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Recall Of Novel Words In Adolescents Following A Brief Mindfulness Exercise

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RECALL OF NOVEL WORDS IN ADOLESCENTS FOLLOWING A BRIEF MINDFULNESS EXERCISE

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This thesis, submitted by Anna L. Schimmelpfennig 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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ABSTRACT

Mindfulness has been associated with various benefits, including enhanced attention, improved recall, and increased emotional well-being. Previous research has suggested that a brief mindfulness exercise can enhance recall of novel words in female college students. Participants in the current study were 82 students (41 female, *M* = 14.6, *SD* =1.2) from a rural, Midwestern secondary school. Participants were randomly assigned to listen to a 20-minute body scan exercise or a control lecture before learning English-Swahili word pairs. Results revealed no significant effect of group on immediate or delayed recall of word pairs. Additionally, there was no significant effect of group on state mindfulness, positive emotions, negative emotions, or distress. However, student self-report scores on measures of trait mindfulness positively correlated with GPA, sleep, and state mindfulness, and negatively correlated with subjective distress, negative emotions, depressive symptoms, perceived stress, and inattention. Limitations and directions for future research are discussed.

Keywords: mindfulness, attention, learning, long-term memory, emotional well-being, academic performance

CHAPTER I

INTRODUCTION

The popularity of mindfulness has flourished over the past 20 years, especially in the field of psychology (Brown, Ryan, & Creswell, 2007). Defined as "the full awareness of one's internal states and surroundings" (APA Dictionary of Psychology, 2007, p. 581), mindfulness is thought to contain two main components: attention and awareness (Brown, Ryan, & Creswell, 2007). Awareness is the conscious registration of information coming from our five senses, whereas attention involves noticing or focusing on that information. Often, we focus on this information only briefly, while we make quick judgments about the information based on previous experience. Consequently, this approach to processing information may lead to biased and distorted perceptions. Mindful processing, in contrast, involves a more open form of processing without knee-jerk responses. This allows the observer to be present rather than to react to information.

Mindfulness interventions have been used in many different areas, including anxiety disorders, depression and suicidality, borderline personality disorder, eating disorders, addictive behavior, attention deficit hyperactivity disorder, psychosis, stress reduction for chronic pain management, and oncology (Didonna, 2008). However, current empirical findings of mindfulness have largely been outcome studies in clinical populations (Tan & Martin, 2012) and few studies have been conducted with adolescents (Wisner, Jones, & Gwin, 2010).

Mindfulness and Cognition

Researchers are applying the success of mindfulness in clinical applications to non-clinical child, adolescent, and adult populations in an effort to increase performance in a number of cognitive areas, including memory, reading comprehension, achievement emotions and self-regulation, and academic performance (Benson et al., 2000; Bonamo et al., 2014; Howell & Buro, 2011; Mrazek, Franklin, Phillips, Baird, & Schooler, 2013). Researchers Shao and Skarlicki (2009) suggested that mindfulness may impact performance in these areas by enhancing, the ability to focus on a task being performed despite the presence of distractions (Sarason, Pierce, & Sarason, 1996; Shao & Skarlicki, 2009; Vroom, 1964). Research findings suggest that mindfulness may impact performance through its effects on attention and memory. Specifically, mindfulness is thought to be associated with selective and executive attention, sustained attention, working memory capacity, and executive functioning (Chiesa, Calati, & Serretti, 2011). Mindfulness has been shown to increase non-directed attention (Anderson, Lau, Segal, & Bishop, 2007), voluntary attentional selection and attentional readiness (Jha, Krompinger, & Baime, 2007), executive attentional control (Chan & Woollacott, 2007; van den Hurk, Giommi, Gielen, Speckens, & Barendregt, 2010; Zeidan, Johnson, Diamond, David, & Goolkasian, 2010), and sustained attention (MacLean et al., 2010; Zeidan et al., 2010). Therefore, individuals who use a more perspective mindfulness may be able to attend to specific stimuli and for longer periods of time than individuals who do not. Further, mindfulness skills may lead to greater cognitive flexibility, as well as greater accuracy and efficiency in attention-based tasks (Moore & Malinowski, 2009).

Cognitive flexibility may be related to a core feature of mindfulness: acceptance. Also known as non-judgmental awareness, acceptance refers to the mindset of mindfulness that stimuli will be noticed without applying automatic judgments. It has been suggested that because mindfulness places an emphasis on focusing attention on the current moment, mindfulness training would lead to increases in cognitive flexibility and ability to respond in a non-habitual, or novel way (Moore & Malinowski, 2009).

Research findings have supported this idea. Experienced meditators and non-experienced control participants completed measures of directed attention and sustained attention (Moore & Malinowski, 2009). The results revealed that experienced meditators performed significant better than the control group on both measures, suggesting that mindfulness training influences cognitive flexibility through the ability to inhibit disruptive automatic responses. This may be accomplished through another core tenant of mindfulness: non-judgmental attention. Mindfulness encourages attending to information without reaction, and accepting whatever experience one is having. It is believed that automatic cognitive processes can be brought back under cognitive control and therefore, responses that were previously automatic can be interrupted or inhibited.

Using an information processing framework, MacLean et al. (2010) conducted a study that found that mindfulness training improved perception, which decreases the resources needed to sustain attention. Specifically, participants received approximately five hours of mindfulness training each day for three months. Visual discrimination, sensitivity, and vigilance were assessed before, during, and after mindfulness training. The researchers found that mindfulness training improved visual discrimination, vigilance, and increased perceptual sensitivity. They propose that mindfulness training,

which often includes the focusing of attention on certain perceptions (e.g., breathing), generalizes attention improvements to other areas such as visual perception. These results suggest that the reduced cognitive load required to sustain attention frees up resources that can be used to improve working memory.

While some studies have found improvements in attentional control as the result of a mindfulness intervention (e.g., Jha et al., 2007), others have not (e.g., Anderson et al., 2007; Quickel, Johnson & David, 2014). Anderson and colleagues investigated the effects of a Mindfulness-Based Stress Reduction (MBSR) course on multiple aspects of participants' attention: sustained attention, attention switching, inhibition of elaborative processing, and non-directed attention. The results revealed no significant differences between control and experimental groups on measures of attention control; however, participation in the MBSR course was related to improvements in emotional well-being. Additionally, Quickel and colleagues investigated the relationship between trait mindfulness and aspects of working memory and focused attention. They found that trait mindfulness was not related to tasks requiring focused attention.

Mindfulness and Well-being

Furthermore, mindfulness is associated with various health benefits in areas that are often associated with memory, attention, and learning, including sleep quality (Caldwell, Harrison, Adams, Quin, & Greeson, 2010; Carlson & Garland, 2005; Howell, Digdon, & Buro, 2010, Howell, Digdon, Buro, & Sheptycki, 2008), and reducing levels of stress, depression, and anxiety in adults (see Hofmann, Sawyer, Witt, & Oh, 2010 and Toneatto & Nguyen, 2007 for reviews) and children (*e.g.,* Beauchemin et al., 2008; Chang & Hiebert, 1989; Franco, Mañas, Cangas, & Gallego, 2010; Liehr & Diaz, 2010;

Mendelson et al., 2010; Raes, Griffith, Gucht, & Williams, 2013). Some research have hypothesized that these benefits result from reducing self-focus (Beauchemin et al., 2008; Herndon, 2008).

Mindfulness training also enhances emotion regulation (Goldin & Gross, 2010; Hölzel et al., 2011; Ortner, Kilner, & Zelazo, 2007; Roberts-Wolfe, Sacchet, Hastings, Roth, & Britton, 2012). Mindful, emotion regulation is the capacity to maintain awareness, regardless of the type or degree of emotion (Chambers, Gullone, & Allen, 2009). It allows the individual to consciously choose the thoughts, emotions, and sensations that warrant attention, instead of reacting to all of them. Mindfulness training has been suggested to reduce reactions to emotionally charged material, enabling better attention (Goldin & Gross, 2010; Ortner, Kilner, & Zelazo, 2007). The associations among mindfulness, attention, and emotion regulation suggests that improved emotion regulation may impact the ability to attend to stimuli and sustain attention, and reduce distractions and mind-wandering.

Mindfulness and Memory

The benefits that mindfulness training have been shown to have on attention and emotion regulation are likely to impact memory. Working memory is the bridge between short-term memory and attention, and is necessary for performing complex tasks such as comprehension, reasoning, and learning (Chiesa, Calati, & Serretti, 2011). Working memory can become burdened by intrusive thoughts, emotions, and other distractions (Baddeley, Eysenck, & Anderson, 2009). Research supports the idea that mindfulness improves working memory through enhanced attention (van Vugt & Jha, 2011). While mindfulness has been shown to improve reaction time and decrease variability in

responding to a working memory task, it did not improve accuracy of performance compared to controls (van Vugt & Jha, 2011), which may have important implications for cognitive performance.

