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The Influence Of Brief Mindfulness Exercise On Encoding Of Novel Words

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THE INFLUENCE OF BRIEF MINDFULNESS EXERCISE ON ENCODING OF NOVEL WORDS

by

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This thesis, submitted by Kristin K. Bonamo in partial fulfillment of the requirements for the Degree of Master of Arts from the University of North Dakota, has been read by the Faculty Advisory Committee under whom the work has been done, and is hereby approved.

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Kristin K. Bonamo
August 2013

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ABSTRACT

Based on research associating mindfulness with improvements in well-being, attention, and memory processes, brief mindfulness exercises may be helpful in enhancing the encoding of novel semantic information. A Swahili-English word pair association task was used to examine whether engaging in a brief mindfulness exercise enhanced the encoding of Swahili-English word pairs, thus improving long-term recall. Participants recruited from the undergraduate population at a Midwestern university were randomly assigned to one of three conditions: engaging in a 20 minute body scan meditation, a 45 minute body scan meditation, or a control group prior to learning Swahili-English word pairs. Separate analyses of variance were conducted for number of words recalled, changes in state anxiety scores, and state mindfulness scores. Results showed significantly more words recalled by members of the 20 minute group compared to members of the control group. Although there were more words recalled by the 45 minute group members when compared to the control group, it was not a statistically significant difference. Self-reported mean levels of state mindfulness were significantly higher after the meditation exercise for the 20 and 45 minute groups compared to the controls. None of the groups showed significant changes in mean levels of self-reported state anxiety on measures collected before and after the meditation exercise. Some preliminary evidence of gender effects was found for both recall and state mindfulness, but more research is needed with a larger representation of male students to strengthen the conclusions that might be drawn from these gender-specific findings.

Keywords: mindfulness, attention, learning, long-term memory, test anxiety

CHAPTER I

INTRODUCTION

The Influence of Brief Mindfulness Exercise on Encoding of Novel Words

Semantic memories refer to the knowledge individuals accumulate over our lifetimes, including language-based knowledge (Baddeley, Eysenck & Anderson, 2009). The development of semantic memories, such as in learning the meaning of novel words, is a process that requires attending to, encoding, and recalling information when it is needed. Attention is inextricably intertwined with this process, as attention is the mechanism through which information is selected and processed from the environment (Atkinson & Shiffrin, 1968). Attention is therefore a prerequisite for the encoding of information and learning, and as such, disruptions in attention can interfere with learning. In a similar fashion, attention also plays a role in the recall of semantic memories, as attention is used to limit interference from competing stimuli while relevant information is selected from an array of semantic networks (Chiesa, Calati, Serretti, 2011).

Mindfulness meditation may be an approach for improving attention through mental conditioning (Jha, Krompinger & Baime, 2007). Mental conditioning is effortful practice of techniques that can improve focus, concentration, and memory. In mindfulness-based techniques, practice includes intentionally focusing on the present moment with an attitude of acceptance (Kabat-Zinn, 1994). Since mindfulness meditation is non-invasive, inexpensive, and feasible for most people to practice, it has the potential to be applied in many situations, from work, to school, to daily life (Kabat-Zinn, 1990). Specific interventions to enhance memory performance may be designed and applied by examining the components of memory and understanding how mindfulness might enhance attention and memory capacity. The current study examined whether engaging in a brief mindfulness exercise, prior to encoding novel words, improved performance on a long-term memory test.

Memory and Attention

Information-processing, an approach to understanding memory and cognition, provides a framework for identifying and explaining the parts and processes involved in remembering new information (Baddeley, et al., 2009). The information-processing theory (IPT) is broadly understood to be modeled after computers, where information is inputted, processed and stored, and retrieved from storage when it is needed. Types of memory identified by IPT include sensory memory, where incoming data is received or perceived; short-term memory (STM), a limited capacity temporary store; and long-term memory (LTM), which houses a seemingly endless quantity of information, such as semantic knowledge and memories of experiences. Learning involves an integration of these different types of memory through the use of encoding, storage and recall (Baddeley, et al., 2009). Encoding involves attending to incoming or perceived information in STM and placing it in long-term memory (LTM) where it is integrated with existing information. Once stored, information can be retrieved from long-term memory and returned to working memory when necessary to be engaged and manipulated within conscious awareness.

Within the IPT model of memory, attention is required for encoding new information. While the attention system is complex and not fully understood, some components of the system have been proposed (Fan, McCandliss, Sommer, Raz & Posner, 2002), including orienting, alerting and executive control. Orienting involves identifying relevant incoming sensory data, whereas alerting entails holding a state of focused awareness so that the information can be encoded. Executive control functions, sometimes referred to as conflict monitoring, are also used to detect and consciously decide among conflicting signals of sensory stimuli. With the development of semantic memories, for example, orienting is required to recognize what incoming information is important to direct attention for encoding. Alerting is needed to sustain concentration on the relevant information. Then executive control functions operate to distinguish between critical information and internal or external distractions, such as intrusive thoughts or background noise when encoding new information.

Mindfulness and Attention

Given the strong association between attention and memory, many researchers have hypothesized that mindfulness involves attention, which in turn facilitates memory processes (Anderson, Lau, Segal & Bishop, 2007; Jha, Stanley, Kiyonaga, Wong & Gelfand, 2010; van Vugt & Jha, 2011). In his work on mindfulness, Kabat-Zinn (1990) developed the Mindfulness-Based Stress Reduction (MBSR) program, which teaches several formal techniques to increase mindfulness, including body scan meditation, sitting meditation, and mindfulness-based yoga. Kabat-Zinn argues that mindfulness consists of three components: intention, attitude, and attention (1994). Intention is an individual's reasons or purpose for behaving mindfully. Attitude is one of acceptance and being aware without evaluation. Attention is awareness and acknowledgement of each moment as it passes.

Using concepts related to MBSR, mindfulness treatment research studies have primarily focused on identifying ways in which mindfulness is associated with a number of different factors, including cognitive shifts in perception, emotion regulation, stress reduction, and flexibility of thoughts, and behaviors (Carmody, Baer, Lykins & Olendzki, 2009). Many of these factors have important implications for attention and memory (e.g. poor emotion regulation may interfere with the attention needed to encode information).

One result of engaging in mindfulness practice seems to be a cognitive shift characterized by acceptance of thoughts and feelings as impermanent and not as a reflection of reality (Carmody et al., 2009). Also labeled detachment, distancing or reperceiving, this change in perception is described as shifting focus from oneself and personal experience to a broader, objective attention to moment-to-moment information (Shapiro, Carlson, Astin & Freedman, 2006). This shift allows for flexibility in thinking and reduced reactivity in responding, which may contribute to improvements in sustained attention and executive control functioning as relevant information is distinguished from interfering stimuli. Reduced reactivity and interference from non-relevant automatic or habitual thought processes can also result in increased accuracy in retrieval (Wenk-Sormaz, 2005).

