-condition differences at pre-intervention. The results showed that the conditions did not differ in any of the primary outcome variables except for WSI-SFI, F (2,556) = 4.881, p = .011. Tukey's HSD indicated that the mean score for WSI-SFI in the brief mindfulness condition (M = 70.60, SD = 31.04) was significantly higher than the score for WSI-SFI in the no-intervention condition (M = 43.63, SD = 22.53). A one-way ANOVA was conducted to determine participants' compliance with practice. A second one-way ANOVA was conducted to determine whether both active interventions were perceived with similar levels of credibility as well as expectancy effects as measured by CEQ scores. Finally, separate mixed-design ANOVAs were conducted to determine whether there were differences in the primary outcome variables among the conditions at post-intervention.

Compliance and Credibility and Expectancy Check

Differences in compliance

A one-way ANOVA indicated no differences in number of minutes of practice between the brief mindfulness (M =45.65, SD = 8.08) and sham mindfulness (M =49.20, SD = 3.12) conditions, F (1,38) = 3.359, p = .075, suggesting that both groups practiced for an equal amount of time.

Differences in CEQ

A one-way ANOVA indicated no differences in credibility scores between the brief mindfulness (M =24.15, SD = 5.99) and sham mindfulness (M =22.75, SD = 7.54) conditions; F (1,38) = .423, p = .520. No differences were found in expectancy scores between the brief

mindfulness (*M* =27.40, *SD* = 8.51) and sham mindfulness (*M* =28.10, *SD* = 9.30) conditions; *F* (1,38) = .062, *p* = .805. These results indicate that both active interventions were perceived at similar levels of credibility and expectancy effects.

Primary Outcome Analyses

Differences in outcome variables

For each outcome measure noted below, a 3 (Condition; brief mindfulness, sham mindfulness and no intervention) X 2 (pre- and post-intervention measures of the pain stimulation task, MTPT-C, anagram solving, DTS, FFMQ, OHQ, SAS,WIS-SFI) mixed-design ANOVA, with intervention type as a between-subjects factor and time of measurement as a repeated measures factor, was conducted to test for differential change over time. A 2 (Condition; brief mindfulness and sham mindfulness) X 2 (pre- and post-intervention measures) mixed-design ANOVA was conducted to test for differential change in state mindfulness (TMS) over time. Two, 3 (Condition; brief mindfulness, sham mindfulness and no intervention) X 2 (Stress condition; low stress and high stress) x 2 (pre- and post-intervention measures of reported levels of stress and dart throw scores) were conducted assess for differential change over time. Table 2 shows the means and standard deviations for each primary outcome variable at pre- and post-intervention.

DTS. Results show that there were no differences in distress tolerance among the conditions, *F* (2,56) = .554, *p* =.578, and across time, *F* (1,56) = 2.321, *p* =.133. The interaction between condition and time was also not significant, *F* (2,56) = .507, *p* =.605.

FFMQ. No differences in trait mindfulness were found among the conditions, *F* (2,56) = .702, *p* =.50, and across time, *F* (1,56) = .003, *p* =.958. The interaction between condition and time was also insignificant, *F* (2,56) = 2.650, *p* =.080.

OHQ. Analyses showed no differences in well-being as a result of condition, F (2,56) = .631, p =.536, and across time, F (1,56) = 1.809, p =.184. The interaction between condition and time was also non-significant, F (2,56) = .494, p = .613.

SAS. Results indicate that sport anxiety did not differ among the conditions, F (2,56) = 2.317, p =.108, and across time, F (1,56) = .435, p =.512. The interaction between condition and time was also not significant, F (2,56) = 1.575, p = .216.

TMS. Results indicate that state mindfulness did not differ between the active intervention conditions, F (1,38) = .337, p =.565, and across time, F (1,38) = 2.230, p =.136. The interaction between condition and time was also not significant, F (1,38) = 2.907, p = .096.