As working memory is important to long-term memory (Baddeley et al., 2009), researchers have investigated the impact of mindfulness interventions on long-term recall of information. According to the multiple component theory of working memory, working memory is relevant to long-term memory in two ways (Baddeley & Logie, 1999). First, working memory often draws from task-relevant information stored in long-term memory in order to apply previous knowledge to novel problems. Second, the results of working memory processes are stored in long-term memory. Neuropsychological findings have shown support for the beneficial impact of multi-week mindfulness practices on memory through increased cerebral blood flow in areas involved in learning and memory in participants who have experienced memory loss (Newberg, Wintering, Khalsa, Roggenkamp, & Waldman, 2010), as well as an increase in hippocampal grey matter density after an eight-week mindfulness intervention (Hölzel et al., 2011). Another study has found links between a brief mindfulness training and enhanced long-term recall of novel information (Bonamo et al., 2014).

Mindfulness Research with Adults

Mindfulness is generally studied in two ways. The first method compares those high in trait mindfulness, usually experienced or expert meditators, with controls. The second method trains participants in mindfulness and compares them to controls. Training in mindfulness is shown to increase levels of trait mindfulness (Chambers, Lo, & Allen, 2008; Robins, Keng, Ekblad, & Brantley, 2012). Mindfulness studies using

expert meditators or those high in trait mindfulness will be reviewed below, followed by mindfulness training studies.

Many studies have evaluated mindfulness in college or adult samples. While not directly assessing achievement, Howell & Buro (2011) investigated the relationship between trait mindfulness, achievement-related self-regulation, and achievement emotions in an undergraduate sample. In this study achievement emotions were defined as positive and negative emotions experienced during class, while studying, and during exams. Positive achievement emotions include enjoyment, hope, and pride, while negative achievement emotions include anxiety, hopelessness and boredom. They found that mindfulness, self-regulation, and achievement emotions are all intercorrelated and that the effect of mindfulness on achievement emotions was mediated by increased achievement-related self-regulation. Specifically for achievement emotions, higher mindfulness predicted an increased ratio of positive to negative achievement emotions.

Additionally, others investigated how gender interacts with trait mindfulness to predict performance in a sample of MBA students (Shao & Skarlicki, 2009). Results revealed that trait mindfulness was positive predictor of academic performance, but this relationship was stronger for women than for men.

Another study investigated the differences in short and long-term memory in meditators and demographically matched non-meditators (Lykins, Baer, & Gottlob, 2010). Participants were given the California Verbal Learning Test (CVLT), which asks participants to recall as many words as possible from a list of 16 words. After five trials of the first list, a new list was introduced and participants were instructed to recall words from a new list to serve as interference. A short-term recall of the first list was then

assessed, and after a 20-minute delay, long-term recall was assessed. The researchers found that experienced meditators recalled more words from the short delay free recall and cued recall as well as the long delay free recall. This suggests that meditators have advantages over non-meditators in verbal memory. The researchers suggest that future research on the influence of mindfulness on short-term and long-term memory is needed.

Other researchers investigated the effects of a two-week mindfulness intervention on reading comprehension and working memory capacity in a college sample (Mrazek et al., 2013). Mindfulness was taught to the participants in a 45-minute, four times a week class. Participants were also encouraged to practice mindfulness each day outside of class for 10 minutes. The results revealed that students who participated in the mindfulness intervention had improved reading comprehension scores and working memory capacity and this effect was mediated by reduced mind wandering, suggesting that enhanced attention can improve skills that were previously thought to be unchanging.

One study of long-term recall involved college students in either a 12-week meditation or active control course (Roberts-Wolfe, Sacchet, Hastings, Roth, & Britton, 2012). Participants in the meditation condition were taught mindfulness strategies for one hour, three times a week. Before and after the course, participants were given an emotional word recall task. Results revealed that participants in the meditation course remembered significantly more positive words than those in the control conditions, and also had improved emotional well-being. However, there was no difference in total amount of words recalled between experimental and control groups. A similar study on the recall of emotionally-valenced words revealed that participants who were exposed to a 12-minute mindfulness exercise, compared to control, remembered less negative words

than control conditions though no difference was found in the total number of words recalled (Alberts & Thewissen, 2011). These studies provide support for the idea that mindfulness improves well-being through the processing of emotional information.

Mindfulness Research with Children and Adolescents

One feasibility study of mindfulness training on attention-deficit hyperactivity disorder (ADHD) symptoms provides the only available research using both adolescents and adults (Zylowska et al., 2008). Adolescents, ages 15 and older, and adults with ADHD participated in an eight-week mindfulness training program in which they met once a week for two and a half hours. Participants were also instructed to practice at home, which consisted of formal meditation and mindful awareness in daily living exercises. Results revealed that the majority of participants experienced a decrease in ADHD symptoms. While age did not affect symptom remission, adults practiced meditation significantly more at home than the adolescent participants.

Few other mindfulness studies have been conducted with children and adolescents. One study examined the effects of a two-year relaxation response program in a middle school on academic performance (Benson et al., 2000). The relaxation curriculum was used to evoke many of the same physiological changes associated with mindfulness and other forms of relaxation including yoga and meditation, such as feelings of calmness and control; the opposite of the stress response. The relaxation curriculum consisted of semester long courses in which the teacher had been trained in the relaxation response. Exposure was identified as the number of such courses the students were in. They found that students who were exposed to the relaxation response curriculum in more than two classes had higher GPA and improved work habits and

cooperation. The researchers posited that these effects were due to the students' abilities to better cope with stressors.

Another study examined the effects of a 5-week mindfulness meditation intervention on adolescent students with learning disabilities (Beauchemin, Hutchins, & Patterson, 2008). Students were given a 45-minute training on mindfulness and then were lead through a mindfulness meditation for five to ten minutes at the beginning of each class period five days a week for five weeks. The researchers found decreased levels of anxiety, enhanced social skills, and better academic performance after the intervention as compared to before the intervention. The researchers suggest that mindfulness decreases anxiety and reduces negative self-focused attention, which fosters better social skills and academic performance.

Anglin, Pirson, and Langer (2008) found that without encouraged mindful learning, males outperformed females in math, but when mindful learning was incorporated, male and female middle school students performed equally. One hypothesis for the gender differences in math performance, based on the information-processing model, is that stereotype threat interferes with cognitive resources, thus disrupting the performance of female students. Anglin et al., thus suggest that mindful learning eliminates stereotype threat. This suggestion is in line with previous thought about the influence of mindfulness on cognitive flexibility. By engaging students in mindful learning, they have better cognitive flexibility, thus they are better able to solve novel math problems.

Brief Mindfulness Interventions

With the majority of the research on mindfulness focus on expert meditators or extended mindfulness trainings (eight weeks or more), few studies have examined the effects of mindfulness after a single, brief mindfulness intervention. One such study, done by Mrazek, Smallwood, and Schooler (2012), used an eight-minute mindful breathing intervention to investigate its impact on mind wandering during a sustained attention task. The researchers found that a mindful breathing intervention was more effective than passive relaxation and reading conditions at reducing mind wandering. A 12-minute mindful breathing exercise was used in another study discussed previously (Alberts & Thewissen, 2011).

Another study showed improved performance under stereotype threat with a five-minute mindfulness task (Weger, Hooper, Meier, & Hopthrow, 2012). In this study, female college students were assigned to either a five-minute mindfulness task or control condition. Participants were then exposed to a stereotype threat involving males outperforming females in math tasks, or no stereotype threat. Math performance before and after the intervention was evaluated. Results revealed that a brief mindfulness intervention protected participants from performance deficits due to a stereotype threat compared to the control condition.

A recent study examined the effects of a single-session mindfulness exercise on encoding of English-Swahili word pairs in female college students (Bonamo et al., 2014). In this study, participants were randomly assigned to one of three conditions: engaging in a 20-minute body scan meditation, a 45-minute body scan meditation, or a no-treatment control group prior to learning Swahili-English word pairs. The researchers found that

members of both the 20-minute and a 45-minute body scan meditation groups recalled more Swahili-English words than the members of the control condition, when controlling for depression, anxiety, attention problems, and trait mindfulness. Though the 20-minute meditation condition scored higher on measures of state mindfulness than the control condition, the 45-minute meditation condition was no different than controls.