Following previous research that found improvements in sustained attention resulting from regular practice or training in attention (Green & Bavelier, 2008), MacLean and colleagues (2010) found that training in meditation can enhance perceptual abilities by freeing up resources that could then be used to expand sustained attention. This ability to shift available resources also adds support to other research showing improvements in working memory following meditation practice.

The link between mindfulness and attention may also be mediated via stress reduction and emotion regulation. Numerous studies on mindfulness and meditation have demonstrated reduction of stress and depressive and anxiety symptoms (Jain, et al., 2007; Zeidan, Johnson, Gordon & Goolkasian, 2010). Improved self-regulation of mood requires the ability to maintain emotional stability, focus attention on the task at hand, and minimize distractions from unpleasant thoughts, feelings and behaviors. Because perceived stress and psychological symptoms of anxiety and depression can all interfere with cognitions through distressing thoughts, feelings and behaviors, some studies have also linked mindfulness with attention (Goldin & Gross, 2010; Ortner, Kilner, & Zelazo, 2007). A study investigating the effects of MBSR on participants diagnosed with social anxiety focused specifically on emotion-regulation (Goldin & Gross, 2010). Following MBSR training, participants demonstrated decreased negative emotion experience as well as increased activity in brain regions associated with attention, detected through functional magnetic resonance imaging (fMRI) during a breath-focused attention task. While this study suggests links among mindfulness, negative emotions, and attention, few studies have examined how these constructs interact and operate together.

Ortner, Kilner and Zelazo (2007) conducted a study that more directly investigated the link between mindfulness, emotionality, and attention. The first part of the study used preliminary correlational data to compare mindfulness meditators with different levels of experience in practicing meditation. More experience with meditation was associated with shorter reaction times when presented with emotionally-charged and distracting stimuli (e.g. unpleasant pictures), thus suggesting that more experienced meditators had more attentional resources. The second part of the study found similar results utilizing an experimental design with university students randomly assigned to an experimental group who received a 7-week class in mindfulness meditation, a relaxation group, or a wait-list control. Using the same measures as the previous study, results showed shorter reaction times when presented with emotionally-charged stimuli for the mindfulness meditation group only. Together these studies demonstrate a link between mindfulness and attention and show that mindfulness meditation is associated with improvements in reaction time among individuals well-trained in mindfulness approaches, as well as novices assigned to mindfulness training.

Shapiro et al. (2006) suggest that improved self-regulation of attention from mindfulness practice will result in better sustained attention, improved switching, and cognitive inhibition or suppressing secondary processing. Along with these types of attention, researchers have examined the effects of mindfulness on proposed subsystems of attention: orienting, alerting and executive control. Chan & Woollacott (2007) found that meditators were faster than controls at orienting and executive control. They also found that amount of experience (i.e. years practicing meditation) was not associated with differences in performance; however consistent practice (i.e. every day) did contribute to improvements. Another study found that mindfulness meditators were better at sustaining attention, more accurate in responding, and less susceptible to expectancy effects than non-meditators (Valentine & Sweet, 1999). Further research including naïve meditators in quasi-experimental designs provides additional support for attentional improvements in orienting, alerting and executive function resulting from meditation training and experience (Jha et al., 2007; van den Hurk, Giommi, Gielen, Speckens & Barendregt, 2010). The results from these studies demonstrate that mindfulness meditators are more efficient and accurate in attention-based tasks, and specifically that they may have an advantage in flexibility of cognition compared to non-meditators. Furthermore, these studies suggest that novice meditators can see the benefits of mindfulness training without needing years of experience.

Research has demonstrated that there are attentional benefits in the long-term practice of meditation, including faster reaction times and reduced interference in tasks using executive control functions (Chan & Woollacott, 2007). It has also been shown that meditation practice can improve accuracy when focused sustained attention is required and faster reaction times during orienting tasks (Valentine & Sweet, 1999; van den Hurk et al., 2010). Moreover, researchers examining electrical activity in the brain have found increased activity in areas associated with attentional control following participation in an 8 week MBSR program (Kerr et al., 2011).

The bulk of the research on the cognitive benefits of mindfulness-based practice outlined above has focused on outcomes associated with multi-week mindfulness training programs. To enhance the efficiency of these programs, future research might focus on identifying the minimum amount of mindfulness practice required in order to benefit attention and learning. Furthermore, while these studies have been helpful in understanding the associations between mindfulness and learning, they fail to address practical applications of improved attention, for example, how gains in attention associated with mindfulness practice may benefit memory and learning in educational settings.

Mindfulness and Memory

Attention is an important component of encoding and recall, supporting working memory in complex tasks such as learning and comprehension (Chiesa, et al., 2011). Working memory, or one's ability to concurrently hold and perform operations upon information, can become taxed and compromised by intrusive thoughts, moods and external distractions (Baddeley, et al., 2009). Attention and working memory work in concert, as researchers have found that a lower working memory capacity increases susceptibility to interference (Kane & Engle, 2000). Although the act of engaging in attentional breathing and other related mindfulness strategies taxes work memory (van den Hout, Engelhard, Beetsma, Slofstra, Hornsveld, Houtveen, & Leer, 2011), the benefits to working memory can be observed following mindfulness-enhancing training and activities (Jha et al., 2010, van Vugt & Jha, 2011).

A study of predeployment Marine Corps reservists compared one group participating in Mindfulness-Based Mind Fitness Training (MMFT), a program similar to MBSR designed especially for members of the military, to a control group not participating in the training prior to deployment (Jha et al., 2010). The researchers found that those who practice the most demonstrated increased working memory capacity, as measured by recall of unrelated words presented while solving math problems. Practice was also associated with improvements in positive affect. Van Vugt and Jha (2011) have proposed that the improvements in working memory noted in the studies above are the result of reduced noise during encoding, which allows for speedier decision-making.

Working memory is an important precursor to long-term memory (Baddeley, et al., 2009), and as such, a few studies have examined the association between mindfulness-based practice and long-term recall of information. Nevertheless, neuropsychological studies provide converging evidence for changes in the brain associated with improved memory resulting from mindfulness practice, including increased cerebral blood flow in subjects with memory loss and increased gray matter density in the hippocampus following mindfulness training (Newberg, Wintering, Khalsa, Roggenkamp, & Waldman, 2010; Holzel, Carmody, Vangel, Congleton, Yerramsetti, Gard, & Lazar, 2011).

In one of the few studies examining long-term recall, researchers had an experimental group participate in a 12 minute focused breathing exercise prior to being presented with ten positive (e.g. "friend), ten negative (e.g. "murder"), and ten neutral (e.g. "door") words (Alberts & Thewissen, 2011). Following a 20 minute delay after being introduced to the word list, the mindfulness and control groups recalled the same number of words; however, participants in the mindfulness group recalled a significantly smaller amount of negative words. A similar study, but with a longer phase of meditation training (i.e. 30 minutes, 3 times per week, for 12 weeks), found slightly different results (Roberts-Wolfe et al., 2012). In this case the meditators recalled significantly more positive words compared to the control group, with no difference in overall recall or negative words.