WIS-SFI. Results indicated that stress among the conditions was significantly different, F (2,56) = 3.974, p =.024, indicating the participants in the brief mindfulness condition reported higher levels of stress than that of the no-intervention condition. Stress did not significantly change across time, F (1,56) = .010, p =.920. There was no significant interaction between condition and time, F (2,56) = .700, p = .501.

Pain Task. No differences in pain ratings were found among conditions, F (2,56) = .020, p =.980, and across time, F (1,56) = .179, p =.674. The interaction between condition and time was not significant, F (2,56) = .550, p =.580.

MTPT-C. Results indicate that persistence on the MTPT-C task did not differ among conditions, F (2,56) = .326, p =.723. Results showed that there was a significant decrease in persistence across time, F (1,56) = 16.796, $p < .001$ indicating that participants were more likely to quit the task sooner at post-intervention than at pre-intervention. The interaction between condition and time, F (2,56) = 1.718, p =.189, was not significant.

Anagram Task. After controlling for correct response, results indicate that the time spent solving anagrams did not differ across conditions, F (2,56) = 1.578, p =.085. Participants showed decreases in time spent on solving anagram across time, F (1,56) = 5.095, p =.028. The interaction between condition and time, F (2,54) = 1.076, p =.348, was not significant.

Dart Throwing

Manipulation Check

VAS. A 3(condition; brief mindfulness, sham mindfulness and no-intervention) x 2 (stress condition; low stress and high stress) x2 (time; pre-intervention and post-intervention) ANOVA showed no differences in level of reported stress across conditions, F (2,56) = .148, p =.862, and across time, F (1,56) = 1.584, p =.213. The level of stress reported across the low stress and high stress conditions was significantly different, F (1,56) = 209.903, p <.001, indicating that participants reported lower ratings for stress in the low stress condition. The interactions between condition and stress condition, F (2,56) = .338, p =.714, condition and time, F (2,56) = 2.147, p =.213, stress condition and time, F (1,56) = 1.127, p =.293 and condition, stress condition and time F (2,56) = .317, p =.730 were not significant.

Performance

A 3(condition; brief mindfulness, sham mindfulness and no-intervention) x 2 (stress condition; low stress and high stress) x2 (time; pre-intervention and post-intervention) ANOVA showed no differences in dart throwing scores across conditions, F (2,56) = 1.013, p =.370, and across time, F (1,56) = 1.691, p =.199. The dart throwing scores between the low stress and high stress conditions was significantly different, F (1,56) = 36.256, p <.001, indicating that participants scored higher in the low stress condition. The interactions between condition and

stress condition, F (2,56) = 1.392, p =.257, condition and time, F (2,56) = .754, p =.475, stress condition and time, F (1,56) = .016, p =.900 and condition, stress condition and time F (2,56) = 2.402, p =.100 were not significant.

Table 2

Descriptive statistics of primary outcome variables for each intervention condition group