This study provided evidence that brief mindfulness training enhanced the encoding of novel information (Bonamo et al., 2014). These results may have important clinical and academic implications, providing a means to enhance students' learning. One limitation of this study includes that it lacked an active control condition. Also, the researchers found that the mindfulness intervention did not influence anxiety scores and suggested that a different measure, more related to performance such as test anxiety, should be used. Because this study used female college students, it is unclear whether these findings might be replicated among other populations, such as male and female adolescents.

Current study

The current study intended to replicate and extend the study conducted by Bonamo, Legerski, and Thomas (2014) with college students to adolescents in a secondary school sample. While research has shown that mindfulness has direct and indirect effects on attention and memory, there currently appears to be no published research investigating the influence of a single session, brief mindfulness exercise on adolescents' recall abilities.

Research with adolescents in this area may especially important given the many developmental differences between adolescents and adults. Adolescents' brains differ

from adults in neurotransmitter activity, hormone levels, grey and white matter volume in prefrontal brain areas, activation and efficiency of the prefrontal cortex, coordination of cortical and subcortical functioning, and connectivity between brain regions, to name a few (Steinberg, 2008). Furthermore, age differences have been identified in areas of attention, and cognitive and interpersonal functioning (Semple et al., 2006). Previous research has used mindfulness interventions in children as young as seven, though no lower limit has been established (Thompson & Gauntlett-Gilbert, 2008). Results from a previously described study suggest that mindfulness practices used with adults can also be successfully used with adolescents (Zylowska et al., 2008). Suggested modifications to mindfulness practices for use with adolescents include greater explanation and rationale; the use of more age-relevant practices, such as incorporating popular music and cell phones into exercises; age-appropriate metaphors of mindfulness practices; balancing a variety of practices and repetition; using shorter practices; engaging parents; and teaching mindfulness in groups (Thompson & Gauntlett-Gilbert, 2008). Because children have more limited memory and attentional capacities than adults, shorter and more repetitive sessions may be beneficial, for example, replacing a 20 to 40 minute breath meditation used with adults with meditation exercises shorter in duration for children (Semple, Lee, & Miller, 2005). Additionally, including sensory experiences and physical activity may be more engaging for children who lack the verbal and abstract abilities of adults.

The current study used many of the methods used by Bonamo, Legerski, and Thomas (2014). Novel words consisted of English-Swahili word pairs, due to Swhaili's readability, as it is written in a Latin script, but has a non-Latin base, and neutral valence (*e.g.,* chakula = food, goti = knee, punda = donkey). These words pairs were normed by

Nelson and Dunlosky (1994). A 20-minute body scan was used as previous research showed it to be effective at inducing state mindfulness (Bonamo et al., 2014). Previous research has used similar body scan meditation exercises to induce state mindfulness (Cropley, Ussher, & Charitou, 2007; Carmody & Baer, 2008; Ostafin and Kassman, 2012). An active control condition was also included, an element that was lacking in the study conducted by Bonamo and colleagues (2014). Furthermore, a measure of test anxiety was added to the current study and a different method of presenting the conditions was used; participants listened to the recordings on individual headsets. Additionally, the current study was conducted with adolescents in an actual classroom settings in order to investigate whether the effects found by Bonamo et al., which was conducted in small groups in lab settings, would generalize to more real world academic settings.

The first hypothesis of this study was that mindfulness would be associated with academic performance and emotional adjustment, as suggested by previous research (Beauchemin et al., 2008; Goldin & Gross, 2010).

The second hypothesis of this study was that participants in the mindfulness group would recall more Swahili word pairs than the control group, as previous research has shown that mindfulness improves attention and working memory (*e.g.,* van Vugt & Jha, 2011). This result, replicating the findings of Bonamo and colleagues (2014), would potentially have important clinical and academic implications. Long-term recall of information is a common method of assessing knowledge, both in the classroom and for standardized tests.

Secondary analyses were conducted to test the hypotheses that a higher frequency of words recalled would be associated with higher scores on measures of state mindfulness and positive affect, and lower scores on measures of negative affect and subjective distress. It was also expected that state mindfulness would increase for those in the mindfulness condition and would not change for those in the lecture control condition, which is supported by previous research (Bonamo et al., 2014). Additionally, it was expected that those in the mindfulness group would experience an increase in positive emotions and a decrease in negative emotions, while the lecture control group would remain the same, as previous research suggests that mindfulness interventions improve well-being (Alberts & Thewissen, 2011; Roberts-Wolfe, Sacchet, Hastings, Roth, & Britton, 2012).

Finally, it was expected that those in the mindfulness group would experience a decrease in subjective distress while the lecture control group would have no change in subjective distress. This hypothesis was based on previous research that has shown decreases in anxiety following a mindfulness intervention (Beauchemin, Hutchins, & Patterson, 2008). Also, mindfulness practice has shown to invoke a relaxation response, which enables individuals to better cope with stressors (Benson et al., 2000).

CHAPTER II

METHOD

Participants

Participants were 82 secondary school students (41 female, 41 male) from a small rural Midwestern school, ranging from 7th to 11th grade. The mean age of participants was 14.6 (*SD* = 1.2), with a range of 13 -18 years. Participants were primarily Caucasian (80%), with approximately 16% Hispanic, 2% African American, and 1% American Indian. In an effort to collect data from as many of the students as possible, across different levels of academic ability, the study was collected during math classes at the school because most students in the age group were enrolled in a math class. The classes ranged from advanced to remedial. Participants were not compensated by the researcher but may have received credit in their class for participation at the discretion of their teacher. In order to increase motivation to engage in the study, participants were given an opportunity to win a pizza party for the class that recalled the most words.

Materials

Audio Headsets. Audio headsets with attached MP3 players were used to deliver audio recordings of the control and experimental conditions, either the body scan meditation recording or the lecture recording. Headsets were randomly assigned an identification number so that the participants and the researchers were blinded to the condition.

Body Scan Meditation. The experimental condition in this study was a 20-minute body scan meditation recording, made available to the public through the UCSD Center for Mindfulness website (http://health.ucsd.edu). This body scan recording was also used in the study conducted by Bonamo, Legerski, and Thomas (2014).

Lecture. The control condition in this study involved listening to a brief podcast highlighting the life of the author Laura Ingalls Wilder, edited for length to match the body scan meditation. This is a free podcast produced by HowStuffWorks in a series called "Stuff You Missed in History Class" (available at https://itunes.apple.com/us/podcast/stuff-you-missed-in-history/id283605519?mt=2). This podcast was selected due to its neutral emotional valence. It was also viewed as topic that might be discussed in many secondary school classroom settings.

Measures

The **Perceived Stress Scale (PSS)** is a 14-item self-report measure that measures the extent to which events within the past month in a person's life are perceived as stressful (Cohen, Kamarck, & Mermelstein, 1983). This measure was included to control for an ongoing stress that might conceivable interfere with students' attention and memory during testing. The PSS is used to determine trait stress and is assessed on a 5-point Likert-type scale (1 – "Never" to 5 – "Very often"). An example item is, "In the past month, how often have you felt nervous and 'stressed'?" Cronbach's alpha reliability for the 14-item PSS from previous published research is .85 (Cohen et al., 1983). Reliability in the current study was .69.

The **Exercise Engagement Scale (ESS)** was used the measure student's engagement. The ESS is one item, which measures the extent to which the participant

engaged in an activity (Niss, 2012), in this case, either the lecture or the mindful body scan exercise. The ESS asks "On a scale of 0 to 100, to what extent did you try to do this listening exercise?" and uses a Likert-type scale from 0-100 (0 – "Not at all" to 100 – "Completely"). This scale has been used in a previous study investigating the effects of a mindfulness intervention on math test anxiety (Niss, 2012).

The **Subjective Units of Discomfort Scale (SUDS)** is a one-item scale, which measures the participant's subjective level of distress, originally evaluated on a 100-point scale (0 – "Feeling completely calm with no anxiety" to 100 – "The most extreme anxiety you've ever felt," Wolpe, 1958). The SUDS was used to measure changes in distress during the testing procedure.

The **Positive and Negative Affect Schedule (PANAS)** was used to measure changes in student's mood. The PANAS is a frequently used, 20-item scale that measures participants' current mood states (Watson, Clark, & Tellegen, 1988). Items are assessed on a 5-point Likert-type scale (1 – "Very slightly or not at all" to 5 – "Extremely"). Cronbach's alpha reliability is .86 for the negative items and .87 for the positive items (Watson et al., 1988). In the current study, reliability for the positive items were .82 and .86, for pre and post measures, respectively; and .80 and .84 for negative pre and post measures, respectively.