Another recent study compared demographically matched experienced meditators to nonmeditators on several measures of attention and verbal memory to assess for entrenched differences (Lykins, Baer, & Gottlob, 2012). While they found no differences on any of the attention measures, there were significant differences on measures of short-term and long-term memory using the California Verbal Learning Test (CVLT). This assessment involves five learning trials of a list of 16 words, followed by another list of 16 words to create interference. After the interference, short delay recall of the first list was assessed, and then long-term recall was assessed following a 20 minute delay. Experienced meditators scored higher on short delay free recall and cued recall, as well as long-term free recall. This suggests that experienced meditators have advantages in verbal memory processes. The authors also note that more research on mindfulness and short- and long-term memory is necessary, with no previous research looking at such measures.

In summary, while a number of studies have focused on links between mindfulness training and working memory, mindfulness research involving long-term memory is just emerging. A few studies have focused on long-term recall of familiar words; however, no studies to date have examined how mindfulness training might enhance performance on the encoding of novel verbal information.

Mindfulness and Learning

Studies highlighting improvements in cognitive performance (i.e., attention and memory) associated with mindfulness-based practice have important implications for learning. Much of the research on mindfulness and learning have focused on the education literature, where mindfulness interventions for teachers and students have been associated with cognitive, behavioral, emotional and social benefits (Meiklejohn, et al., 2012). Mindfulness has also been shown to directly enhance learning, with most studies focusing on changes in overall academic performance. Among academic applications, mindfulness may be described as open-minded and nonjudgmental voluntary use of cognitive processes to engage in learning (Salomon & Globerson, 1987).

In a three year study of middle school students engaged in relaxation response training, including mindfulness techniques, students with more than two exposures to semester classes using the relaxation curriculum showed significantly higher GPA, higher levels of cooperation and better work habits (Benson, et al., 2000). In another school-based study, using a five-week classroom mindfulness intervention with high school students diagnosed with learning disabilities, there were demonstrated improvements from pretest to posttest in state and trait anxiety, and teachers reported significant improvements in social skills and academic performance, as well as a reduction in problem behaviors (Beauchemin, Hutchins, & Patterson, 2008). In an experimental design with high school students in Spain, similar results were found among students with 10 weeks of mindfulness training compared to controls (Franco, Mañas, Cangas, & Gallego, 2010).

Education researchers have identified a need for controlled studies on the potential benefits of mindfulness for adult learners (Crumley & Schutz, 2011). Methods involving components of mindfulness have been introduced to college students with promising results. One early study targeted students with significant anxiety and used relaxation techniques along with EMG biofeedback, with results showing reduction in anxiety and increased GPA compared to a no-treatment control group (Thompson, Griebstein, & Kuhlenschmidt, 1980). More recently, it has been found that a one time 5-minute mindfulness exercise was able to reduce stereotype threat effects on performance (Weger, Hooper, Meier, & Hopthrow, 2011). Notably, this study also found that there was no difference in groups when there was no stereotype threat, suggesting mindfulness did not act to generally improve performance but assisted in lessening the effect of threats to performance. This is similar to what is proposed in the van Vugt and Jha noise reduction model, and is further supported by studies examining mind-wandering (Mrazek, Smallwood, & Schooler, 2012; Mrazek, Franklin, Phillips, Baird, & Schooler, 2013). Improvements in both working memory and reading comprehension as a result of reduced distraction have been found among college students following mindfulness training (Mrazek et al., 2013). This study used a two week mindfulness training program with undergraduates and also found reduced mind-wandering on a complex working memory task and on a modified verbal-reasoning portion of the GRE (Graduate Record Examination) compared to controls.

Much of the learning and memory research on mindfulness involves expert meditators or novices who go through extensive multi-week trainings. In many studies, “brief” interventions are considered 8 weeks or less; however, a few studies have shown associations with changes in state mindfulness, memory, and learning following a single administration of a mindfulness exercise. Following only 8 minutes of mindful breathing, college students have displayed reduced mind-wandering during a sustained attention task compared to relaxation and reading control groups (Mrazek et al., 2012). Another study used a single 12 minute mindful breathing exercise, compared to a no-treatment control, on memory for emotional words and found significantly fewer negative words recalled for the mindfulness group (Alberts & Thewissen, 2011). Even a 5 minute mindful eating exercise (i.e. instruction on eating two raisins and noticing the sensory experiences as if it was the first time eating a raisin) has been shown to reduce the negative effects on math performance associated with induced stereotype threat (Weger et al., 2012).

Current Study

While emerging research has shown mindfulness to directly and indirectly improve attention and recall, there is limited research evaluating brief mindfulness applications in the context of improving long-term recall of novel words, especially among adult learners. We designed a single session brief mindfulness intervention using body scan meditation to address the gaps in the literature noted above. The body scan meditation was selected because it quickly engages participants with a familiar, concrete object, their own bodies, and does not require the comparatively complicated movements of yoga-based meditation (Kabat-Zinn, 1994). The study involved three groups that were each presented novel words (20 Swahili terms paired with English translations presented at 10 second intervals per pair) to test the effect mindfulness training has on their ability to remember the meaning of the novel words approximately 1 minute later. Group 1 in the study engaged in a 20 minute body scan exercise prior to learning Swahili-English word pairs; Group 2 completed a 45 minute body scan exercise prior to encoding. Participants in Group 3 were administered the Swahili terms without the body scan, thus serving as a control group. The 45 minute body scan was chosen since it is the length of time recommended in the Mindfulness-Based Stress Reduction program, while the 20 minute body scan was included as a more efficient alternative for comparison, and to begin to explore the associated benefits of different durations of meditation. The task of learning Swahili-English word pairs was chosen as the primary outcome variable in an effort to approximate a task students might be exposed to in an actual academic setting in which novel words are learned.

Hypotheses

The goal of the current study was to evaluate whether engaging in a brief mindfulness exercise, a single session abbreviated body scan meditation, improved learning of novel words. Since previous findings indicate that mindfulness improves executive functioning and working memory, possibly by reducing the impact of interference (Jha et al., 2010; van Vugt & Jha, 2011), it was predicted that there would be differences between the mindfulness and control groups. Specifically, the groups participating in both the 20 minute and 45 minute body scan exercises before learning Swahili-English word pairs were predicted to demonstrate a higher number of Swahili words learned than the members of the control group. We postulated that if a single administration of mindfulness training demonstrated improvements in long-term recall, this could have important implications for interventions designed to enhance academic performance, given that long-term recall is a common method of testing knowledge acquisition.

In addition to recall, measures of depressive symptoms, state and trait anxiety, attentional difficulties, and mindfulness measures were incorporated into the study.