Measure	Brief Mindfulness		Sham Mindfulness		No-Intervention	
	Pre	Post	Pre	Post	Pre	Post
	M (*SD*)	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)
DTS	3.47(.68)	3.59 (.68)	3.20 (.59)	3.45 (.70)	3.47 (.66)	3.50 (.96)
FFMQ	130.60(15.33)	126.20(16.57)	122.25(12.56)	126.10(12.70)	128.16(14.25)	128.95(14.52)
OHQ	135.10(17.50)	130.85 (21.62)	134.70 (10.33)	133.80 (11.52)	129.47 (18.19)	128.37 (17.27)
SAS	46.00 (9.14)	47.60 (12.94)	46.90 (9.56)	45.55 (11.10)	41.58 (10.58)	39.58 (9.04)
TMS	31.30 (5.67)	31.10 (7.55)	30.50 (5.39)	34.05 (8.22)	-	-
WIS-SFI	70.60 (31.04)	66.65 (35.42)	52.10 (28.46)	55.15 (29.00)	43.63 (22.53)	45.32 (24.02)
Pain Rating	56.45 (28.38)	55.25 (27.65)	53.35 (26.27)	55.25 (27.30)	57.26 (26.98)	54.00 (28.55)
MTPT-C	254.28(64.38)	208.97(99.27)	251.54 (67.37)	233.65 (81.11)	256.17 (55.44)	190.91 (120.58)
Anagram	310.53(144.20)	290.80(156.51)	345.97(150.11)	281.19 (168.91)	279.54(105.81)	206.26 (73.90)
Stress Low	13.50 (14.24)	13.50 (14.97)	15.50 (13.17)	19.50 (18.77)	18.95 (14.49)	12.63 (11.47)
Stress High	46.00 (20.37)	45.50 (30.69)	48.00 (28.58)	46.00 (20.88)	48.42 (26.10)	39.47 (22.23)
Dart Low	51.63 (15.73)	47.88 (13.38)	47.38(13.32)	51.36 (12.65)	45.00 (13.79)	51.32 (15.33)
Dart High	42.75 (15.60)	45.50 (14.60)	38.75 (13.82)	42.88 (12.91)	37.37 (11.23)	36.05 (11.56)

Note. DTS = Distress Tolerance Scale full scale score, FFMQ = Five Facet Mindfulness Questionnaire full scale score, OHQ = Oxford Happiness Questionnaire full scale score, SAS = Social Anxiety Scale full scale score, WSI-SFI = Weekly Stress inventory – Short Form Impact score, Pain Rating = Heat sensation at 48°C, Anagram = Time spent solving anagrams in seconds, MTPT-C = Time spent on the start shape in seconds, Stress Low = Self-reported level of stress during the low stress dart throw task, Stress High = Self-reported level of stress during the high stress dart throw task, Dart Low = Score on Dart Throwing task under low stress and Dart High = Score on Dart Throwing task under high stress

DISCUSSION

It has been suggested that mindfulness training improves performance and other psychological variables that are important for sport performance (Gardner & Moore, 2004; John et al., 2011; Moghadam et al., 2013). However, the results from most intervention studies are hard to interpret due to poorly described interventions and lack of active control groups. I tried to address these shortcomings in this study by including comparison conditions to control for the passage of time and participation in a structured intervention, clearly describing both active interventions used and by conducting a randomized trial. I also included multiple outcome measures that are hypothesized to be influenced by the intervention and are important for sport performance and well-being. The purpose of this study was to help determine whether cultivating mindfulness in college athletes is beneficial for distress tolerance and potentially to improve athletic performance under distressing conditions. This study also hoped to demonstrate whether a brief mindfulness training can be used to ensure mental health well-being among college athletes.

Unfortunately, the results did not support the hypotheses that a brief mindfulness intervention improves distress tolerance, performance in a motor task or mental health well-being. There are a few potential explanations to this. Some studies have shown that brief mindfulness interventions improve stress reactivity, pain sensitivity and other psychological factors (Creswell et al., 2014; Zeidan, Gordon, et al., 2010; Zeidan, Johnson, Gordon, & Goolkasian, 2010). These studies have shown that interventions as brief as 60 minutes of total practice across three consecutive days to be effective. While this study also employed a similar duration of practice, it is possible that more intense interventions longer in length and across

consecutive days are more likely promote skills to cope with distress, improve performance and mental health well-being.

Furthermore, participants were not given instructions to use their mindfulness or "attention control" skills while participating in the post-intervention tasks. It's possible that explicitly instructing participants to use mindfulness skills during the post-intervention tasks could have benefitted the participants in the brief mindfulness condition.

