Minding Attention: The Relationship Between Dispositional Mindfulness and Attention

by

Andrew Charles Philip

A dissertation submitted to the Graduate Faculty of
Auburn University
in partial fulfillment of the
requirements for the Degree of
Doctor of Philosophy

Auburn, Alabama
May 4, 2013

Keywords: dispositional mindfulness, attention

Approved by

Christopher J. Correia, Chair, Alumni Professor of Psychology
William F. Buskist, Distinguished Professor of Psychology
John C. Dagley, Associate Professor of Counseling Psychology
Richard E. Mattson, Assistant Professor of Psychology
Michael M. Steele, Assistant Professor of Psychology

Abstract

Mindfulness refers to experiencing one's self and environment in a conscious and unbiased manner focusing on the temporary, passing quality of thoughts, feelings, and life. Treatment providers have employed mindfulness-based interventions to manage issues including stress, depression, and substance abuse; however, few have measured exactly what mechanisms underly these changes. The present study found significant relationships between behavioral measures of attentional selectivity and inattention and scores of self-report mindfulness. ANOVA and MANCOVA analyses revealed that individuals reporting significantly higher levels of dispositional mindfulness are more likely than their less mindful counterparts to demonstrate stronger attentional abilities. Implications for the usage of attentional data in mindfulness treatment interventions, mindfulness to improve attention-related issues, and further research are discussed.

Acknowledgments

The author would like to thank Chris Correia, not only for his advisement and mentorship, but for being an exemplar of humility and balance amidst an impressive and growing line of accomplishments. His mother, Sylvia Bornfriend Philip, for her unending sacrifice to promote his well-being and fostering an intellectual curiosity and appreciation for education. Many thanks are also due to his committee members and many mentors at Auburn University; the lessons learned from these individuals have been vastly greater than could have been imagined and reach far beyond the walls of academia. Finally, he would like to thank his dear friends; they have witnessed his greatest and most trying moments, and supported equal parts relaxation and mayhem necessary for a full life. It has been his relationships, both with others and himself, that have been his drive and reward throughout this journey.

Table of Contents

List of Tables

Introduction

Minding Attention: The Relationship Between Dispositional Mindfulness and Attention

Attention to mindfulness is increasing within scientific psychology (Kabat-Zinn, 2000). Over 1000 articles and books became available on the topic over the past two decades. Although most often associated with Buddhist roots, mindfulness has been cited as originating thousands of years earlier in meditative practices described in the pre-Buddhist Upanishad texts (e.g., Miller, Fletcher, & Kabat-Zinn, 1995). Similarly to its history, there also exist varied opinions about its precise definition. Published definitions of mindfulness have ranged from "…to see reality exactly as it is," (Gunaratana, 2002, p. 33) to "a process that involves moving toward a state in which one is fully observant of external and internal stimuli in the present moment, and open to accepting (rather than attempting to change or judge) the current situation," (Orsillo, 2004, p. 77). Jon Kabat-Zinn, one of the most cited figures in the mindfulness literature defined mindfulness as "the awareness that emerges through paying attention on purpose, in the present moment, and nonjudgmental to the unfolding of experience moment by moment" (2003, p. 145). The concept of mindfulness as a conscious and unbiased experience, with a focus on the temporary passing quality of thoughts, feelings, and life in general has been largely accepted by many researchers (e.g., Brown & Ryan, 2003; Fjorback, Arendt, Ørnbøl, Fink, & Walach, 2011). Researchers such as Bishop, Lau, Shapiro, Carlson, and Anderson (2004) have distilled this operational definition of mindfulness though a series of meetings with recognized mindfulness experts with the goal of generating a testable working definition. The authors concluded that

mindfulness can most accurately be described as an integration of attention, awareness, and acceptance.

Mindfulness allows individuals to interpret bodily signals and the world around them without applying traditional value statements and feelings to them. Value statements can include self-talk such as "I'm pathetic for feeling guilty," or "it's shameful that I can't stay focused on this conversation." This type of inner commentary can be harmful because individuals may be adding a layer of negativity to an already difficult situation. This negativity can result in feeling worse and less able to solve a problem. By interpreting signals in their original form, an individual practicing mindfulness can evaluate events clearly without adding confusing and possibly inaccurate messages of emotional reactions or associations.

This type of unpolluted experience can help individuals understand and respond to events clearly and honestly (Gunaratana, 2002). For example, although an individual may see a nice car passing by and become overwhelmed by jealousy and begin to think negative thoughts about the driver, one employing mindfulness will observe the feeling of jealousy (attention), label it as jealousy (awareness), and then allow the feeling to pass without dwelling on it or judging the emotion as wrong or shameful (acceptance). Similarly, an individual with a drug addiction may experience memories or feelings that he associates with substance abuse when he passes by a location where he previously used, and these memories and feelings may increase the risk of relapse. With mindfulness training, an individual becomes keenly aware of his body and mind (attention), noticing that as he passes a certain area his pulse begins to increase and a somewhat nervous sort of feeling arises (awareness). An individual can label this feeling as a craving, observe that it will pass just like any other feeling, and allow it to do so without acting on it or judging the craving (acceptance).

This document will describe two types of mindfulness: mindfulness-based meditation and dispositional mindfulness, and will then focus on the proposed overlap between one of the three major mindfulness facets mentioned above: attention. In particular, I will examine how mindfulness is scientifically measured and conceptualized. I will apply a degree of scrutiny towards these two concepts, with the goal of confirming basic research on the attentional quality of mindfulness and the ability to capture it in a research application.