Performance or test anxiety has been identified as a common stressor for college students (Paul, Elam & Verhulst, 2007). One purpose of the measures listed above was to control for within group differences that may affect attention and memory and to test whether depressive and anxiety symptoms may moderate the associations between mindfulness and test performance. Gender was also considered as an important variable given that there is some evidence that mindfulness is significantly related to performance in women more strongly than in men (Anglin, Pirson & Langer, 2008; Shao & Skarlicki, 2009). Studies suggest that mindful approaches to learning moderate gender differences in performance on math tasks (Anglin et al., 2008) and that trait mindfulness has a stronger positive association with academic performance for women than for men (Shao & Skarlicki, 2009).

In addition to word recall as the primary outcome variable, two additional analyses with measures of state anxiety and mindfulness were included as outcome variables. It was expected that improvements in word recall across groups would coincide with increases in state mindfulness and reduction in state anxiety. Since predicted differences for all dependent variables are between meditation and control groups only (i.e. there was no expected difference between the two body scan conditions), it was determined that Dunnett's test would be conducted for comparisons following ANCOVAs.

CHAPTER II

METHOD

Participants

Participants were recruited from the population of undergraduates attending a Midwestern university through flyers, SONA systems, and in class sign-ups (N = 189; see Table 1 for demographics). Participants recruited from psychology courses were offered a choice between extra credit and ten dollars (EC = 178, $10 = 7; n = 185); non-psychology students received ten dollars (n = 4). Participants were 142 women, 46 men, and 1 not reported; M_{age} = 19.68, age range: 18-42 years. Since the majority of participants were psychology students, the gender breakdown was expected and is consistent with national higher education statistics for psychology majors (Snyder & Dillow, 2012). One participant ended participation prior to completion of the study, 17 had incomplete survey data and 4 encountered technical difficulties during administration; 167 were included in the analysis. Using G*Power 3, a power analysis was conducted for an ANCOVA with fixed effects, main effects, and interactions to determine the number of participants needed for desired power of .80 and assumed moderate effect size. With three groups and four covariates including depressive symptoms, trait anxiety, attention difficulties, and trait mindfulness, a minimum sample size of 159 was needed.

Table 1

Participant Characteristics as a Percentage of the Sample

Characteristic	Female (n =142)	Male (n = 46)
Degrees Obtained		
High School/GED	95.1	95.7
Associates Degree	2.8	0
Bachelor's Degree	0.7	2.2
Not Reported	1.4	2.2
Current year in college		
Freshman	52.8	39.1
Sophomore	31.7	26.1
Junior	9.9	19.6
Senior	2.8	15.2
Not Reported	2.8	0
Ethnicity		
Hispanic or Latino	2.8	0
Not Hispanic or Latino	73.2	80.4
Not Reported	23.9	19.6
Race		
American Indian or Alaskan Native	3.5	0
Asian	3.5	6.5
Black or African American	1.4	4.3
Native Hawaiian or Other Pacific Islander	2.1	0
White	93	91.3

Measures

Several paper-and-pencil assessments were included in this study: two outcome measures, four covariates, and a demographic survey. They are described in detail below.

Mindfulness Scale. The Toronto Mindfulness Scale (TMS) was used as an outcome variable to assess for group differences in mindfulness-related qualities at post-treatment. The TMS is a 13-item measure created to assess for state qualities of mindfulness following meditation practice (Lau, et al., 2006). Respondents answer items such as “I experienced myself as separate from my changing thoughts and feelings” on a 5-point scale of agreement ranging from 0 (“not at all”) to 4 (“very much”). The TMS demonstrated good internal consistency with an alpha coefficient of .86; scores that are comparable to what was reported by test developers (Lau, et al., 2006).

State-Trait Anxiety Inventory. The State-Trait Anxiety Inventory (STAI) consists of two twenty-item scales; one to measure state anxiety and one to measure trait anxiety (Spielberger, 1985). The State scale of the STAI was used as an outcome variable to examine changes in immediate feelings of anxiety during the testing administration; whereas, the Trait scale was used as a covariate to control for long-term, enduring anxiety. The State measure includes items that measure how a respondent feels at the moment, e.g. “I feel upset”; while the Trait measure targets more consistent, general features, e.g. “I lack self-confidence”. Items are rated on a 4-point Likert scale, ranging from 1 (“not at all”) to 4 (“very much”) for the State measure, and 1 (“almost never”) to 4 (“almost always”) on the Trait measure. In the current study, the State and the Trait measures had internal consistencies ranging from .93 to .94; both are congruent with past research (Barnes, Harp & Young, 2002).

Center for Epidemiologic Studies Depression Scale (CES-D), NIMH. The CES-D was used as a potential covariate to control for symptoms of depression, which have been demonstrated to affect memory (Burt, Zembar & Niederehe, 1995). The CES-D is a twenty-item inventory to assess for symptoms of depression over the past week (Radloff, 1977). Items such as “I felt I was just as good as other people” and “I felt sad" are rated on a 4-point frequency scale ranging from 1 ("rarely or none of the time/less than 1 day)" to 4 ("most or all of the time/5-7 days)". Internal consistency was high (α = .90), which is congruent with other research (Radloff, 1977).

Adult ADHD Self-Report Scale Symptom Checklist. The Adult ADHD Self-Report Scale (ASRS-v1.1) was given to control for existing attention and ADHD symptoms among participants. The ASRS is an 18-item checklist to assess for ADHD symptoms in adults. Items such as "How often do you have problems remembering appointments or obligations?" and "How often are you distracted by activity or noise around you?" address various symptoms of ADHD. Responses are on a 5 point frequency scale from 1 ("never") to 5 ("very often"). The ASRS has demonstrated good internal consistency reliability (α = .86), which is generally within the range of other studies (Kessler et al., 2007; Adler et al. 2006).

Five Facet Mindfulness Questionnaire. The Five Facet Mindfulness Scale (FFMQ) was included as a covariate to control for varying levels of experience and trait mindfulness. The FFMQ is a 39-item self-report measure consisting of statements regarding facets of mindfulness (e.g. "When I have distressing thoughts or images I am able just to notice them without reacting) rated on a scale of 1 ("never or very rarely true") to 5 ("always true"). It was designed using a factor analysis of existing measures of mindfulness. The authors identified observing, nonreactivity, nonjudging, describing and acting with awareness as the five factors that contribute to an overall trait-like mindfulness score. The full scale score was used in the current study. The factors showed good internal consistency of .86, similar to the ranges found in other studies (Baer, Smith, Hopkins, Krietemeyer & Toney, 2006).

Demographics Questionnaire. The demographic questionnaire included items to report age, gender, race, ethnicity, previous and current psychological diagnoses, and current medications.