There were a few strengths to this study. The study was a randomized controlled trial designed to study the impact of a brief mindfulness intervention on distress tolerance and other psychological outcomes among athletes. The study included an active control group to be able to rule-out potential placebo effects and a no-intervention control group to rule-out practice effects. The interventions used in the study were based on core mindfulness principles, well-matched across conditions and have been clearly described to the reader. Participants in the active intervention conditions were given audio-recorded files, thereby promoting portability and consistency of the practice sessions across participants. The recordings also ensured that the interventions were well-matched on training demand, instructor and duration. This study attempted to measure distress tolerance using four different tasks, each measuring a different type of distress tolerance, that might be important for athletic performance or well-being among athletes. In addition to distress tolerance, other mental health variables that are important to athletes' performance and well-being were also included in this study.

In future studies, it is recommended that more intense interventions are carried across consecutive days. It is likely that consistent practice promotes mindfulness, makes mindfulness skills more habitual and results in better outcomes. Having participants come in to the lab to practice may also help participants to fully engage in the practice and minimize distractions

during practice. Participants may also benefit from further psychoeducation on mindfulness across sessions, providing more opportunities to the participants to learn about mindfulness. It is also recommended that during post-intervention measures, participants are instructed to use their skills learned through the interventions. Being accepting, non-reactive and non-judgmental can be expected to increase distress tolerance and thereby improve performance and well-being.

Many authors have suggested that mindfulness training can be beneficial to athletes. Based on the literature in medicine and psychology, the extension of benefits of mindfulness to athletic performance and well-being is logical and credible. Thus, additional studies are needed to study the impact of mindfulness on athletic performance and performance related constructs.

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APPENDIX A. INSTRUCTIONS FOR THE BRIEF MINDFULNESS INTERVENTION GROUP

Introduction

"Mindfulness is a way to bring your attention, purposefully, to the present moment, while being non—judgmental of this very moment. If you check in with the mind, you will notice that your mind is either pre-occupied with the past or with the future; you may think back to what you did wrong (or right) yesterday or constantly worry about tomorrow. Even though your body is always in the present moment, your mind may not. Mindfulness is a way to bring both your body and mind to this moment, right now; the only moment you are alive. So why is mindfulness important? Research has shown that mindfulness decreases psychological symptoms such as anxiety and stress, improve attention and help us cope with pain. We also think that mindfulness might be beneficial to athletes and might aid in performance enhancement and distress tolerance."

"Let's discuss a little bit about how mindfulness can be applied to sport. There may be times when you are faced with distress during which, you would either try to avoid thinking about what is causing distress or you would repetitively think about the distressing situation or worry. Avoidance, rumination and worry have been found to negatively impact well-being and performance. Mindfulness is a more adaptive way to cope with distress. Mindfulness helps by improving the ability to experience negative or distressing emotions, to accept and let go. This is in contrast to trying to control thoughts or emotions but instead fully experiencing what is in the mind and focusing on the present moment. For example, consider that you are participating in a sport activity. Say that you are making a pass to your teammate and your pass is intercepted by an opponent. What are some of the emotions that you may experience? What are some of the

thoughts that would arise in your mind? How would these emotions and thoughts typically impact your performance? Now imagine that instead, you accepted that your pass was intercepted, let go of that event and focused on the game? How would this impact your performance? This is how being mindful will help you."

"So how mindful is each one of us? Each person has a certain level of mindfulness unique to that person. This ability can be improved through practice. This can be done formally and informally. In formal practice, a few minutes each day are set aside to practice mindfulness. Guided mindfulness exercises can be used as an aid for beginning formal practice. These exercises require no special equipment, instead make use of things that are readily and freely available, like the breath, the body, the sounds around or any object. Paying attention to the physical state could also be thought of as a first step to being aware of your emotions. Also, focusing on one object, like your breath, or using progression, moving from focusing on one body part to the other, will help keep the focus on the present moment and when you get distracted, this will help you bring back your attention back to the present moment. These exercises will also help recognize and be aware of when the body gets tensed, or when you experience stress. This is a radical shift in the way you usually live and it will take some practice before you get better at living in the present moment, with acceptance and without judgment. The final goal is to bring this mindful quality to your daily life, when performing daily activities, including athletic events. By practicing for just 10 minutes a day, is a sufficient way to start being mindful. That is what this workshop is going to focus on; to instill mindfulness, to improve mental health well-being and athletic performance. You will spend a few minutes today practicing two different mindfulness exercises. There are many different mindfulness exercises that can be employed but for this study, two different mindfulness exercises will be used. It is

possible that some of you may prefer one exercise over the other. The reason to focus on two exercises is to give you some options. Any questions before we proceed?"