The **Barkley Current Symptoms Scale (BCSS) Self-Report Form** was used to control for individual student attention difficulties that might influence testing performance during the current study. The BCSS is a rating scale used to assess attention deficit hyperactivity disorder (ADHD) symptoms (Barkley & Murphy, 2006), but was used in this study to assess for general attention problems, not to diagnose ADHD. It

consists of 18 items, nine of which assess inattention, six assessing hyperactivity, and three items assessing impulsive symptoms. The scale uses a 4-point Likert-type scale (0 – "Never or rarely" to 3 – "Very often"). An example item is, "I fail to give close attention to details or make careless mistakes in my work." Based on previous research, Cronbach's alpha reliability is .91 for the overall scale (Ladner, Schulenberg, Smith, & Dunaway, 2011). Reliability for the current study was .92.

The **NIH Toolbox Sadness Survey (NIHSS)** is an 8-item, self-report measure assessing depression in adolescents aged 8-17 (http://www.nihtoolbox.org). The NIHSS was included to control for the potential effect depression can have on attention and memory. The scale uses a 5-point Likert-type scale (1 – "Never" to 5 – "Almost Always") that evaluates thoughts and feelings over the past seven days. An example item is, "I felt that I had nothing to look forward to." Cronbach's alpha reliability in the current study was .95, consistent with previously reported data (Salsman et al., 2013).

The **Test Anxiety Inventory Short Form (TAI-5)** is a 5-item self-report measure of participants' test anxiety (Taylor & Deane, 2002). The TAI-5 was used to control for test anxiety that might interfere with participants' attention and memory. The scale uses a 4-point Likert-type scale (1 – "Almost Never" to 4 – "Almost Always"). An example item is, "feel very panicky when I take an important test." Chronbach's alpha reliability has shown to be .88 in previously published research (Taylor & Deane, 2002). Reliability in the current study was .85.

Mindful Attention Awareness Scale – Adolescent (MAAS-A). The MAAS-A is a trait mindfulness measure for normative and psychiatric adolescent populations (Brown, West, Loverich, & Biegel, 2011). The MAAS-A was used to evaluate potential

interaction effects on individual differences in trait mindfulness. The scale uses a 6-point Likert-type scale (1 – "Almost always" to 6 – "Almost never"). An example item is, "I find myself doing things without paying attention." Chronbach's alpha reliability has ranged from .85-.88 in previously published research (Brown et al., 2011). Reliability in the current study was .90.

The **Cognitive and Affective Mindfulness Scale Revised (CAMS-R)** is a 10-item self-report measure of state mindfulness (Feldman, Hayes, Kumar, Greeson, & Laurenceau, 2007). The CAMS-R was used to track differences in state mindfulness following the mindfulness activity. The scale uses a 4-point Likert-type scale (1 – "Rarely/Not at all" to 4 – "Almost Always"). This measure was adapted to specifically suit the purposes of this study. The original items assessed general state mindfulness prior to the intervention, while the adapted items assessed mindfulness specifically related to the intervention. An example adapted item is, "It was easy for me to concentrate on what I was doing." Cronbach's alpha reliability for based on the original version, based on previously published research, is .78 (Feldman et al., 2007). Reliability in the current study for the original version prior to the intervention was .75, while the adapted version, used after the intervention, was .84.

Interference Task. In order to prevent rehearsal of word-pairs, an interference task, consisting of various multiplication and division problems, was administered for one minute. The multiplication and division problems were obtained from an academic skill-building website (www.homeschoolmath.net).

An additional demographics questionnaire was included, consisting of self-report questions regarding age, gender, ethnicity, estimated GPA, sleep, and hunger.

Procedure

The study was approved by the Institutional Review Board at the university housing the research lab that conducted the study. Permission was also sought and granted from the school principal. Informed consent was obtained by sending opt-out consent forms home to the parents of all students who were in the classes selected for participation. Parents signed and returned the consent form or notified the researcher if they did not want their student to participate. Assent forms were given by the primary researcher to all students whose parents agreed to their participation. In order to replicate the typical learning setting of students, data was collected in the students' classroom.

During the study, two research lab members presented materials, walked around the classroom, and answered questions. Participants were able to talk throughout testing, but were encouraged to focus on the materials by the researchers. Assent forms were given to all students and the assent form was read to the students by a researcher. If the students agreed to participate, they signed the assent forms, which were collected by the research lab members. Participants kept one copy of the assent form. A researcher then presented the following instructions,

> "There will be a little bit of testing with this, whichever class does the best will win a pizza party on the last day of school. We will let your teacher know which period wins. Please answer these questions the best you can. There is no right or wrong answer. When you get to the page that says STOP, please stop and wait for instructions. Do not go on."

The participants then completed the demographic questionnaire, NIHSS, BCSS, PANAS, PSS, SUDS, CAMS-R, MAAS-A and TAI-5. Following the completion of the

self-report measures, the participants were randomly assigned to one of two groups. Students were randomly given a headset with either the experimental or control condition. As noted above, the headsets were numbered so that participants and researchers were blinded to condition. Each participant in Group 1 (experimental) received an audio headset that contained the 20-minute body scan exercise. Each participant in Group 2 (control) received an audio headset that contained the 20-minute lecture. The participants were given the following instructions,

> Now you will be listening to something that is thought to enhance learning. Please pay attention. Please stay seated, keep your head up, and your cell phones away. When you are done listening to the recording, please wait for instructions. To listen to the recording, turn the mp3 player on using the switch on the side. It should automatically start playing. You may need to press the back button to get to the beginning of the recording. If you hear classical music, you need to press the forward button to get to the recording. Please turn the mp3 off after the recording is finished.

Following the intervention, the participants were given the following instructions,

> Now you will be shown 20 Swahili words and their English translations. Try to remember what each Swahili word means in English. Remember, whichever class remembers the most words will win a pizza party, so do your best.

The participants then viewed 20 Swahili-English word pairs (see Appendix A), normed by Nelson and Dunlosky (1994). The word pairs were randomly presented one at a time using a timed PowerPoint presentation that automatically presented the next word pair

after 10 seconds. The slide show was presented using an LCD projector and a Smart Board. The timing of the presentation of word pairs is supported by previous research (Bonamo et al., 2014, Grimaldi, Pyc & Rawson, 2010; Cepeda, Coburn, Rohrer, Wixted, Mozer & Pashler, 2009). Following the presentation of word pairs, participants completed an interference task in order to prevent rehearsal of word pairs. During the first recall portion, Swahili words learned previously were shown in a PowerPoint presentation. Participants were instructed as follows: "Now you will be shown a list of the Swahili words. Write down as many of the English words as you can remember in your packet. Make sure to match the number on the slide with the number in your packet when writing down the words. Then complete the rest of the questionnaires." After the first recall trial, participants completed the EES, SUDS, PANAS, and CAMS-R.

The next day, 24 hours after the initial recall, participants were again asked to recall and write down the English word pair when the Swhaili equivalent was presented. Participants were unaware that they would have to recall the word pairs after the initial session. Participants were given the following instructions,

> We want to see how many words you can remember from the ones you learned yesterday. Like yesterday, I will show you a list of the Swahili words and ask you to write down the English word that goes with it. Remember to match the number on the slide with the number in your packet. The number of words you remember today will not affect which class gets the pizza party, but try to do your best to remember as many as you can.

Participants were debriefed on the intent of the study and offered access to the results of the study once complete.

CHAPTER III

RESULTS

Pre-analysis and Data Screening

Data was entered twice and cross-checked for data entry accuracy. Descriptive statistics and frequency distributions were inspected for missing values and to ensure that data appeared reasonable and fell within expected ranges. Outliers were examined using boxplots and stem-and-leaf plots.

Due to a brief delay caused by setting up and distributing the research materials, three measures (post-tests for the SUDS, CAMS-R, and PANAS) were not completed by all students in the first two class periods. Listwise deletion was used to account for the missing measures from these class periods, reducing the sample size from 82 to 57 on analyses that included one or more of these three measures. Independent samples t-tests were computed to determine if significant differences existed in outcome variables and covariates between participants who completed these three measures and participants who did not. Differences were found in Recall at Time 2 for participants who were unable to complete the PANAS post-test (M = 5.29, SD = 4.20, N = 24) compared to participants who did complete the measure (M = 3.42, SD = 2.88, N = 52), $t(74)$ = 2.264, p = .006. No significant differences were found for other variables. Participants with missing data on SUDS post-test also recalled more words at Time 2 (M = 5.29, SD = 4.20, N = 24) compared to those without missing data (M = 3.42, SD = 2.88, N = 52), $t(74)$ = 2.264, p = .006. No significant differences were found for other variables. No

significant differences were found for participants with missing data on CAMS post-test. For less extensive missing data (e.g. skipping a question on a measure), mean substitution was used. This was done for less than 3% of the data.