Procedures

Data was collected with individual participants or in small groups, ranging from 2 to 5 participants (single participant = 23%, group of 2 = 26.7%, group of 3 = 36.9%, group of 4 = 10.7%, group of 5 = 2.7%). The consent and all testing procedures were administered by the primary investigator or upper-level undergraduate and graduate research assistants who received human subjects research educational training authorized by the UND Institutional Review Board. Participants were randomly assigned to one of three groups: a 20 minute body scan (females = 46; males = 14), 45 minute body scan (females = 51; males = 21), or control (females = 39; males = 9). After completing the consent procedure, all participants completed the demographic questionnaire, the CES-D, both components of the STAI, the ASRS, and the FFMQ. Following completion of self-report measures, participants assigned to Group 1 listened and followed instructions in a recorded 20 minute body scan meditation. Group 2 listened and followed instructions in a recorded 45 minute body scan meditation. Body scan meditations were MP3 format obtained from the UCSD Center for Mindfulness website and played through external computer speakers (http://health.ucsd.edu).

Data were collected on campus in rooms that were used as classrooms. No effort was taken to minimize noises that would be expected to occur in a typical academic environment (e.g. bells signaling the end of instructional periods, people talking in the hallway and walking to class). For the two mediation groups, participants listened to the body scan instruction while in a seated position at traditional school desks, rather than lying down.

Following the meditation, Groups 1 and 2 viewed 20 Swahili-English word pairs from those normed by Nelson and Dunlosky (1994). For the control condition, participants did not engage in a mindfulness activity and viewed the 20 word pairs immediately after completing the first set of assessments. The 20 Swahili-English word pairs were randomly presented one at a time in a Qualtrics presentation that automatically transitioned to a new pair after 10 seconds. The amount of time pairs were presented and number of words used is based on previous research (Grimaldi, Pyc & Rawson, 2010; Cepeda, Coburn, Rohrer, Wixted, Mozer & Pashler, 2009). Following the encoding task, all three groups completed basic arithmetic for 1 minute to interrupt potential rehearsal efforts. The arithmetic problems were selected from an academic skills-building website (www.homeschoolmath.net). In the recall phase all participants were presented (via Qualtrics) with the Swahili terms from the pairs they learned earlier. They were given 10 seconds to free recall and write down the English word translation of each Swahili word. Following presentation of all 20 Swahili words, the State portion of the STAI was completed again to assess for changes from baseline, and the TMS was completed to identify any group differences in state mindfulness at the end of the process. Finally, participants were debriefed on the intent of the study and offered information for accessing results at the conclusion of the study.

Once data had been collected, it was entered twice by undergraduate and graduate research assistants and cross-checked for accuracy.

CHAPTER III

RESULTS

Pre-analysis and Data Screening

Following established procedures (Mertler & Vannatta, 2010), descriptive statistics and frequency distributions were visually inspected for missing values and to ensure that data appeared reasonable and fell within expected ranges. This was done primarily to identify potential data entry errors or extremely unusual scores. Following visual inspection, graphic and statistical analyses for univariate and multivariate outliers was conducted, using boxplots, stem-and-leaf and Mahalanobis distance. For missing data and outliers, each case was reexamined for accuracy. For participants with random missing data of less than 5% and those that were nonrandom and incomplete for known reasons not related to the outcome measures (e.g. missing assessment forms in packets), listwise deletion was used. Using this criteria, data from 18 participants was eliminated. For outliers identified through stem-and-leaf plots, the analysis was run including and excluding the outliers. When it was determined that outliers were valid and entered correctly and therefore should remain in the analyses, they were adjusted to the extreme minimum/maximum value depending on the direction of the outlier. Normality for each variable was met as assessed using measures of skewness and kurtosis, following the adjustment of outliers. In order to meet normality assumptions, a square root transformation was applied to CES-D and STAI (State-Time 1), and a log10 transformation was applied to STAI (Trait).

Following transformations, preliminary analyses of variance (ANOVA) were conducted with dependent variables and all covariates. There was no difference between groups for state anxiety scores at Time 1 or Time 2 ($F_{STAI\text{-}S1}$ (2,174) = 1.04, *p* = .36; $F_{STAI\text{-}S2}$ (2,175) = .07, *p* = .93). There were significant differences between groups for recall (F_{RECALL}(2,178) = 4.27, *p* = .02), and a trend towards significance for state mindfulness (F_{TMS} (2,176) = 2.84, *p* = .06). None of the covariates (i.e. depression symptoms, trait anxiety, trait mindfulness, attention problems) were significantly affected by the independent variable of group ($F_{CES\text{-}D}$ (2,175) = 1.78, *p* = .17; $F_{STAI\text{-}T}$ (2,175) = .35, *p* = .70; F_{FFMQ} (2,175) = .75, *p* = .47; F_{ASRS} (2,170) = .66, *p* = .52). Means for ANOVAs are reported in Table 2.

Table 2

Untransformed Means for Covariates and Dependent Variables (with Standard Deviations in Parentheses)

	Group		
Measure	20 Minute Body Scan	45 Minute Body Scan	Control
CES-D	8.71 (1.01)	6.77 (1.24)	6.92 (1.11)
STAI (Trait)	33.43 (0.11)	33.74 (.12)	32.36 (.12)
FFMQ	130.13 (17.81)	131.13 (14.21)	133.73 (14.04)
ASDS	42.64 (9.03)	41.96 (8.79)	40.64 (8.64)

Table 2 (continued)

	Group		
	20 Minute Body Scan	45 Minute Body Scan	Control
	32.09 (.78)	31.54 (.82)	29.72 (.76)
STAI (State 2)	32.29 (8.57)	31.77 (9.21)	31.69 (9.66)
TMS	27.78 (7.36)	28.34 (8.10)	25.04 (7.44)
Recall	8.18 (4.11)	7.21 (4.19)	5.88 (3.90)

Note: CES-D: depressive symptoms, STAI (Trait): trait anxiety, FFMQ: trait mindfulness, ASDS: attention difficulties, STAI (State 1): state anxiety, Time 1, STAI (State 2): state anxiety, Time 2, TMS: state mindfulness

Analyses of Variance

Three separate analyses of covariance (ANCOVAs) were conducted to analyze data to measure differences in English word recall, state mindfulness, and state anxiety levels. Given a priori predictions of greater recall and state mindfulness, and greater reduction in state anxiety, for the groups engaging in the body scan meditation, planned Dunnett's tests were conducted to compare group means.

Recall. The data was first evaluated to determine whether assumptions of ANCOVA were met. Correlations between covariates were examined for multicollinearity and it was determined that all covariates could be included (i.e. $r < .80$). There was a linear relationship between the covariates and recall for each group, as assessed by visual inspection of scatterplots. There was homogeneity of regression slopes for all covariates; the interaction term was not significant ($F_{\text{CES-D}}(2,172) = 1.49$, $p = .228$; $F_{\text{STAI (trait)}}(2,172) = 1.38$, $p = .254$; $F_{\text{FFMQ}}(2,172) = .79$, $p = .455$; F_{ASRS}

(2,172) = 2.05, p = .133). To test for homogeneity of the regression hyperplanes, which indicates that the relationship between the covariates and the DV are the same in all groups, a preliminary ANCOVA was conducted. The preliminary ANCOVA tested the interaction between the IV (Group) and all covariates, controlling for main effects (F (3,161) = .80, p = .495). Following ANCOVA, standardized residuals for the groups and for the overall model were normally distributed, as assessed by Shapiro-Wilks test (p > .05). There was homoscedasticity and homogeneity of variances of the residuals, as assessed by visual inspection of a scatterplot and Levene's Test of Homogeneity of Variance (p = .739).