Meditation-based Mindfulness (MBM)

Traditionally used as a component of meditation, mindfulness is employed in clinical settings as a technique for reducing stress, decreasing symptoms of social anxiety disorder, decreasing cigarette smoking, affecting coping strategies in patients with Parkinson's disease, and managing many other maladies (Anderson, Lau, Segal, & Bishop, 2007; Bowen & Marlatt, 2009; Fitzpatrick, Simpson, & Smith, 2010; Goldin & Ross, 2010). For example, Lengacher and colleagues (2009) used MBM to decrease psychological distress in breast cancer survivors. Using 84 female breast cancer survivors, they assigned participants either to a 6-week MBM stress reduction (MBSR) program or a usual care (UC; waitlisted control) group. Using the MBSR program developed by Kabat-Zinn (1985; 1992) the 41 MBSR participants attended 6 2-hour weekly group sessions conducted by a psychologist. Investigators gave participants training manuals and audio-tapes for meditative exercises that they completed outside of sessions. Participants also kept a daily diary for recording these "homework" experiences. During the group sessions, participants discussed their homework experiences, interacted and shared their ongoing meditation experiences with one another, and practiced and further developed their meditative techniques. More specifically, during the first week participants received a course overview by the instructor and initial instruction on body-scan and meditation

techniques. During the second week, participants practiced visualization techniques and practiced sitting meditation with attention to breathing. In the third week, participants worked towards understanding reactions towards pleasant events and the body scan exercises, were led through introduction to basic yogic postures by the instructor, and listened to information about physiological correlates of their exercises. The fourth week focused on understanding reactions to unpleasant feelings and events, and the fifth week consisted of meditative exercises geared towards attending to awareness with the ability to adjust how they react to patterns of stress and pain, as well as increasing awareness of bodily sensations, sounds, thoughts, and feelings. During the final week, the instructor encouraged participants to internalize what they had learned, and to develop a life-long practice with the aim of using meditation to attain overall wellness.

The goal of these weeks of practice was managing psychological stress as well as physical symptoms related to the participants' experience with cancer. Participants used the techniques they were instructed upon to increase awareness of their reactions to thoughts and feelings and to observe their responses to stressful experiences. Ultimately, the researchers hypothesized that participants could use the intervention to become active in regulating their levels and responses to stress, thus managing symptoms and emotions and better coping with their stress. The MBSR group, in comparison to the control UC group, had significantly lower levels of fear and concern of reoccurrence of their cancer, lower state and trait anxiety, fewer symptoms of depression, higher quality of life ratings, fewer health-related role limitations, and greater energy levels.

Everyday and Dispositional Mindfulness

Work over the past 5 years has begun to tease apart the exact mechanisms by which mindfulness functions and to what extent meditation is required to possess or employ mindfulness techniques. Although encouraging mindfulness during sitting meditation is a useful aspect of treatment, the end goal of MBM is to promote mindfulness during everyday life (everyday mindfulness). For example, although one may become more aware of thoughts and feelings during mindful meditation, one will hopefully also find oneself more aware and present-focused while driving to the grocery store or reading a journal article. Given the goal of mindfulness in meditation generalizing to everyday life, it may be important to distinguish between mindfulness experienced during MBM and everyday mindfulness related to meditation.

Thompson and Waltz (2007) examined the relationship between everyday mindfulness, mindfulness during meditation, and personality using a sample of undergraduates with no prior mindfulness experience. Participants completed mindfulness measures before and after practicing a session of mindfulness-based meditation. The authors found that everyday mindfulness was unrelated to one's skill in practicing mindfulness during one session of sitting meditation. When Thompson and Waltz examined personality, everyday mindfulness was positively correlated with conscientiousness and agreeableness and negatively correlated with neuroticism. In contrast, MBM correlated positively with openness but there was no relationship to other personality characteristics. Given the lack of relationship between MBM and everyday mindfulness and differential patterning of correlations among mindfulness and personality, a dispositional model of mindfulness may indicate a more trait-like type of mindful existence. When viewed as a trait, mindfulness need not be specifically tied to any form of meditation.

Lakey, Campbell, Brown, and Goodie (2007) used the term "dispositional mindfulness," (DM) to describe the idea of everyday mindfulness being unrelated to MBM: DM is mindfulness possessed as a stable trait that is not gained through meditation or other specific techniques. The authors conducted two studies to understand better DM as it relates to severity of gambling behaviors in a sample of college students. According to the authors, mindfulness may be related to gambling behaviors because gambling problems are linked to difficulties in attending to thoughts and events, which are connected to impulsivity and poor decision-making. In the first study, Lakey et al. (2007) tested frequent gamblers to determine whether DM relates to problematic gambling, and what, if any, mediating variables are involved in the relationship. Participants who rated higher on DM reported less severe gambling problems when controlling for frequency of gambling and trait self-control. A second study (Lakey et al., 2007) indicated that participants with greater levels of mindfulness make more effective and accurate judgments and have a less myopic reward focus.

Researchers have also come to similar findings in a study examining the relationship between DM and problems related to substance use (Philip & Correia, 2010). This study examined substance-use behaviors and DM in a sample of meditation-naïve college students. Self-reported levels of DM offered significant predictive validity in identifying drinkers with a greater likelihood of having alcohol-related problems. Specifically, participants' higher reported levels of DM were correlated with lesser frequency of problems, even after controlling for amount and frequency of drinking and the Big Five personality traits.

In another recent study, Way, Creswell, Eisenberger, and Lieberman (2010) also examined DM in college students. The investigators measured neural activity to determine the relationship between DM and depression. Areas of the brain related to depressive

symptomatology (the right amygdala, in particular) responded oppositely in regard to depression and mindfulness. Participants with lower resting amygdala activity tended to be higher in mindfulness and lower in depressive symptoms, with the reverse being true for participants with higher resting amygdala activity. The authors posited that this relationship may be a result of the amygdala's involvement in attention. The amygdala has many cortical connections and serves to direct attention between processing various stimuli with the aim of guiding one's focus towards the most "emotionally relevant stimuli" (p. 20). In processing emotional information, participants with greater resting activity in the amygdala seem to be induced into a state of hypervigilance such that they are more likely to perceive and orient towards negative stimuli. Thus, the authors stated that the lower levels of amygdalar activity may result in a "less biased and broader attentional stance," leading to "a greater proclivity to engage in an open and receptive attentional style" (p. 21). They also suggested that some amount of plasticity may exist such that increases in mindfulness may eventuate decreased resting activity in the amygdala.