For outliers identified through boxplots and stem-and-leaf plots, they were examined for validity (in the possible range of scores) and accuracy (correctly entered). When it was determined that the outliers were valid and entered correctly and therefore should remain in the analysis, they were adjusted to the minimum or maximum acceptable value depending upon the direction of the outlier. Four outliers were recoded for the PANAS Pre-test Negative, two for the PANAS Post-test Positive, and five for the PANAS Post-test Negative. One outlier was recoded for the SUDS Pre-test and four for the SUDS Post-test. Four outliers for the NIHSS were recoded, one for the BCSS, one for the PSS, one for the Recall Time 1, and eight for the Recall Time 2.

Following the adjustment of outliers, normality was assessed using the Kolmogorov-Smirnov statistic. In order to meet the normality assumptions, square root transformations were applied to the Recall Time 1 and the Recall Time 2; the BCSS Total score, the SUDS pre and post-test, and the EES scores; a log transformation was applied to the NIHSS, and an inverse transformation was applied to the PANAS pre-test and post-test negative scores. Untransformed means are reported in Table 1.

Preliminary independent samples t-tests were computed to ensure that the groups did not differ on pre-intervention levels of distress, state mindfulness, positive emotions, and negative emotions. No significant differences were found between groups on measures of pre-intervention levels of distress, $t(73) = .561$, $p = .521$; state mindfulness,

t(77) = .688, *p* .119; positive emotions, *t*(77) = .964, *p* = .239; or negative emotions, *t*(77) = -1.161, *p* = .577.

Table 1. *Untransformed Means for Dependent Variables and Covariates (with Standard Deviations in Parentheses)*

Measure	Group	
	Mindfulness	Control
Dependent Variables		
Recall 1	5.42 (3.98)	4.10 (2.84)
Recall 2	4.71 (4.06)	3.49 (2.75)
SUDS Pre	24.03 (22.81)	22.51 (22.98)
SUDS Post	23.21 (20.43)	23.07 (23.75)
PANAS Pos Pre	26.38 (7.50)	24.87 (6.45)
PANAS Pos Post	23.43 (9.75)	21.46 (7.01)
PANAS Neg Pre	15.46 (4.45)	14.74 (5.27)
PANAS Neg Post	16.46 (4.98)	14.10 (5.74)
CAMS Pre	32.71 (6.00)	31.89 (4.54)
CAMS Post	30.05 (6.07)	33.54 (6.33)
Covariates		
MAASA	61.49 (12.19)	61.18 (13.54)
PSS	38.27 (5.97)	38.71 (6.94)
BCSS	13.32 (10.98)	12.90 (9.23)
NIHSS	18.66 (7.79)	18.69 (9.33)
TAI	10.48 (3.56)	10.63 (3.41)
EES	50.97 (29.17)	55.73 (29.60)

Note: SUDS: distress, PANAS Pos: positive affect, PANAS Neg: negative affect, CAMS: state mindfulness, MAASA: trait mindfulness, PSS: perceived stress, BCSS: inattention, NIHSS: depressive symptoms, TAI: test anxiety, EES: exercise engagement. N = 57 for SUDS, CAMS-R, and PANAS posttest measures, *N* = 82 for all remaining measures.

Bivariate correlations were conducted to investigate relationships among scores on state mindfulness, trait mindfulness, and aspects of emotional adjustment and academic performance (Table 2). Trait mindfulness scores were positively correlated with GPA, sleep, and state mindfulness scores. Trait mindfulness scores were also negatively correlated with subjective distress, negative emotions, depressive symptoms, perceived stress, and symptoms of ADHD. State mindfulness prior to the intervention was positively correlated with positive emotions, GPA, and trait mindfulness scores.

Table 2. *Correlations Between Variables*

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.
1. Gender[a]																						
2. Age	0.02																					
3. Grade	0.07	.94**																				
4. Race[b]	0.12	.33**	.28**																			
5. Group[c]	-0.14	-0.03	-0.03	.20*																		
6. GPA	.29**	-0.13	-0.12	-0.14	-0.08																	
7. Sleep	-0.03	0.09	0.05	-0.08	0.00	.33**																
8. Recall 1	0.17	.28**	.30**	-0.03	-.19*	.22*	0.12															
9. Recall 2	0.11	0.18	.26*	-0.07	-0.18	0.16	0.18	.81**														
10. SUDS Pre	0.12	-0.16	-0.15	-0.15	-0.03	-.24*	-0.14	-0.04	-0.15													
11. SUDS Post	0.05	-0.07	-0.11	0.04	-0.01	-.38**	-0.22	-0.11	-0.21	.80**												
12. PANAS Pre Positive	0.11	0.07	0.07	.22*	-0.11	0.12	0.01	0.05	-0.01	0.12	.26*											
13. PANAS Post Positive	0.04	-0.02	-0.01	-0.06	-0.12	0.08	-0.03	0.16	0.16	.32**	.29*	.77**										
14. PANAS Pre Negative	0.05	-0.09	-0.11	-0.02	-0.08	-.26*	-0.14	-0.04	-0.11	.71**	.55**	.29**	.28*									
15. PANAS Post Negative	0.05	0.13	0.13	-0.05	-0.22	-0.02	-0.12	0.13	0.07	.52**	.48**	.35**	.30*	.73**								
16. CAMS Pre	-0.03	0.04	0.02	-0.06	-0.08	.32**	0.18	0.04	-0.02	-.26*	-.35**	.26*	0.04	-.23*	-0.09							
17. CAMS Post	-0.13	-0.02	-0.02	0.08	.27*	.39**	.35**	-0.08	-0.01	-.28*	-.24*	0.18	0.08	-.29*	-0.18	.65**						
18. MAASA	0.16	0.14	0.12	0.10	-0.01	.33**	.26**	-0.02	0.16	-.32**	-0.21	-0.03	-.33**	-.32**	-0.20	.22*	.27*					
19. PSS	-0.01	-.22*	-.20*	-0.13	0.03	-.32**	-0.18	-0.11	-0.13	.53**	.48**	-0.17	0.03	.39**	0.21	-.46**	-.4**	-.44**				
20. BCSS	-0.06	-0.11	-0.12	-0.02	-0.02	-.36**	-0.14	-0.05	-0.16	.34**	.30*	-0.06	-0.01	.50**	.31**	-.29**	-.33**	-.54**	.44**			
21. NIHSS	.20*	-0.05	-0.02	-0.13	0.01	-.34**	-.20*	-0.01	-0.03	.54**	.30*	-0.11	-0.04	.53**	.26*	-.34**	-.32**	-.37**	.53**	.44**		
22. TAI	.32**	0.07	0.10	0.15	0.02	-0.17	-.28**	0.06	0.06	.29**	.36**	-0.05	-0.06	.25*	.23*	-.36**	-.38**	-0.18	.37**	0.16	.28**	
23. EES	-0.06	0.01	0.01	-0.04	0.08	.26*	.22*	-0.06	0.02	0.14	0.12	0.21	0.17	0.14	.23*	0.13	.45**	0.20	-0.09	-.27*	-0.05	0.17

** Correlation is significant at the 0.01 level (1-tailed).
* Correlation is significant at the 0.05 level (1-tailed).
[a] Male = 1, Female = 2
[b] Caucasian = 1,
[c] Mindfulness = 1, Control = 2
Note: SUDS: distress, PANAS Pos: positive affect, PANAS Neg: negative affect, CAMS: state mindfulness, MAASA: trait mindfulness, PSS: perceived stress, BCSS: inattention, NIHSS: depressive symptoms, TAI: test anxiety, EES: exercise engagement.

State mindfulness scores was also negatively correlated with subjective distress, test anxiety, depressive symptoms, perceived stress, symptoms of ADHD, and negative emotions. In addition, state mindfulness scores after the intervention were also positively correlated with group and sleep. Group status was negatively correlated with recall at Time 1. Specifically, as group status changed from mindfulness (group 1) to control (group 2), recall decreased.