The first ANCOVA was conducted to compare the effect of engaging in a body scan meditation on learning, as measured by recall of English translations of Swahili words, across the three groups: 20 minute body scan (Group 1), 45 minute body scan (Group 2), and no body scan (i.e. control, Group 3) conditions. Measures of depression and anxiety, attention problems, and trait mindfulness were also included as covariates to remove systematic variance and potential confounds, as well as to allow for finding smaller effects more directly influenced by group treatments. The possible range of English translations of Swahili words recalled was 0-20; the obtained range was 0-17. English-Swahili recall score was significantly different between groups, F (2, 160) = 4.13, $p < .05$, $\acute{\omega}^2 = .04$. As a summary of the entire ANCOVA, this represents a small effect size (Kirk, 1996); this means that almost 10% of the total variance in recall scores is accounted for by group assignment after controlling for depression and anxiety symptoms, trait mindfulness, and attention problems. Adjusted and unadjusted group means are shown in Table 3. Results from planned Dunnett’s two-tailed test revealed that those participating in the 20 minute body scan recalled significantly more words than those in the control group control (t = 2.90, $p < .01$); i.e. the 20 minute group recalled 2.83 more words, on average, than the control group. The 45 minute body scan condition did not significantly differ from the control (i.e. no body scan) condition, however there was a potential trend towards significance compared to the control group (t = 1.79, $.20 > p > .10$). This partially confirms the original hypothesis, in that the 20 minute body scan significantly differed from the control group in the expected direction; however, the 45 minute group did not quite reach significance. The covariates were not significantly related to recall ($F_{CES\text{-}D}(2,160) = .01$, $p = .97$, $r = .00$; $F_{STAI\text{-}T}(2,160) = .84$, $p = .36$, $r = .07$; $F_{FFMQ}(2,160) = .25$, $p = .62$, $r = .03$; $F_{ASRS}(2,160) = .31$, $p = .58$, $r = .04$).

Table 3

Adjusted and Unadjusted Mean Recall Scores after Controlling for Depression Symptoms, Trait Anxiety, Trait Mindfulness, and Attention Problems

	Group		
	Control	20 Minute Body Scan	45 Minute Body Scan
N	45	56	66
Unadjusted			
M	5.84	8.20	7.26
SD	3.60	4.26	4.20
Adjusted			
M	5.83	8.21	7.25
SE	.61	.55	.51

Note. *N* = number of participants, *SD* = Standard Deviation, *SE* = Standard Error

State mindfulness. For the second analysis, data was again evaluated to ensure that assumptions of ANCOVA were met. There were no issues with multicollinearity (i.e. $r < .80$). Visual inspection of scatterplots suggested a linear relationship between the covariates and state mindfulness for each group. Homogeneity of regression slopes was met for all covariates with non-significant interactions ($F_{CES\text{-}D}$ (2,170) = .99, p = .375; $F_{STAI\text{-}T}$ (2,170) = .03, p = .971; F_{FFMQ} (2,170) = .05, p = .950; F_{ASRS} (2,165) = 1.08, p = .341). A preliminary ANCOVA tested the interaction between the IV (Group) and all covariates, controlling for main effects, and the assumption of homogeneity of the regression hyperplanes was met (F (3,159) = .517, p = 671). Standardized residuals for the groups and for the overall model were normally distributed, as assessed by Shapiro-Wilks test (p > .05). There was homoscedasticity and homogeneity of variances of the residuals, as assessed by visual inspection of a scatterplot and Levene's Test of Homogeneity of Variance (p = .605).

The second analysis of covariance examined the effect of engaging in a mindfulness body scan on state mindfulness using the Toronto Mindfulness Scale across the three groups. The possible range of scores was 0 to 52; actual range was 11 to 44, with higher scores representing greater levels of state mindfulness. Adjusted and unadjusted group means are shown in Table 4. The state mindfulness score was statistically significantly different between different groups, F (2,158) = 4.88, p < .05, with a small effect, $\acute{\omega}^2 = .05$ (Kirk, 1996). Results from planned Dunnett's two-tailed test with adjusted means revealed that those participating in the 45 minute body scan had higher mindfulness scores than those in the control group control (t = 3.04, p <.01). The 20 minute body scan condition also significantly differed from the control (t = 2.36, p <.05) (see Table 4 for means). This is congruent with the original hypothesis that both experimental groups would be significantly different from the control, and differences were in the expected direction (i.e. higher state mindfulness scores for the body scan groups compared to the control). The covariates were not significantly related to state mindfulness ($F_{CES\text{-}D}$ (2,158) = .84, p = .36, r = .07; $F_{STAI\text{-}T}$ (2,158) = 1.59, p = .21, r = .10; F_{FFMQ} (2,158) = .12, p = .73, r = .03; F_{ASRS} (2,158) = .902, p = .34, r = .08).

Table 4

Adjusted and Unadjusted Mean State Mindfulness Scores after Controlling for Depression Symptoms, Trait Anxiety, Trait Mindfulness, and Attention Problems

	Group		
	Control	20 Minute Body Scan	45 Minute Body Scan
N	45	56	66
Unadjusted			
M	24.44	28.05	28.74
SD	7.15	6.85	8.10
Adjusted			
M	24.42	27.96	28.83
SE	1.12	1.02	.93

Note. *N* = number of participants, *SD* = Standard Deviation, *SE* = Standard Error

State anxiety. As in previous analyses, data was first evaluated for assumptions of ANCOVA. Linearity between covariates and state anxiety was confirmed with visual inspection of scatter plots. There was homogeneity of regression slopes for all covariates; interaction term was not significant ($F_{CES\text{-}D}$ (2,166) = 2.39, p = .095; $F_{STAI\text{-}T}$ (2,166) = 1.38, p = .256; F_{FFMQ} (2,165) = 1.95, p = .146; F_{ASRS} (2,161) = 1.28, p = .282). A preliminary ANCOVAs tested the interaction between the IV (Group) and all covariates, controlling for main effects (F (3,158) = 4.416, p = .005). Homogeneity of the regression hyperplanes was not met with all covariates; CES-D was subsequently removed from the analysis because of the relatively strong correlation between trait anxiety and depression (*r* = .78); this achieved homogeneity (*F* (3,159) = 2.010, *p* = .115). Standardized residuals for the groups and for the overall model were normally distributed, as assessed by Shapiro-Wilks test (p > .05). There was homoscedasticity and homogeneity of variances of the residuals, as assessed by visual inspection of a scatterplot and Levene's Test of Homogeneity of Variance (*p* = .667).