Mindfulness and Attention

As noted by Way and colleagues (2010), there seems to be a measurable relationship between DM and attentional focus, which may account for some benefits found in those higher in mindfulness, as discussed earlier. Brown and Ryan (2003) described attention and awareness as enhanced by mindful practices, and a "core characteristic," of mindfulness (p. 822). Attention, not unlike mindfulness, has itself been a rather elusive term. As Mirsky (1996) noted, "…the construct of attention as studied in neuropsychology is multidimensional and can refer to alertness, arousal, selectivity or focus—execution, encoding, sustained attention, distractibility, or span of apprehension, among others" (p. 78). It is not adequate merely to assume that DM comprises a particular amount or level of attention; rather, it is necessary to characterize the

attention qualities that DM affects. Although most individuals possess the ability to notice or be observe salient stimuli, experienced meditators and specifically those with mindfulness meditation experience, have shown greater selectively with regard to abilities to attend to information in a purposeful and efficient manner. Mindfulness training encourages development of one's ability to monitor internal and external states (sustained attention) and has been associated with increased ability to focus purposefully on stimuli that may otherwise go unnoticed (distractibility). Supporting this notion, individuals with attentional difficulties such as attention deficit hyperactivity disorder have been found to have lower levels of dispositional mindfulness (Smally et al., 2009). One would expect highly mindful individuals to be capable of using their attentional abilities to affect their behavior, particularly with regard to inhibition of automatic responses in favor of purposeful action/acting with awareness, selectively switching between different objects of attention (also called set-switching, a description of redirecting attention to different aspects of a stimulus; (Rushworth, Passingham, & Nobre, 2005). Thus, it may be appropriate to assume that DM involves a type of attention that is characterized by the ability to engage in tasks of sustained attention, to resist distraction when purposefully focusing by inhibiting responses to distracters, and to be able purposefully to select and switch between which stimuli one chooses. These assumptions have recently begun to be tested by several researchers.

For example, Hodgins and Adair (2010) compared meditators to non-meditators on measures of attention. Subjects completed the flickering task (Rensink, O'Regan, & Clark, 1997) to measure change blindness, the gorilla video task to measure sustained inattentional blindness (Simons & Chabris, 1999), an ambiguous image perspective-switching task to measure perspective-shifting ability, and the selective attention task (Posner, 1980) to measure ability to

focus processing on specified stimuli. The investigators hypothesized that participants with meditation experience would demonstrate greater skill and flexibility in attention involving visual perceptual processing on each measure. On certain measures of visual attention and flexibility, particularly the flickering task, the selective attention task, and the ambiguous image task, meditators demonstrated significant differences in performance. More specifically, investigators found that meditators were able to detect a greater number of changes and to detect changes with a greater speed. Meditators were also able to identify a larger breadth of perspectives in images with multiple perspectives, and were less affected by invalid cuing during the selective attention task.

Semple (2010) conducted an experiment in which randomly assigned individuals either practiced MBM, progressive muscle relaxation, or were wait-listed. The individuals assigned to the MBM group's responses on self-report measures indicated significantly larger improvements between pre- and post-tests on a measure of sustained attention (Continuous Performance Task; Rosvold et al., 1956) than either of the other two groups. Although similar results were not found on other measures of attention used (a digit symbol task and the Stroop Color-Word Test), MBM seemed to uniquely benefit qualities of attention beyond the effects of relaxation alone.

Giommi et al. (2001) studied 25 individuals diagnosed with anxiety and mood disorders and compared MBM training with psychoeducation and investigated related attentional processes using a neuropsychological battery. The investigators assigned participants to receive either MBM training or psychoeducation. Each group was also monitored by investigators using electroencephalography and clinical psychiatric rating scales as well as the neuropsychological battery. For the purposes of measuring attention, the investigators used the Stroop Color-Word Test and the Continuous Performance Test. The investigators also used the Trail-making Test

part B, WISC-Mazes, and Test Digit Symbol Substitution Task to measure sensorimotor and cognitive functioning. Of the neuropsychological variables, subjects' performance on the Stroop Test, Digit Symbol Task, Continuous Performance Test, and Trail-Making Test part B showed significant pre-to-post improvement in the MBM group whereas only the Continuous Performance Test demonstrated significant improvement within the psychoeducational group. These results indicated the presence of higher levels of sustained attention, set-switching, and inhibition/selectivity in those participants trained in MBM.

In a study to examine the ability of self-report measures to correlate with behavioral measures of attention, Schmertz, Anderson, and Robins (2009) administered three self-report mindfulness measures and two measures of attention to a sample of mindfulness-naïve undergraduates (thus, measuring DM). The Continuous Performance Test II (CPT-II; Conners, 2002) and the Paced Auditory Serial Addition Test (Gronwall & Sampson, 1974) were used to assess attention behaviorally. Investigators used three self-report measures to assess mindfulness: The Mindful Attention Awareness Scale (MAAS; Brown & Ryan, 2003); Kentucky Inventory of Mindfulness Skills (Baer et al., 2004); and the Cognitive and Affective Mindfulness Scale—Revised (CAMS-R; Feldman et al., 2007). The authors found associations between target omissions on the CPT-II (indicating the presence of higher sustained attention and inhibition) and the MAAS and CAMS-R. Despite this association, predicted correlations between mindfulness and facets of attention were not found on other scales of the CPT-II nor the PASAT, and the KIMS was not related to any measures of attention. Thus, the authors concluded that the study demonstrated "mixed support for the relation between self-report mindfulness and sustained attention…" (p. 65).

Taken together, these studies offer multiple findings of positive correlations between MBM, DM, and measures of sustained attention, inhibition, and set-switching. Although these findings indicate that mindfulness may play a role in attentional processes, none of the studies were able completely to meet their hypotheses regarding attention, and findings were mixed. To this point, very few studies have examined the relationship specifically between DM and attention, further raising the question of how accurately measured mindfulness relates to proposed correlates.