Multiple Regression

Stepwise multiple regressions were conducted to determine which variables were predictors of GPA, sleep, distress, test anxiety, depression, positive and negative emotions, and ADHD (see Tables 3 and 4). Regression results indicated an overall model of two predictors (GPA and trait mindfulness) that significantly predict sleep, $R^2 = .152$, $R^2_{adj} = .128$, $F(2,71) = 6.355$, $p = .003$. Regression results indicated an overall model of three predictors (state mindfulness, gender, and sleep) that significantly predict test anxiety, $R^2 = .246$, $R^2_{adj} = .214$, $F(3,70) = 7.623$, $p<.001$. Regression results indicated an overall model of one predictor (negative emotions) that significantly predicts distress, $R^2 = .494$, $R^2_{adj} = .487$, $F(1,72) = 70.292$, $p<.001$. Regression results indicated an overall model of five predictors (positive and negative emotions, trait mindfulness, gender, and GPA) that significantly predict depression, $R^2 = .515$, $R^2_{adj} = .479$, $F(5,68) = 14.432$, $p<.001$. Regression results indicated an overall model of three predictors (state mindfulness, negative emotions, and depression) that significantly predict positive emotions, $R^2 = .312$, $R^2_{adj} = .283$, $F(3,70) = 10.583$, $p<.001$. Regression results indicated an overall model of four predictors (distress, ADHD, positive emotions, and depression)

Table 3. *Standardized Coefficients of Multiple Regression Models – GPA, Sleep, Distress, and Depression Models*

	GPA Model	Sleep Model	Distress Model	Depression Model
Gender [a]	.357			.263
Trait Mindfulness		.239		-.198
Negative Emotions			.703	.491
Positive Emotions				-.269
Sleep	.231			
Depressive Symptoms	-.366			
GPA		.245		-.195
F Total	9.957**	6.355*	70.292**	14.432**
R^2	.299	.152	.494	.515
Adjusted R^2	.269	.128	.487	.479

Note. N = 73. Degrees of freedom for the regression equations are $F(3,70)$ for the GPA Model, $F(2,71)$ for the Sleep Model, $F(1,72)$ for the Distress Model, and $F(5,68)$ for the Depression Model.
[a] 1 = male; 2 = female.
* p < .05. ** p < .01.

Table 4. *Standardized Coefficients of Multiple Regression Models – Test Anxiety, Positive Emotions, Negative Emotions, and ADHD Models*

	Test Anxiety Model	Pos Emotions Model	Neg Emotions Model	ADHD Model
Gender [a]	.313			
State Mindfulness	-.284	.392		
Trait Mindfulness				-.355
Negative Emotions		.497		.449
Positive Emotions			.252	-.202
Sleep	-.225			
Depressive Symptoms		-.303	.244	
Distress			.456	
ADHD			.287	
F Total	7.623**	10.583**	34.521**	17.179**
R^2	.246	.312	.667	.424
Adjusted R^2	.214	.283	.647	.399

Note. N = 73. Degrees of freedom for the regression equations are $F(3,70)$ for the Test Anxiety Model, $F(3,70)$ for the Positive Emotions Model, $F(4,69)$ for the Negative Emotions Model, and $F(3,70)$ for the ADHD Model.
[a] 1 = male; 2 = female.
* p < .05. ** p < .01.

that significantly predict negative emotions, R^2 = .667, R^2_{adj} = .647, $F(4,69)$ = 34.521, p<.001. Regression results indicated an overall model of three predictors (negative emotions, trait mindfulness, and positive emotions) that significantly predict ADHD, R^2 =

.424, R^2_{adj} = .399, $F(3,70) = 17.179$, $p<.001$. Regression results indicated an overall model of three predictors (sleep, gender, and depression) that significantly predict GPA, R^2 = .299, R^2_{adj} = .269, $F(3,70) = 9.957$, $p<.001$.

Analysis of Covariance

Recall Time 1. The data were evaluated to determine whether the assumptions of ANCOVA were met. Multicollinearity was assessed by examining bivariate correlations between covariates. All correlations were within an acceptable limit (i.e., $r < .90$, Tabachnick & Fidell, 2007). Residual plots comparing standardized residuals to predicted values were examined to check for linearity. No curvilinearity was detected. Homogeneity of regression slopes was assessed using a preliminary ANCOVA to test the interaction between the independent variable and each covariate. The interaction terms were not significant, therefore homogeneity of regression slopes has been met for all covariates; $F_{\text{TAI}}(1, 48) = .452$, $p = .505$; $F_{\text{NIHSS}}(1, 48) = .229$, $p = .634$; $F_{\text{BCSS}}(1, 48) = 3.539$, $p = .066$; $F_{\text{MAASA}}(1, 48) = 2.023$, $p = .161$; $F_{\text{PSS}}(1, 48) = .225$, $p = .637$; $F_{\text{EES}}(2, 48) = 1.498$, $p = .234$. Homogeneity of regression hyperplanes was assessed using a preliminary ANCOVA testing for the interaction between the independent variable (group) and all covariates, controlling for main effects, $F(2, 59) = .345$, $p = .710$. Homogeneity of variance was assessed using Levene's Test of Equality of Error Variances, $F(1, 60) = 1.739$, $p = .192$.

An analysis of covariance (ANCOVA) was conducted to determine the effect of group (mindfulness or control) on recall at Time 1 when controlling for depressive symptoms, perceived stress, attention problems, trait mindfulness, test anxiety, and exercise engagement. The possible range of scores, untransformed was 0-20; the obtained

range was 0-15. Results indicated no significant main effect of group, $F(1, 54) = 1.161$, $p = .286$. None of the covariates significantly influenced recall; $F_{TAI}(1, 54) = .483$, $p = .490$; $F_{NIHSS}(1, 54) = .436$, $p = .512$; $F_{BCSS}(1, 54) = .090$, $p = .766$; $F_{MAASA}(1, 54) = .436$, $p = .512$; $F_{PSS}(1, 54) = .845$, $p = .362$; $F_{EES}(1, 54) = 1.161$, $p = .286$.

Because of previous research suggesting that mindfulness interventions may be more effective with females (Bonamo et al., 2014) and the correlation of recall with age, as noted above, a 2x2 ANCOVA was conducted to determine the effect of group on recall at Time 1 when including age as an additional covariate and gender as a fixed factor. Results indicated no significant main effect of group, $F(1, 69) = 1.921$, $p = .17$, nor gender, $F(1, 69) = 2.117$, $p = .15$. There was no significant interaction of group and gender. However, age significantly influenced recall $F(1, 69) = 6.259$, $p = .015$. None of the other covariates significantly influenced recall.

Recall Time 2. For the second analysis, the data were inspected to ensure that the assumptions of ANCOVA were met. There was no evidence of multicollinearity (i.e., $r > .90$). Inspection of residual plots suggested a linear relationship between the covariates and recall at time 2. Homogeneity of regression slopes was met for TAI, $F(1, 43) = .589$, $p = .447$; NIHSS, $F(1, 43) = 1.067$, $p = .307$; MAASA, $F(1, 43) = 1.856$, $p = .180$; PSS, $F(1, 43) = .179$, $p = .674$; and EES, $F(1, 43) = .095$, $p = .910$. Homogeneity of regression slopes was not met for BCSS, $F(1, 43) = 5.104$, $p = .029$, therefore the covariate was not included in the subsequent analyses. Homogeneity of regression hyperplanes was met, $F(2, 54) = 1.045$, $p = .359$. Homogeneity of variance was assessed using Levene's Test of Equality of Error Variances, $F(1, 55) = 1.440$, $p = .235$.

A second ANCOVA was conducted to determine the effect of group on recall at Time 2 when controlling for depressive symptoms, perceived stress, trait mindfulness, test anxiety, and exercise engagement. The possible range of scores, untransformed was 0-20; the obtained range was 0-14.Results indicated no significant main effect of group, $F(1, 49) = 0.615$, p = .437. None of the covariates significantly influenced recall; $F_{TAI}(1, 50) = .162$, $p = .689$; $F_{NIHSS}(1, 50) = .779$, $p = .383$; $F_{MAASA}(1, 50) = .121$, $p = .729$; $F_{PSS}(1, 50) = 1.090$, $p = .302$; $F_{EES}(1, 50) = .078$, $p = .781$. Therefore, the primary hypothesis was not supported.

The current study has noted a correlation between age and recall, and previous research has suggested that mindfulness interventions may be more effective with females (Bonamo et al., 2014), therefore, a 2x2 ANCOVA was conducted to determine the effect of group on recall at Time 2 when including age as an additional covariate and gender as a fixed factor. Results indicated no significant main effect of group, $F(1, 64) = 1.671$, $p = .201$, nor gender, $F(1, 64) = .079$, $p = .779$. There was no significant interaction of group and gender, $F(1, 64) = .138$, $p = .711$. None of the covariates, including the addition of age, significantly influenced recall.