Guided breathing exercise

"First, is a breathing exercise. Please find a comfortable position, place your feet flat on the ground, legs uncrossed and have your backs straight in a way that your posture helps you to be awake and aware of your surroundings. You may close your eyes if you would like to. Bring your awareness to the sensations you feel while supporting yourself on the chair. Now, bring your attention to your breathing, focus on your breath moving in and out of the body. Notice how your breathing patterns change. Just allow yourself to feel the sensations, as they are, without trying to change or control your breath. You will find that your mind will wander away from your breathing. Notice it when it happens and gently bring your attention back to the breathing. You will find your mind wandering over and over again. When this happens, no need to judge, just bring your mind back to the breath. Continue to focus on your breathing, as your breath moves in and out of your body. Focus your attention on the sensations on your nostrils as you inhale and exhale. Notice whether the breathing pattern changes. Just feeling what is already there, nor trying to change anything. Notice how your abdomen and chest move as you take a breath in and as you exhale out. If your mind wanders to other thoughts, other feelings, notice it and gently bring back your attention to your breathing. Let's spend the next couple of minutes, continuing to focus on your breathing. Now when you are ready, if you had your eyes closed, you may gently open your eyes."

Guided body scan

"Next is a guided body scan exercise. Again, find a comfortable position, place your feet flat on the ground, legs uncrossed and have your backs straight in a way that your posture helps you to be awake and aware of your surroundings. You may close your eyes if you would like to do so. Notice your body as a whole and the sensations you feel against the chair supporting your body. Just allow yourself to feel the sensations, as they are, without trying to change or control your sensations. You will find that your mind will wander away. Notice it when it happens and gently bring your attention back to the sensations you are currently experiencing. You will find your mind wandering over and over again. When this happens, no need to judge, just bring your mind back to the exercise. Gather your attention and focus on your feet. Pay attention what you feel on your toes, the sole, the heel and the top of your feet. Just focusing on what is here right now. Now focus your attention on the ankles. Notice your sensations. Now move your attention to your lower legs and the knees. Focus on what you feel on the outside on your skin as well as the inside. Shift your attention to the thighs and noticing what is there. Focus your attention on your hips and pelvis now. Notice your sensations on the inside and the outside. Now shift your attention to the lower back, middle of the back and now the upper back. Move your attention to the front of the body, your abdomen. Focus on what you are feeling in this region. Gather your attention on your chest now. Focusing on the sensations on this part of the body. Now shift your attention to the hands and your arms. Holding your hand and your arms in your attention. Now focus your attention on your shoulders and your neck. Just feeling whatever you are feeling in these parts. Not trying to change anything. Now shift your attention to the face, your eyes, chin, mouth, nostrils, cheeks, the sides of the face, your eyes, your head and now your scalp. Now hold your whole head in your attention. If your mind wanders to other thoughts, other feelings,

notice it and gently bring back your attention to your bodily sensations. Let's take the next couple of minutes to hold your whole body in your attention. Now when you are ready, if you had your eyes closed, you may gently open your eyes."

"Now that we have practiced mindfulness using two different exercises, I would like each one of you to practice mindfulness at home. I will give you recordings of the two exercises we did today. Each exercise lasts for 10 minutes. You will be expected to practice for 10 minutes per session and complete 5 sessions. Please don't practice for more than once during a day. We want to make sure that you are consistent with your practice across days. Please use homework log sheets to log your practice. You may use one or both recordings for practice. Also, please refrain from any other mindfulness or meditation exercises (including yoga). You will come back to the lab next week for some measurements. Thank you for coming in today."