Measuring Mindfulness

Grossman (2008) offered an in-depth discussion of problematic issues encountered in the measurement of mindfulness (as opposed to using MBM as a treatment and using treatment outcome variables as evidence that mindfulness was responsible for observed changes). Notable concerns in measuring mindfulness are in the areas of semantics (i.e., differing understandings among respondents of what it means to "pay attention"), definitions (different authors define mindfulness differently), biases of developers (some developers are known predominantly within a particular theoretical orientation and conceptualize mindfulness in a similar manner), and problems of self-report (Hawthorne effect, social desirability, etc.). Essentially, much of the current difficulty in measuring mindfulness stems from problems of defining mindfulness and its constructs, as well as differentiating between measuring actual mindful qualities versus one's ability to describe and report these qualities.

To understand better the role of attention in mindfulness and to ensure that the current measures of mindfulness indeed measure the type of attention they purport, it may be of use to compare measures of mindfulness to behavioral measures, as has been done in recent attentional work (e.g., Schmertz et al., 2009; Semple, 2010). In the case of MBM, this research will ensure

that some other quality germane to the act of meditation (e.g., breathing changes, relaxation, effects of diligent practice and skill building) does not better account for the benefits noted in highly mindful individuals than the generally described goals of meditation (increasing awareness, nonjudgmental present focus, etc.). In the case of DM, examining behavioral correlates of mindfulness is necessary to clarify further the similarities and differences between DM and mindfulness garnered through MBM, as well as validate current self-report techniques and further define DM.

A number of self-report measures currently exists for the measurement of mindfulness. However, they offer differential utility in measuring DM. Baer et al. (2006) summarized and compared measures of mindfulness in terms of their psychometric properties. The Freiburg Mindfulness Inventory (FMI; Buchheld, Grossman, & Walach, 2001) measures nonjudgmental present-moment observation and openness to negative experience. The authors of the FMI developed the scale for usage in an intensive MBM treatment setting and it is interpreted unidimensionally. The authors reported an internal consistency of .93. The measure is useful in assessing increases in mindfulness due to meditation (Walach et al., 2005). However, it was not developed for DM measurement.

The MAAS (Brown & Ryan, 2003) is a unifactorial measure that assesses daily attention and awareness. It has an internal consistency as .82, and test-retest reliability as .81 (intraclass correlation). The MAAS correlates modestly with the NEO-PI (.18, $p < .01$) and moderately with other measures of mindfulness such as the MMS (.33, $p < .001$; Bodner & Langer, 2001). The MAAS has been used in MBM programs and more recently in DM studies (Lackey et al., 2007). The MAAS has been found to be positively correlated with openness, emotional intelligence, and well-being.

A third assessment tool, the Kentucky Inventory of Mindfulness Skills (KIMS; Baer et al., 2004) measures DM without relation to MBM. The KIMS was released in very close temporal proximity with the MAAS and is notable for its measurement of mindfulness as an attribute rather than a meditation-related skill set. The KIMS has a four factor design measuring observing, describing, acting with awareness, and accepting without judgment. Each of the scale's measures is interpreted separately with good internal consistencies ranging from .76 to .91. The measure has been used with individuals with borderline personality disorder and college students (Baer et al., 2006).

Measuring Attention

As noted earlier, a variety of measures have been used to measure attention related to mindfulness. The Conners' Continuous Performance Task-II (CCPT II; Conners, 2002) is a computerized test designed to measure subjects' ability to maintain vigilance and either react or inhibit reaction in response to stimuli presented continuously stimuli (sustained attention and inhibition). According to the CCPT-II technical manual, the CCPT-II was standardized using a database of 2,686 clinical and non-clinical subjects and includes validity checks for invalid response styles. The task is suitable for use in both clinical and research settings. In a single administration (proceeding a practice administration) the CCPT-II program prompts participants to press the spacebar whenever they see a letter other than "X." Over the course of the 14-minute task, the program collects information about response times and errors (both omission and commission), yielding data that include information on perseverations, changes in reaction time and accuracy over time, and changes in reaction time across different inter-stimulus intervals. Extensive information regarding the test's psychometric properties is offered in the technical manual for each facet measured by the CCPT-II. The split-half reliability of the CCPT-

II outcome measures range from .66 to .95. Test-retest coefficients range from .08 to .92, with the majority of coefficients at .60 or higher. The CCPT-II has been used in a number of mindfulness studies (e.g., Schmertz et al., 2009; Semple, 2010).

The Delis-Kaplan Executive Function Scale (D-KEFS) comprises nine tests designed to measure components of high-level functioning such as cognitive flexibility and shifting, inhibition of learned responses, and problem solving ability (Delis, Kaplan, & Kramer, 2001). The D-KEFS has been standardized on a large (N=1,750) U.S. representative sample of both adult and child populations with all but one subtest being suitable for individual administration age ranges of 8-89. The D-KEFS manual describes the following nine tests as suitable for stand-alone or integrative usage: Trail Making Test, Verbal Fluency Test, Design Fluency Test, Color-Word Interference Test, Sorting Test, Twenty Questions Test, Word Context Test, Tower Test, and Proverb Test. Statistical data vary from test to test and each test has several subtests for which information is also available in the K-DEFS manual. As most of the subtests produce practice effects, test-retest scores are varied. For example, primary test scores range from a low of 0.36 to a high of 0.86. The D-KEFS tests have been used extensively both in those with impaired and intact attentional and general cognitive functioning (e.g., Lopez, Lincoln, Ozonoff, & Lai 2005; Wodka et al., 2008; Wecker, Kramer, Hallam, & Delis, 2005). In a review of the D-KEFS, Homack, Lee, and Riccio (2005) described the test as statistically adequate and useful for systematic evaluations of executive functioning (including inhibition and other forms of attention) in multiple testing conditions, both in applied and research settings. Tests from the D-KEFS have been used in mindfulness and attention research as well as measures of inhibition, set-switching, and general processing speed (e.g., Schmertz, 2006).