State Mindfulness. As with the previous analyses, the data was first checked to ensure that the assumptions of ANCOVA were met. Linearity between covariates and state mindfulness was confirmed with visual inspection of residual plots. Homogeneity of regression slopes was confirmed, as all interactions were not significant; $F_{TAI}(2, 41) = .213$, $p = .809$; $F_{NIHSS}(2, 41) = 1.962$, $p = .154$; $F_{BCSS}(2, 41) = .251$, $p = .779$; $F_{MAASA}(2, 41) = .751$, $p = .478$; $F_{PSS}(2, 41) = .275$, $p = .761$; $F_{EES}(2, 41) = 2.405$, $p = .103$. Homogeneity of regression hyperplanes was met, $F(2, 41) = 1.768$, $p = .183$.

Homogeneity of variance was met for both dependent variables, as assessed by Levene's Test of Equality of Error Variances; $F_{CAMS\text{-}PRE}(1, 55) = .325$, $p = .571$; $F_{CAMS\text{-}POST}(1, 55) = .681$, $p = .413$; however, Box's Test of Equality of Covariance Matrices was significant, $F(3, 568048) = 4.333$, $p = .005$. However, if sample sizes are equal, it is not necessary to evaluate the homogeneity of covariance matrices (Tabachnick & Fidell, 2007).

A repeated measures ANCOVA was conducted to compare pre-post differences of state mindfulness by group while controlling for depressive symptoms, perceived stress, attention problems, trait mindfulness, and test anxiety. Results indicated a significant interaction of state mindfulness and group, $F(1, 49) = 7.303$, $p = .009$. Specifically, state mindfulness scores in the mindfulness condition decreased (pre-test $M = 32.68$, $SD = 5.71$; post-test $M = 30.05$, $SD = 6.071$) and increased in the control condition (pre-test $M = 32.48$, $SD = 4.43$; post-test $M = 33.56$, $SD = 6.51$). This indicates that the mindfulness condition was not effective in inducing state mindfulness. There were significant effects of the covariates of perceived stress, $F(1, 49) = 4.094$, $p = .049$; test anxiety, $F(1, 49) = 4.966$, $p = .030$; and exercise engagement, $F(1, 49) = 4.404$, $p = .041$.

Positive Affect. The data was first checked to ensure that it met the assumptions of ANCOVA. Linearity between covariates and state mindfulness was confirmed with visual inspection of residual plots. Homogeneity of regression slopes was confirmed, as all interactions were not significant; $F_{\text{TAI}}(2, 39) = .199$, $p = .820$; $F_{\text{NIHSS}}(2, 39) = .129$, $p = .880$; $F_{\text{BCSS}}(2, 39) = .445$, $p = .644$; $F_{\text{MAASA}}(2, 39) = 1.861$, $p = .169$; $F_{\text{PSS}}(2, 39) = .253$, $p = .778$; $F_{\text{EES}}(2, 39) = .045$, $p = .956$. Homogeneity of regression hyperplanes was met, $F(2, 39) = .144$, $p = .866$. Homogeneity of variance was met for both dependent

variables, as assessed by Levene's Test of Equality of Error Variances; $F_{PANASPos\text{-}PRE}(1, 53) = 1.213$, $p = .276$; $F_{PANASPos\text{-}POST}(1, 53) = 2.760$, $p = .103$. Box's Test of Equality of Covariance Matrices was not significant, $F(3, 529248) = .899$, $p = .441$.

A repeated measures ANCOVA compared pre-post differences in positive affect by group, while controlling for depressive symptoms, perceived stress, attention problems, trait mindfulness, test anxiety, and exercise engagement. Results indicated no significant interaction of positive affect and group, $F(1, 47) = .002$, $p = .966$. There was a significant effect of the covariate of trait mindfulness, $F(1, 47) = 6.107$, $p = .017$.

Negative Affect. The data was first checked to ensure that it met the assumptions of ANCOVA. Linearity between covariates and state mindfulness was confirmed with visual inspection of residual plots. Homogeneity of regression slopes was confirmed, as all interactions were not significant; $F_{\text{TAI}}(2, 39) = .390$, $p = .679$; $F_{\text{NIHSS}}(2, 39) = 1.971$, $p = .153$; $F_{\text{BCSS}}(2, 39) = 1.459$, $p = .245$; $F_{\text{MAASA}}(2, 39) = .667$, $p = .519$; $F_{\text{PSS}}(2, 39) = .914$, $p = .409$; $F_{\text{EES}}(2, 39) = 1.391$, $p = .261$. Homogeneity of regression hyperplanes was met, $F(2, 39) = .391$, $p = .679$. Homogeneity of variance was met for pre-test negative affect, as assessed by Levene's Test of Equality of Error Variances; $F_{PANASNeg\text{-}PRE}(1, 53) = 1.837$, $p = .181$; but not for post-test negative affect; $F_{PANASNeg\text{-}POST}(1, 53) = 4.324$, $p = .042$. Box's Test of Equality of Covariance Matrices was not significant, $F(3, 529248) = .272$, $p = .846$.

Another ANCOVA assessed group differences in number of negative emotions endorsed before and after the intervention, while controlling for depressive symptoms, attention problems, trait mindfulness, and test anxiety. Results indicated a non-significant interaction of group and negative affect, $F(1, 47) = 2.486$, $p = .122$. There was a

significant effect of the covariates of depressive symptoms, $F(1, 47) = 4.931$, $p = .031$; and exercise engagement, $F(1, 47) = 6.213$, $p = . 016$.

Distress. The data was first checked to ensure that it met the assumptions of ANCOVA. Linearity between covariates and state mindfulness was confirmed with visual inspection of residual plots. Homogeneity of regression slopes was met for most covariates; $F_{\mathrm{TAI}}(2, 37) = 1.313$, $p = .281$; $F_{\mathrm{NIHSS}}(2, 37) = 1.370$, $p = .267$; $F_{\mathrm{MAASA}}(2, 37) = 2.766$, $p = .076$; $F_{\mathrm{PSS}}(2, 37) = .035$, $p = .966$; $F_{\mathrm{EES}}(2, 37) = .485$, $p = .619$. However, homogeneity of regression slopes was not met for BCSS, $F_{\mathrm{BCSS}}(2, 37) = 3.790$, $p = .032$, therefore, the covariate was not included in subsequent analyses. Homogeneity of regression hyperplanes was met, $F(2, 37) = 1.353$, $p = .271$. Homogeneity of variance was met, as assessed by Levene's Test of Equality of Error Variances; $F_{SUDS\text{-}PRE}(1, 50) = .873$, $p = .355$; $F_{SUDS\text{-}POST}(1, 50) = 1.846$, $p = .180$. Box's Test of Equality of Covariance Matrices was not significant, $F(3, 450000) = .983$, $p = .400$.

A repeated measures ANCOVA compared changes in subjective distress by group, while controlling for depressive symptoms, perceived stress, test anxiety, trait mindfulness, and exercise engagement. Results indicated no significant interaction between distress and group, $F(1, 46) = .750$, $p = .391$. There was a significant effect of the covariate of perceived stress, $F(1, 46) = 4.704$, $p = .048$.

Engagement. Due to the almost 5-point difference in unadjusted exercise engagement scores by group and the findings that the mindfulness exercise was not effective at producing state mindfulness, group differences in exercise engagement were compared. An ANCOVA compared exercise engagement by group, while controlling for depressive symptoms, perceived stress, test anxiety, pre-test levels of distress, pre-test

levels of positive and negative emotions, pre-test state mindfulness, and trait mindfulness. Results revealed no significant main effect of group, $F(1, 47) = 2.611$, $p = .113$. There were no significant effects of covariates.

CHAPTER IV

DISCUSSION

The present study predicted that mindfulness would be related to aspects of academic performance and emotional adjustment. The findings from this study supported this hypothesis. Specifically, individuals who had higher self-reported scores on trait mindfulness also reported higher GPAs, and had lower scores on measures of distress, negative emotions, depressive symptoms, perceived stress, and symptoms of ADHD. Further, higher scores on trait mindfulness were associated with lower scores on measures of depression, ADHD, and hours of sleep. Higher GPAs were also associated with lower scores on measures of ADHD and depression, more hours of sleep, and female gender.

The relationship between trait mindfulness and sleep may suggest that sleep may be an important factor in the maintenance of mindfulness. Conversely, individuals who are more mindful may be more aware of the needs of their bodies. These results are consistent with previous research that suggested that mindfulness is associated with self-regulation of sleep (Howell, Digdon, & Buro, 2010) and sleep quality (Caldwell, Harrison, Adams, Quin, & Greeson, 2010; Carlson & Garland, 2005; Howell, Digdon, Buro, & Sheptycki, 2008). The results did not show support for a relationship between trait mindfulness and test anxiety, contrary to previous research (Niss, 2012). Also, contrary to expectations, trait mindfulness had no relationship with positive emotions.