Table 5

Adjusted and Unadjusted Mean Change in State Anxiety Scores after Controlling for Trait Anxiety, Trait Mindfulness, and Attention Problems

	Group		
	Control	20 Minute Body Scan	45 Minute Body Scan
N	45	56	66
Unadjusted			
M	-1.64	.13	.26
SD	5.43	6.36	5.92
Adjusted			
M	-1.57	.12	.22
SE	.88	.80	.72

Note. N = number of participants, *SD* = Standard Deviation, *SE* = Standard Error

The third ANCOVA assessed for proposed changes in anxiety, using difference scores between time one and time two completion of the State portion of the STAI across the three groups while controlling for trait anxiety, attention problems, and trait mindfulness. State anxiety scores represent the difference between state anxiety at Time 1 (prior to body scan and learning word pairs; *M* = 32.20, *SD* = 9.94) and Time 2 (after recall; *M* = 31.97, *SD* = 9.53) on the STAI State portion. The scores at Time 1 and

Time 2 are consistent with student group samples; with approximately 15% scoring in the clinically significant range (Knight, Waal-Manning & Spears, 1983; Eisenberg, Gollust, Golberstein & Heffner, 2007). Difference scores ranged from -13 to +16, where negative scores represent a decrease in state anxiety. Adjusted and unadjusted group means are shown in Table 5. Contrary to predicted differences between experimental and control groups, there was no statistically significantly difference between groups on changes in state anxiety, F (2, 157) = 1.44, p = .24, $\acute{\omega}^2$ = .00. The covariate of trait anxiety was significantly related to state anxiety ($F_{\text{STAI-T}}$ (2, 157) = 9.00, p < .05), r = .23 (small to medium effect size). Trait mindfulness and attention difficulties were not significantly related to state anxiety difference scores (F_{FFMQ} (2,157) = .3.14, p = .08, r = .14; F_{ASRS} (2,157) = .105, p = .75, r = .02).

Gender. It was decided that the analyses would be rerun, controlling for gender. With as few as 8 male participants in the control group, it was recognized that strong conclusions regarding gender interactions could not be drawn due to the small number of male participants recruited. Therefore these results should be interpreted with caution. Regarding recall, there was a significant interaction between gender and group (F (2, 174) = 3.49, p = .03, $\acute{\omega}^2$ = .01). To further understand the interaction, an ANCOVA was run for males and females independently. Results showed that there was a main effect of group for females only (F (2, 121) = 4.91, p = .01, $\acute{\omega}^2$ = .01). Again using Dunnett's test, those in the 20 minute body scan condition recalled significantly more words than the control (t = 3.06, p < .01); and those in the 45 minute group recalled significantly more words compared to the control (t = 2.37, p < .05). Adjusted and unadjusted mean recall scores for males and females are reported in Table 6. There was no difference between groups for males (*F* (2, 31) = .50, *p* = .61). For state mindfulness there was also a significant interaction between gender and group (*F* (2, 154) = 3.21, *p* = .04, $\acute{\omega}^2$ = .002), as well as a significant main effect of group (*F* (2, 154) = 5.61, *p* < .01, $\acute{\omega}^2$ = .003) and a trend towards a main effect for gender (*F* (1, 154) = 3.32, *p* = .07). With only females in the analysis there was a significant effect of group (F (2, 120) = 4.11, p = .02), with those in the 20 minute meditation group having significantly higher scores on the TMS than the control group (*t* = 2.82, *p* < .05), and a trend towards significance in the 45 minute group compared to the control (*t* = 2.12, *p* < .10). For males, there was also a significant effect of group (F (2, 30) = 9.01, p < .01) with those in the 45 minute body scan scoring significantly higher the control group (*t* = 4.29, *p* < .01). Adjusted and unadjusted mean TMS scores for males and females are in Table 7. Finally, on difference in state anxiety, there was no interaction (*F* = .909, *p* = .41). Again, caution must be used when interpreting these results because of the relatively low number of male participants; however, findings are consistent with existing research on gender differences involving mindfulness and performance (Anglin, Pirson & Langer, 2008; Shao & Skarlicki, 2009).

Table 6

Adjusted and Unadjusted Mean Recall Scores by Gender after Controlling for Depression Symptoms, Trait Anxiety, Trait Mindfulness, and Attention Problems

	Group		
	20 Minute Body Scan	45 Minute Body Scan	Control
Females *n*	44	47	37
Unadjusted *M*	8.34	7.70	5.49
SD	4.29	4.43	3.57
Adjusted *M*	8.36	7.68	5.50
SE	0.64	0.61	0.69
Males *n*	11	19	8
Unadjusted *M*	7.91	6.16	7.50
SD	4.44	3.42	3.46
Adjusted *M*	7.73	6.19	7.67
SE	1.22	0.99	1.51

Note. *n* = number of participants, *SD* = Standard Deviation, *SE* = Standard Error

Table 7

Adjusted and Unadjusted Mean State Mindfulness Scores by Gender after Controlling for Depression Symptoms, Trait Anxiety, Trait Mindfulness, and Attention Problems

	Group		
	20 Minute Body Scan	45 Minute Body Scan	Control
Females *n*	43	47	37
Unadjusted *M*	29.49	28.26	24.84
SD	6.55	8.75	7.46
Adjusted *M*	29.57	28.29	24.70
SE	1.19	1.13	1.28
Males *n*	11	18	8
Unadjusted *M*	24.00	30.00	22.63
SD	4.12	6.13	5.53
Adjusted *M*	23.14	30.87	21.86
SE	1.55	1.29	1.92

Note. *n* = number of participants, *SD* = Standard Deviation, *SE* = Standard Error

CHAPTER III

DISCUSSION

The present study predicted that a brief mindfulness intervention would increase the number of English words free recalled when newly learned Swahili words. Our findings supported this hypothesis in the 20 minute body scan meditation condition, with those participants recalling more words than the control group. Those who engaged in a 45 minute body scan did not recall significantly more words than the control group; however, there was a practical trend in that direction, with those in the 45 minute group recalling 1.42 more words, on average, than the control group.

The effect size for the newly learned Swahili words ANCOVA is in the small range. Although the effect was relatively small, participants in the 20 minute group recalling approximately 10% more words than the control group. To put this into context, according to accepted grading practices used in many academic settings, a 10% increase in performance on a given assignment would result in moving up a student's score a full letter grade.

The ANCOVA results on the recall of newly learned Swahili words suggest that, rather than a dose effect between time engaged in body scan mediation and improvements in recall, there appears to be what we call a "Goldilocks" effect with the 20 minute duration being just right, not being too long or short in duration to have the optimal effect. One possible explanation for the difference in performance between the

20 minute group and 45 minute group is that the 45 minute group may have been overly relaxing, thus hampering performance. According to theories such as individual zone of optimal functioning theory (Hanin, 1980, 1986) and the Yerkes-Dodson Law (Yerkes & Dodson, 1908) individuals maximize their performance on any given task when neither overly relaxed nor overly aroused.