The Stroop Color and Word Test (Golden & Freshwater, 2002) measures cognitive inhibition abilities and flexibility. In completing the test, participants first read the names of colors printed on a page in black ink, then view columns consisting of the repeated string "XXXX" printed in different colors, and then report the color in which the rows of "XXXX" are printed. Finally, participants read a page of color names printed in colors that do not match the word (for example, "RED" may be printed in green ink). The speed at which the participants are able to read the words or colors on the pages accurately determines their score, with lower scores, particularly on the final page, indicating greater ability to avoid cognitive interference. The task has been used extensively in psychological research with both clinical and non-clinical populations, with versions suitable for both children and adults (e.g., Van der Elst, Van Boxtel, Van Breukelen, & Jolles, 2006; Seo et al., 2008). The Stroop Color and Word Test has demonstrated test-retest reliability coefficients from 0.69 to 0.86 and has been used in studies of mindfulness and attention as a measure of inhibition (Semple, 2010).

Thus far, there have been mixed findings regarding measures of attention correlating with mindfulness in a predictable manner (e.g., Hodgins & Adair, 2010; Semple, 2010; Schmertz et al., 2009). Although not published in a peer-reviewed journal, a 2006 Master's thesis produced by Schmertz combined one of the largest number of measures of attention (including the CCPT-II, a Stroop test, and the D-KEFS Color-Word Interference Test) and mindfulness (including the MAAS and the KIMS). Schmertz's goal was to validate self-report measures of mindfulness on the tenet that mindfulness research has suggested that MBM leads to increases in attentional abilities (and thus individuals with higher scores on measures of DM should also score higher on measures of related forms of attention). All of the measures were given to 51 largely meditation-naïve undergraduates, and their scores on the mindfulness measures ranged quite widely (e.g., on

the MAAS, participants' scores ranged from 36 to 69 with a mean of 55 and an SD of 9.36). Although the study found some evidence indicating that self-reported DM may be related to attention (eg., fewer target omissions on the CCPT-II were positively correlated with lower mindfulness scores on the MAAS), the findings were limited in that a number of expected correlations were not supported (e.g., mindfulness scores were unrelated to reaction time/sustained attention on tasks such as the CCPT-II, the mindfulness construct of "acting with awareness" on the KIMS was not significantly related to target omissions on the CCPT-II, and the Color-Word Interference test failed to reach significant levels of association on any the measures of mindfulness). Schmertz was neither able to support nor reject completely the potential validity of the measures of DM and the proposed relationship among mindfulness and sustained, selective/inhibition, and set-switching features of attention.

Current Study

The present study sought to determine the nature and extent of the relationship between DM and measures of attention (sustained attention, selectivity/inhibition, and set-switching) in college students. As noted, the current literature does not allow for a firm hypothesis on the nature of relationship between mindfulness and attention as findings have been mixed. However, the primary hypothesis was that there would be positive relationships between measures of sustained and selective/switching abilities of attention and measures of DM. More specifically, the investigator expected that aspects of the CCPT-II (faster reaction time and lower error scores), the D-KEFS Trail Making Task (faster completion time), the D-KEFS Color-Word Interference test (faster completion and lower error scores), would vary as a function of mindfulness levels as measured by the MAAS and KIMS. Similarly to work by Schmertz et al., (2009), the expectation was that connections would emerge between attentional performance and

MAAS scores, such that students assessed as having higher levels of DM would score in the higher ranges of attentional focus and shifting. This research builds upon Schmertz's original study (2006) in that it could increase the ability to detect differences by including in the participant sample only those participants that fall within the upper and lower-most quartiles of mindfulness scores (as established by a representative sample of 479 undergraduates in Philip & Correia, 2010). Participants completed the mindfulness measures and demographic information during a separate pre-screening and the single-session laboratory study of attention was limited to just three measures. By separating the completion of measures and limiting the time required to complete multiple measures of attention, a "purer" estimate of attentional abilities could theoretically be obtained, as there should be less mental fatigue and other by-products of extended task-demands.

Methods

Participants

Participants were Auburn University undergraduates age 19 or older enrolled in psychology courses during the Fall 2011 and Spring 2012 semesters. Of the 793 pre-screened participants who completed the online pre-screener, 419 subjects fell within the upper and lower quartiles of MAAS scores and were invited to complete a laboratory-based task to measure attention. Participants were compensated for their involvement in the study with psychology course research credit. Participants with substantial (bi-weekly or more) meditation experience were excluded to ensure that the dispositional quality of the mindfulness measured.

Study design

Procedure and Measures All participants completed an online pre-screener survey consisting of questions about demographic variables including questions about Attention-Deficit/Hyperactivity Disorder, motor abilities, and ability to see colors. These issues may have the potential to confound performance on attentional tasks, and assessing these variables allowed for statistical control should subjects exhibit abnormal performance. Pre-screener participants also completed two surveys about mindfulness (MAAS & KIMS). Participants who had MAAS scores at or below 3.20 (low-mindfulness group) and at or above 4.20 (high-mindfulness group) were invited back via e-mail to complete a laboratory-based component. None of the participants were informed of their MAAS scores, in which grouping they were placed, or that they had been grouped at all.