Although additional research is needed, the associations between mindfulness and adjustment found in the current study suggest that trait mindfulness may serve as a protective factor for emotional adjustment among adolescents. This provides support for Chambers and colleague's (2009) theory of mindful emotion regulation, suggesting that mindfulness enables an individual to decide whether to respond to emotions, rather than automatically react to them. The relationship between mindfulness and symptoms of ADHD may suggest that mindfulness enables better attentional abilities, as supported by previous research (Zylowska et al., 2008), or that ADHD disrupts one's abilities to be mindful. Future research regarding this relationship is needed.

State mindfulness prior to the intervention was positively correlated with positive emotions, GPA, and trait mindfulness. State mindfulness was negatively correlated with subjective distress, test anxiety, depressive symptoms, perceived stress, symptoms of ADHD, and negative emotions. Interestingly, state mindfulness was correlated with test anxiety whereas trait mindfulness was not. Post-intervention state mindfulness, in addition to the relationships found with pre-intervention state mindfulness, was also positively correlated with group and sleep. The correlation between post-intervention state mindfulness and sleep may suggest that a certain amount of sleep is necessary to be mindful. Also, the relationship between state mindfulness and group is consistent with the above finding that the control group was associated with higher levels of state mindfulness after the intervention.

The second hypothesis predicted that a brief mindfulness exercise would increase the number of English words free-recalled for newly learned Swahili words, both immediately (approximately one minute after learning the words), and long-term (the

next day). However, the findings from this study did not support this hypothesis. There were no significant differences in immediate or long-term recall between groups.

According the research assistants that facilitated the data collection, many students were observed talked to each other throughout testing. One possible explanation for the lack of group finding is that, despite being encouraged to pay attention to the materials, many students were more focused on socializing that engaging in the study. This may have resulted, it part, from the novelty of collectively engaging in an experimental study in the classroom setting. It was also observed that many students found the English-Swahili word pairs amusing, as they became quite animated during the learning trial, perhaps impeding the learning of the items. Additionally, while the almost 5-point difference between exercise engagement group means was not significantly different, this may be an important factor when considering the effectiveness of a brief mindfulness exercise.

Additionally, compared to the study conducted by Bonamo et al. (2014), recall for control and experimental groups was lower in the present study (Bonamo control M=5.28, experimental M=8.35; present study control M=4.10, experimental M=5.42). This difference may be due to cognitive and developmental difference between the college students in the Bonamo et al. study and the secondary school students in the current study.

While these results are contrary to the Bonamo et al. findings (2014), other studies have failed to find increased recall after a mindfulness intervention. Both Alberts and Thewissen (2011) and Roberts-Wolfe et al. (2012) found no differences in total number of words recalled between control and experimental groups. Also, van Vugt and

Jha (2011) found no differences in accuracy of performance on a working memory task. Therefore, the research is mixed regarding whether mindfulness improves recall. Further research is needed to clarify this area.

The third hypothesis predicted that those in the mindfulness condition would experience increases in levels of state mindfulness, as shown by previous studies (e.g., Bonamo et al., 2014). However, this hypothesis was not supported by the results from this study. While there was a significant difference in post-intervention state mindfulness scores between groups, the control group experienced an increase in state mindfulness while the mindfulness group experienced a decrease in state mindfulness.

One possible explanation for these findings is that the mindfulness exercise was too long for a first-time experience with mindfulness in adolescents. Some research has suggested adapting mindfulness exercises to the developmental level of the participants, including a shortened practice (Semple, Lee, & Miller, 2006; Thompson & Gauntlett-Gilbert, 2008), while others have successfully used the same mindfulness exercise with both adolescents and adults (Zylowska et al., 2008). It is feasible that the mindfulness exercise used in this study, a 20 minute body scan, was too long for the attention span of adolescents, therefore the participants in the control condition may have stayed more engaged in the listening activity than the participants in the mindfulness condition. This may be supported by the approximately 5-point difference between conditions, with the control condition reporting being more engaged that the mindfulness condition; however, this difference was not significant. Perhaps a first exposure to mindfulness must reach a delicate balance between a mindfulness exercise that is neither too short nor too long. Conversely, it may suggest that adolescents require repeated practice of mindfulness

before they experience any potential benefits of a mindful state, contrary to adults who appear to be able to become mindful after a single, brief exercise, as suggested by the results of Bonamo's study.

Additionally, though research has suggested teaching mindfulness to adolescents in groups (Thompson & Gauntlett-Gilbert, 2008), it is likely that the group sizes used in this study (generally classes of 20-30 students) were too large, and therefore detracted from, rather than enhanced, the mindfulness exercise. The study conducted by Bonamo et al. (2014) used small groups of participants. This research suggests that the results obtained from that study may not generalize into real world settings, i.e., large groups of students in a classroom environment. Also, participants were able to talk to one another, though encouraged to focus on the materials. It was observed that participants did talk and joke with one another between listening to the recording and learning the word pairs, which may have disrupted any benefits gained from the mindfulness intervention. Future research may choose to use smaller groups of participants in order to limit the possible interference of participant interaction.

Also, the post-intervention state mindfulness measure was administered after the participants viewed and recalled the word pairs, as well as filled out three other measures. Therefore, the delay between the intervention and the subsequent assessment of state mindfulness may have impacted scores, and may have been higher if the measure was administered immediately following the intervention. However, Bonamo et al. (2014) found differences in state mindfulness despite administering the state mindfulness measure after a brief delay. Therefore, these results could indicate that the mindfulness

intervention simply wasn’t effective, or that state mindfulness levels decreased due to the delay, which would contradict the results obtained by Bonamo et al.

Another hypothesis of the present study was that participants who received the mindfulness intervention would experience increased positive affect and decreased negative affect compared to controls. However, the findings did not support this hypothesis. There were no significant differences between groups in levels of positive or negative affect following the intervention. However, this result would be expected given that the mindfulness intervention was ineffective at inducing a mindful state. The covariate of trait mindfulness significantly influenced positive emotions, however, providing support for previous research findings that mindfulness may improve well-being through the processing of emotional information (Alberts & Thewissen, 2011; Howell & Buro, 2011; Roberts-Wolfe, Sacchet, Hastings, Roth, & Britton, 2012).

The final hypothesis of this study was that participants in the mindfulness condition would experience a decrease in distress, compared to controls. The results revealed no significant differences between groups in levels of distress, therefore, the hypothesis was not supported. Again, these results may be expected, and explained by, the ineffectiveness of the mindfulness intervention.

The major limitation of this study is the failure of the mindfulness exercise to induce a mindful state. Other limitations include the time constraints inherent in the setting that led to missing data. Also, the large group setting may have been less than ideal, especially for adolescents. The sample size of the present study may not have been sufficient to find significant differences, as suggested by a priori and post hoc power analyses. Additionally, participants with missing data on some measures had higher recall

at Time 1 than participants without missing data. This may suggest that the participants who took their time filling out the measures, and therefore not finishing, may also have been more careful when learning the novel words.

The contributions of this study include the findings associating mindfulness with aspects of emotional well-being and academic performance. This suggests that mindfulness based interventions may be beneficial to adolescent populations. Future research should examine the length and type of mindfulness interventions that are effective for single, brief mindfulness interventions for adolescents, as well as the most effective group size for conducting mindfulness interventions. For example, a mindful movement activity may be more engaging for adolescents and may therefore be more effective at inducing a mindful state. Additionally, it is suggested that adolescents be evaluated in small group settings, such as individually in a lab.

Future research should also explore the importance of engagement in and acceptance of mindfulness based practice. Developmental differences between children, adolescents, young adults, and adults may be important factors to consider when designing and implementing mindfulness practices. Additionally, research should examine if intragroup differences affect engagement and acceptance of mindfulness practices.

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APPENDIX

Appendix A

Swahili-English Word Pairs

1. Pipa = barrel
2. Malkia = queen
3. Fagio = broom
4. Adui – enemy
5. Dafina = treasure
6. Chakula = food
7. Mbwa = dog
8. Sumu = poison
9. Goti = knee
10. Vuke = steam
11. Leso = scarf
12. Ziwa = lake
13. Fununu = rumor
14. Harini = silk
15. Zulia = carpet
16. Punda = donkey
17. Ndoo = bucket
18. Lulu = pearl
19. Theluji = snow
20. Bustani = garden