Another related explanation for the poorer performance among the 45 minute body scan group is that the longer procedure may have had a tendency to elicit non-mindful and unhelpful reactions among some participants, e.g., drowsiness, boredom, concerns about time. The longer duration might also have created boredom or impatience in participants, whereas the 20 minute scan was long enough to improve attention processes and reduce distractions, and short enough to avoid these potential side effects. The content of the two body scans is essentially the same, with fewer and shorter pauses in the 20 minute version, and less detail in the different areas of the body (e.g. the 20 minute calls attention to all of the fingers of each hand collectively, whereas the 45 minute scan focuses on each finger individually). Although we failed to include an exit interview polling participants on their reactions to the mindfulness exercise, on a number of occasions the primary investigator and research assistants observed participants becoming restless, sleepy, or irritated by the duration of the meditation practice during the 45 minute body scan condition. Despite these observations, the 45 minute condition was associated with the highest scores in state mindfulness.

Brief mindfulness activities, like the one used in the current study, range widely in the duration of administration time from as brief as 5 minutes (Weger et al., 2012), to several days (Zeidan et al., 2010), to as long in duration as several weeks or more (van Vugt & Jha, 2011). This may explain why similar studies that used brief mindfulness tasks with a wider duration failed to find significant results on some of their measures (MacLean, et al., 2010; van Vugt & Jha, 2011; Roberts-Wolfe, et al., 2012). While we found the 20 minute to have the best results, additional research may be useful in determining the optimal duration to facilitate improvement in long-term memory processing.

Consistent with the hypothesis, both the 20 and 45 minute meditation groups displayed significantly higher state mindfulness at the conclusion of the study than controls. This finding is consistent with other studies that have shown that mindfulness-based exercises elicit changes is state mindfulness (Lau et al., 2006; Carmody, Reed, Kristeller & Merriam, 2008). We included the TMS to measure changes in state mindfulness as a validity check to make sure that differences in performances on the word pair task coincided with actually differences in state mindfulness. The variability in state mindfulness across groups indicates that the brief body scan did perform as expected following a single brief mindfulness practice session. Also note that the TMS was administered after the participants were shown English-Swahili word pairs rather than immediately following the body scan exercise. In other words, we found these differences even with a brief delay, differences that may have been higher had we given the TMS immediately following the body scan exercise.

While this study has shown that a brief mindfulness exercise can improve learning of new words, more research is needed to better understand the underlying mechanisms through which mindfulness exercises enhance performance. Although it was suspected that a reduction of state anxiety would be one such mechanism, there was not support for this in the data. There are a number of possible explanations for this finding. One possible explanation is that the participants we recruited were simply not anxious enough. Most of the research that links anxiety and mindfulness has used clinical samples with individuals who meet criteria for an anxiety disorder (Kabat-Zinn et al., 1992; Goldin & Gross, 2010; Hoffman, Sawyer, Witt & Oh, 2010), whereas the majority of the current sample reported anxiety within the low to moderate range. Future studies in this area might be able to find differences in anxiety scores across the groups after recruiting participants with more variable and severe levels of anxiety.

Another explanation for the lack of changes in anxiety scores is that the body scan might have addressed anxiety symptoms that were not captured on the state-trait anxiety inventory. This measure evaluated general aspects of state anxiety rather than specific anxiety and concerns related to performance. Researchers in the future are encouraged to include measures designed to evaluate test anxiety, such as the Test Anxiety Inventory (Spielberger, 1980) or Benson's Revised Test Anxiety Scale (Benson, Moulin-Julian, Schwarzer, Seipp, & El-Zahhar, 1992), to identify potential reductions in anxiety specific to academic performance.

An additional explanation is that mindfulness practice may enhance performance on recall in ways that are independent of anxiety reduction, such as increased attention. Although we found the ASDS v1.1 score, a self-report measure of attention, was not significant as a covariate of performance on the word-pair task, it would be helpful in future studies to include a brief measure of attentional performance or imaging data (e.g. fMRI to monitor changes in attention that coincide with mindfulness meditation and encoding of novel information). This could be used to evaluate whether improved performance is mediated by enhance attention via the brief mindfulness exercise. Without such measures, it is uncertain exactly which mechanisms contributed to differences in recall scores.

Although unable to recruit sufficient male participants to allow drawing strong conclusions regarding gender effects, there was some evidence of the potential for a gender by group interaction with recall and state mindfulness. Some research has shown that the positive association between mindfulness and performance is stronger for women than it is for men (Shao & Scarlicki, 2009). Future research is needed with an adequate sample size of male participants to discount or strengthen these preliminary findings; this is crucial to understanding limitations of mindfulness-based practice in different “doses” and across different settings.

A broad limitation of this study is that it was conducted with the general student body. It would be useful to replicate these findings in a community sample. Furthermore, this study utilized a very brief gap of a few minutes between introducing novel words and assessing recall. Although a 1 minute simple math task was included to reduce effects of rehearsal, additional research would be needed to ascertain whether the benefits of mindfulness exercise prior to encoding would be seen over a longer duration (e.g. 3 hours, 1 day, one week).

Finally, the mindfulness practice was administered prior to learning learn new words, with the assumption that the exercise would enhance the encoding of new information. Analysis of the measure of state mindfulness showed, however, that differences in mindfulness were observed even after the delay of learning the new words. It is unclear from the current design whether there may have been a carryover effect, with changes in mindfulness influencing not only the encoding but also lingering to influence the recall on novel words as well. Additional research on mindfulness and learning is needed to delineate how brief mindfulness exercises might separately influence encoding and recall. A study comparing groups engaged in a mindfulness activity prior to encoding and/or prior to recall might be helpful in this regard. This could provide information regarding at what point in the learning process a mindfulness exercise may be most beneficial, as well as determining whether there is an additive effect of practicing prior to learning and prior to recall (e.g. before an exam). Moreover, a repeated measure after a delay could help determine whether the effects of longer meditations last longer than brief exercises.

Researchers have identified the need for more research on the benefits of mindfulness to long-term memory and learning (Crumley & Schutz, 2011; Lykins et al., 2012). This study begins to address this need, and findings provide additional support for the cognitive benefits of mindfulness, namely in improvements in long-term memory in the context of learning novel information. Additionally, it was demonstrated that there were increases in recall and higher state mindfulness after a single body scan meditation, highlighting the efficiency of such interventions. Finally, there is no consistency in the duration of mindfulness exercises used across existing studies in the research and clinical literature. By including two different meditation durations, it was found that there are potentially important differences that have not been previously examined. In order to increase understanding and successful implementation of mindfulness strategies, this research provides several directions for continuing research.

These results have important clinical and academic implications. Although more research is needed, similar brief mindfulness exercises may be used to enhance learning for college students. The 20 minute body scan is relatively easily utilized and can be administered in classrooms and group settings with minimal training. The pre-recorded exercise, and of which are in the public domain, can easily be disseminated by teachers, educational specialists, school counselors, and/or directly to students via MP3 available on university websites or elsewhere.

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