All participants in the two groups completed the same three measures of attention and reviewed informed consent materials in the laboratory. The order of the measures was counterbalanced to avoid artifacts related to order of presentation. Trained research assistants blind to the purpose of the research and unaware of the mindfulness grouping of the participants administered the tasks. The double-blind nature of the study provided for minimization potential experimenter bias and response-bias based on knowledge of mindfulness grouping or expected task performance. Each participant completed the attentional tasks individually and in a quiet laboratory room to minimize distractions. Prior to administration of the tasks, participants silenced and stowed their cell phones/devices and had the opportunity to visit the restroom to minimize disruptions during the testing procedures. Research assistants administered both D-KEFS measures directly (face-to-face) to the participants. During the CCPT-II participants were led to an adjoining room where they were read instructions by the research assistant, completed a brief practice trail to ensure proper understanding of CCPT-II instructions, and were left alone to complete the computer task. Research assistants informed participants that they would be monitored via a small closed-circuit camera placed discretely behind them. To record any grossly observable behaviors that may have interfered with CCPT-II performance (e.g., engaging in non-task related behaviors such as looking at a cellular phone or moving about the room), the camera was monitored in real-time by the research assistant. The entire laboratory procedure typically lasted 40 minutes or less, and at the conclusion of each session the research assistant debriefed the subject and solicited information about the participant's experience (e.g., if they had a headache, felt they were uncomfortable, or had difficulty focusing during any of the tasks) which was recorded along with the CCPT-II observations.

Mindfulness. The MAAS was used in order to draw comparisons with earlier research examining dispositional mindfulness (e.g., Lakey et al., 2007; Schmertz, 2006). As noted, although the MAAS is reported to survey several variables related to mindfulness (mindful observation, letting go, nonaversion, and nonjudgment), it is best utilized as a unifactorial measure. The 15-item measure is scored on a 6-point Likert-scale (*1 = Almost Always*, *6 = Almost Never*).

Attention. The Conners' Continuous Performance Test II (computerized) was used to measure sustained attention. This test consists of multiple blocks comprising sub-blocks with varying inter-stimulus intervals. The stimuli are letters presented on a computer screen, with the participant's objective being to press a key whenever a letter other than "X" appears. The test includes one trial session to ensure the subject understands the instructions and response technique. Following the practice trial, the blocks of letters present one-by-one on the screen over the span of 14 minutes. Scores are computer-generated and measure response time, change in reaction time, overall speed and consistency, signal detection, and errors of omission and commission. As discussed earlier, the test has been used with similar populations and experimental designs, and offers several outcome measures with which mindfulness may be compared. As recommended in the CCPT-II administration guide (Conners, 2002), participants were observed while completing the task to ensure grossly observable intrusions that could invalidate test performance could accounted for (e.g., coughing fits, incorrect response methods/noncompliance with administration instructions).

The D-KEFS Trail Making Test, a revised portion of the original Halstead-Reitan Battery (TMT-B; Reitan & Davison, 1974), was used to measure flexibility of attention, set-switching (changing the method one uses for selecting responses) and inhibition of otherwise automatic

responses. The Trail Making Test is a pen and paper task involving five conditions: Visual Scanning, Number Sequencing, Letter Sequencing, Number-Letter Switching, and Motor Speed. The Number-Letter Switching task is the primary measure of cognitive flexibility, with the remaining four tasks being measures of the basic skills needed for completion of that primary task. The Number-Letter Switching task requires participants to draw a line connecting 17 numbers and 17 letters scattered across a page in sequential order as quickly and correctly as possible (such that one draws a line connecting 1 to A, then to 2, then B, then 3 to C, and so forth). The subject must effectively switch his or her search parameter back and forth from numbers to letters while maintaining the correct sequence. Participants' time of completion is recorded, with lower times indicating higher performance.

The D-KEFS Color-Word Interference Test is similar to the Stroop Color Interference test (Golden & Freshwater, 2002); however, the D-KEFS Color-Word Interference Test provides the additional benefit of inhibition/switching over the Stroop's primary utility as an inhibition task. The Color-Word Interference test consists of four conditions: Color Naming, Word Reading, Inhibition, and Inhibition/Switching. Similarly to the D-KEFS Trail Making Test, the Inhibition/Switching task is the primary task with the preceding three conditions being component measures of skills needed to complete the task. The Inhibition/Switching task requires the test-taker to name the color of ink used to print the names of different colors if a box surrounds the word; however, if the word is not inside of a box, the participant is to switch his or her response and read the word, rather than the color of the ink. The Inhibition task, which only asks participants to say the color of the ink the letters are printed on (and inhibit reading the word) is administered prior to the Inhibition/Switching task, providing the ability to forgo the Inhibition/Switching task if the participant is unable to complete the inhibition task (or any other

component task). Lower time to completion is considered higher performance, and error analysis (corrected versus uncorrected errors) is also available as a measure of accuracy.

Results

Of the 793 participants who completed the online mindfulness pre-screener, the investigator invited 419 to complete the laboratory portion to measure attention with 33% accepting the invitation and scheduling sessions. Attentional data was gathered on the 137 laboratory participants, matched to their pre-screener mindfulness responses, and entered into SPSS. The investigator examined the data for univariate outliers on the subscales of attention, detailed below in Table 1.

Table 1
Measures, subscales, and abbreviations of attentional measures

Measure	Subscale	Abbreviation
CCPT-II	Hit Reaction Time Block Change	HITRTBL
CCPT-II	Omission errors	OMIS
CCPT-II	Commission errors	COMIS
D-KEFS Trail Making Test	Number-Letter Switching Standard Score	TMSS
D-KEFS Trail Making Test	Number-Letter Switching Standard Score Error	TMSSe
D-KEFS Color-Word Interference	Inhibition/Switching Standard Score	COL4SS
D-KEFS Color-Word Interference	Inhibition/Switching Error	COLeSS4

An outlier was determined to be any value that was 3.29 standard deviations from the mean (Stevens, 2009). One value was removed from HITRT, five from OMIS, one from

COMIS, two from TMSS, one from TMSSe, one from COL4SS, and two from COLeSS4, for a total of 13 univariate outliers removed.