APPENDIX B. INSTRUCTIONS FOR THE SHAM MINDFULNESS INTERVENTION GROUP

Guided breathing exercise

"This first exercise will incorporate some focus on your breathing. Please find a comfortable position, place your feet flat on the ground, legs uncrossed and have your backs straight in a way that your posture is comfortable. You may close your eyes if you would like to. You may start by first, focusing your attention on your breathing as a way to center yourself. Now you may start thinking about anything that comes to your mind. These thought maybe related to events that happened yesterday, in the past, trying to figure out what went wrong or what went right. Were there things that you would have liked to do differently? Now you may think about tomorrow, the future. Think about what you need to get done tomorrow. Focus on upcoming events, be it classes, exams, competitions, social gathering or any other event. Think about how these upcoming events make you feel. Pay attention to other thoughts that come up. The current thoughts you have might lead you to other thoughts. Some of these thoughts may be associated with emotions. These emotions may lead to other emotions. Fully engage yourselves in these thoughts and emotions. You may feel happy or sad, content or angry. You may want to change how you feel. Feel free to do so. You may want to change some of the thoughts that arise. Feel free to do so. If you may, you may focus again on your breath for a brief moment, as a way to center yourself, and then guide you mind to any thought, feeling or sensation that arises. You may want to use this time to plan. Let's spend the next couple of minutes, continuing to guide your mind to important things in your life that need attention. Now when you are ready, if you had your eyes closed, you may gently open your eyes."

Guided body scan

"This next exercise requires you to focus on your body; to use it as a map to guide your thinking and organizing. Again, find a comfortable position, place your feet flat on the ground, legs uncrossed and have your backs straight in a way that your posture is comfortable. You may close your eyes if you would like to do so. Let's start by first noticing your body as a whole. Now make a list of things that needs you attention, these may include classes, exams, competitions, social gathering, any other event, events that have already taken place, events that are yet to take place. These might even be sport skills that you need to practice or activities that need to be completed for classes. Now pick one item from your list that is of least importance and associate this item with your feet. Think about this item, does this need planning? Resolving? Are there emotions or thoughts associated with this? Do these emotions and thoughts need resolving? Now choose an item which is a little higher in importance than the previous item. Associate this item to the ankles. Think about this item, does this need planning? Resolving? Are there emotions or thoughts associated with this? Do these emotions and thoughts need resolving? Pick an item of more importance and associate this item with your lower legs, while repeating the process of thinking and exploring. Pick another item and associate this item with your upper legs and repeat the process of thinking. Now associate your back with an item of higher importance than the previous item. Pay attention to other thoughts that come up with this item. The current thoughts you have might lead you to other thoughts. Some of these thoughts may be associated with emotions. These emotions may lead to other emotions. Fully engage yourselves in these thoughts and emotions. You may feel happy or sad, content or angry. You may want to change how you feel. Feel free to do so. You may want to change some of the thoughts that arise. Feel free to do so. Pick an item of greater importance and associate that with

the arms. Feel free to pay attention to any thought or emotions that come up as a result. Now pick the item of most importance and associate that with your head. Let's take the next couple of minutes to pay attention to any thoughts and emotions that come to your mind. Any planning and organizing you need to do. Now when you are ready, if you had your eyes closed, you may gently open your eyes."

"Now that we have practiced this skill by using two different exercises, I would like each one of you to practice this at home. I will give you recordings of the two exercises we did today. Each exercise lasts for 10 minutes. You will be expected to practice for 10 minutes per session and complete 5 sessions. Please don't practice for more than once during a day. We want to make sure that you are consistent with your practice across days. Please use homework log sheets to log your practice. You may use one or both recordings for practice. Also, please refrain from any attention or meditation exercises (including yoga). You will come back to the lab next week for some measurements. Thank you for coming in today."