The investigator conducted analyses to see if attention differed as a function of DM. More specifically, DM as measured with the MAAS served as the independent variable (upper quartile versus lower quartile) and each measure of attention served as the dependent variable. Analyses included the following attention measures: CCPT-II Omission and Commission scores, and Hit Reaction Time Block Change (inhibition/selectivity and sustained attention, respectively), the D-KEFS Trail Making Number-Letter Switching Completion Time & Error Score (inhibition/selectivity and set-switching), and the D-KEFS Color-Word Interference Test Inhibition/Switching Completion Time and Error Score (inhibition/selectivity and set-switching). Because the analysis calls for a MANOVA, multivariate outliers were also examined for by way of Mahalanobis distances. With seven total variables, the critical value was determined to be χ^2 (7) = 24.32 at p = .001 (Tabachnick & Fidell, 2006). No multivariate outliers had to be removed. Normality was assessed for via Q-Q plots of normality. Only slight deviations in normality occurred, which have little effect on Type I error when there are more than 20 participants per group are present (Pallant, 2007).

The investigator employed descriptive statistics to characterize the sample in terms of demographics, attention, and DM. Most of the participants in the study were female (95, 69%) and white (111, 81%). Participants ranged in college grade level, with the largest group being seniors (47, 34%) followed by sophomores (36, 26%). Most of the participants lived off campus in a house or apartment (104, 76%). Of the 137 participants, 28 carry diagnoses of ADHD, of which eight did not take medication (6%) and the other 20 do (15%). Only five participants reported diagnoses of colorblindness (4%) and only two participants had difficulty moving their

arms, hands, or fingers (2%). A slight majority of the participants were in the lower quartile mindfulness group (MAAS score of 3.20 or less, N=73, 53%) with 64 participants comprising the high mindfulness group (MAAS score of 4.20 or above). Frequencies and percentages for the participant demographics are presented in Table 1.

Participants' ages ranged from 19 years old to 48 years old. The average age of the participants was 20.79 years old (*SD* = 2.87). High school GPA for the participants ranged from 2.00 to 4.50. The average high school GPA was 3.63 (*SD* = 0.40). College GPA ranged from 0.83 to 4.00. The average college GPA was 3.09 (*SD* = 0.57). Means and standard deviations for participant characteristics are presented in Table 2.

The seven variables of attention were examined. HITRTBL ranged from 27.16 to 67.23. (*M* = 47.92, *SD* = 7.54). OMIS ranged from 20.79 to 69.35 (*M* = 46.50, *SD* = 5.39). COMIS ranged from 31.60 to 75.25 (*M* = 52.17, *SD* = 9.97). TMSS ranged from 3 to 14 (*M* = 9.54, *SD* = 2.36). TMSSe ranged from 6 to 12 (*M* = 10.82, *SD* = 1.64). COL4SS ranged from 1 to 15 (*M* = 11.13, *SD* = 2.39). COLeSS4 ranged from 4 to 13 (*M* = 10.45, *SD* = 2.00). Means and standard deviations for the seven variables of interest are presented in Table 3.

As part of checking the assumptions for the MANOVA, preliminary correlations assessed for the relationships between the variables of attention. The correlation matrix (see Table 4) showed that OMIS scores were significantly positively correlated with COMIS scores, r (129) = .22, p = .012, suggesting that as OMIS scores increased, COMIS scores also tended to increase. TMSS scores were also significantly positively correlated with COL4SS scores, r (132) = .26, p = .003, and TMSSe scores, r (132) = .50, $p < .001$, suggesting that as TMSS scores increased, COL4SS and TMSSe scores also tended to increase. COL4SS scores were significantly positively correlated with COLeSS4 scores, r (132) = .37, $p < .001$, suggesting that as COL4SS

scores increased, COLeSS4 scores also tended to increase. TMSSe scores were significantly positively correlated with COLeSS4 scores, r (132) = .39, $p < .001$, suggesting that as TMSSe scores increased, COLeSS4 scores also tended to increase. Even though there were significant correlations among the variables of attention, none of the variables were correlated at the .80 or .90 level to suggest multicollinearity issues with the MANOVA, and thus all seven variables were used.

The investigator examined demographic variables for potential inclusion as covariates for the MANOVA. A set of preliminary MANOVAs assessed if the dependent variables (HITRTBL, OMIS, COMIS, TMSS, TMSSe, COL4SS, and COLeSS4) were significantly different by sex, race, education, ADHD status, and residence. Race was dichotomized into white vs. other, ADHD was dichotomized into diagnosed vs. not diagnosed, and residence was dichotomized into off campus or apartment vs. other. Results showed that the dependent variables were significant different by race (F (7, 117 = 2.25, p = .035) and by residence (F (7, 117) = 2.58, p = .017). Therefore, race and residence were used as covariates in the MANOVA, which is now a MANCOVA.

Correlations assessed if age, high school GPA, and college GPA should be used as covariates. Age was significantly negatively correlated with HITRTBL (r (133) = -.24). High school GPA was positively correlated with TMSS (r (132) = .18, p = .034), COL4SS (r (133) = .23, p = .009) and COLeSS4 (r (132) = .23, p = .007). College GPA was positively correlated with COLeSS4 (r (122) = .19, p = .034). Whereas there were significant correlations among the demographics variables and the measures of attention, the majority of the correlations (76%) were not significant, and thus age, high school GPA and college GPA were not used as covariates in the final MANCOVA.

A MANCOVA to assessed if the seven variables of attention (HITRTBL, OMIS, COMIS, TMSS, TMSSe, COL4SS, and COLeSS4) were significantly different by group (low mindfulness vs. high mindfulness), with race and place of residency included as covariates. A Box's M test assessed the assumption of equality of covariance matrices. The result of the test was not significant, confirming that the assumption was met. Seven Levene's tests assessed the assumption of equality of variance. Only OMIS scores violated the assumption, and thus the investigator used a more stringent *p*-value of .025 in the univariate interpretation of the OMIS ANCOVA.

The results of the MANCOVA were significant, F (7, 115) = 3.18, p = .004, suggesting that there was a significant difference among the seven variables of attention by group. Univariate ANCOVAs assessed where the differences lie. OMIS scores were significantly different by group, F (1, 121) = 9.02, p = .003, and COMIS scores were significantly different by group, F (1, 121) = 11.81, p = .001. Although the OMIS had to use a more stringent *p*-value for significance, the ANCOVA still was determined to be significant. Comparisons of the means (see Table 5) showed that those with low mindfulness had significantly larger means for OMIS and COMIS than those with high mindfulness. Because the MANCOVA was significant even after adjusting for significant differences in attention by residence (see Table 4), the null hypothesis that there was no difference in attention variables by mindfulness group can be rejected in favor of the alternative hypothesis. Results of the MANCOVA and seven ANCOVAs are presented in Table 4. Means and standard deviations by group are presented in Table 5.

Discussion

The present study aimed to clarify the relationship between DM and behaviorally-measured attention. Results indicated mixed support for a predictive relationship between mindfulness and four forms of attention (sustained attention, selectivity/inhibition, and set-switching). As predicted, participants with DM scores in the highest quartile evidenced significantly stronger selectivity and inhibition abilities than those in the lowest quartile of DM. Lower scorers on the MAAS were more likely to miss responding to stimuli to which they were instructed respond. Similarly, low-mindfulness scorers were significantly more likely to respond in the presence of stimuli they should not have when compared to their highly mindful counterparts.

These findings support the notion that mindfulness involves the ability to respond selectively and in a goal-oriented fashion, as opposed to responding in a manner more aligned with habit or automatic (without purposeful intent) reactions to a particular circumstance (Brown, Ryan, & Creswell, 2007). This type of intentional responding may be why mindfulness has been described as a method for acting with awareness (Baer et. al, 2006), enabling highly mindful individuals to resist a "gut" or emotion-driven response in favor of a more deliberate action that may better serve their ultimate aim. In a review of judgment and decision making literature, Weber and Johnson (2009) discussed the role of selective attention in first identifying the need to make decisions within a field of other potential focal points. The authors also described selective attention as necessary to determine the appropriate decision making strategy

for deciding between continuous judgments or categorical choices. This selectivity seems to be a necessary first step in making purposeful choices, as encouraged in mindful practices.

The hypotheses that mindfulness would be significantly related to sustained attention and set-switching were not supported. This lack of support does not necessarily invalidate the supposition that these forms of attention have a role in mindfulness. It is possible that the primary measure of sustained attention, the CCPT-II, was not sufficiently sensitive to measure significant differences in this collegiate population. Supporting this possibility, mean reaction time scores for both high- and low-mindfulness groups both fell within the average range, indicating that the measure may not be optimal for teasing apart performance gradations within a non-clinical sample. Recent work has found that computerized tests of attention offer insufficient specificity in distinguishing between clinical and sub-clinical attentional disorders in children (Bloch et al., 2012), and specifically that the CCPT is not always able to detect differences in reaction time variability between ADHD and normal adults (Kovner, Budman, Frank, Sison, Lesser, & Halperin, 1998). Though lacking statistically significant predictive validity, scores of sustained attention in the present study were in the predicted direction with highly mindful participants exhibiting slightly faster reaction times across testing blocks. Huang-Pollock, Karalunas, Tam, & Moore (2012) have noted that items on the CCPT-II can be quite easily differentiated with regard to those which participants should and should not respond. Detecting differences in letters in order to decide whether to respond was likely an easier task for both groups than day-to-day events that may involve less discernible differences. For example, it may be unclear in the moment that screaming at an inconsiderate driver on the highway is less beneficial than allowing the angry emotion to pass, making mindful action quite difficult. In fact, the actor in a given scenario may be completely unaware that a decision exists at all

(Rapgay & Bystrisky, 2009). Conversely, when completing the CCPT-II, it is made explicitly clear to participants that there exists a correct and incorrect response, and exactly when and in the presence of which stimuli that response is to be made.

Regarding set-switching abilities, it is difficulty to account for the lack of significant findings . Similar to the CCPT-II, the Trail Making Test showed mean scores in the predicted direction (non-significantly) with fewer errors and shorter completion times in highly mindful participants. On the Color-Word Interference Test, participants in the low mindfulness group took slightly less time, on average, than those in the high mindfulness group, though in the process accumulated slightly more errors. Here, response style may play a role in test scores. Highly mindful individuals may have answered more carefully, taking more time to navigate tasks in order to make fewer errors. Less mindful participants may have also exercised well-intentioned caution in completing the task, but did so ineffectively without reducing the number of errors due to their poorer attention. With regard to set-switching, differences accounted for by these response styles may result in a watering-down effect wherein attention to accuracy results in mindful scorers completing the tasks as slowly as their less cognitively skilled counterparts, resulting in similar outcomes. Although possible, this hypothesis contradicts van Vugt and Jha's 2011 findings that MBM results in reliably *faster* response times on tasks of working memory. As noted, however, the extent to which MBM can be related to DM as measured in the present study remains unclear.

Another interestingly absent finding concerns errors on the Color-Word Interference test. Both the Color-Word Interference test and the CCPT-II require an individual to inhibit a learned response in favor of a response demanded by the task. Despite this similarity, only the CCPT-II revealed significantly different rates of errors by mindfulness grouping. This difference may be

due to artificiality and recency of the CCPT-II demands versus the more distally learned abilities measured by the Color-Word Interference test. Respondents likely learned how to name colors and read the names of colors years ago, whereas pressing a key when the letter X is presented on the CCPT-II is a less ingrained ability as the participants are unlikely to have done so ever before. As such, it is possible that DM levels are influential at the level of inhibiting superficial response tendencies such as pressing a button when a letter appears on a screen, but less able to inhibit longer-standing responses of naming colors or reading words. Elliot and Raymond (1999) measured responses in different types of matching tasks and suggested that inhibiting a response to familiar stimuli involves an "additional processing stage" in comparison to responses based on unfamiliar stimuli (p. 5070). Past work has also demonstrated that unfamiliar tasks differ from learned skill-based tasks at the cortical level, with specifically different brain regions activated in the respective task types (Petersen, van Mier, Fiez, & Raichle, 1998). This anatomic distinction may point towards a functional difference in how seemingly similar tests may have differing levels of demands based on the novelty of the test. When coupled with more familiar stimuli that require an additional processing load, it seems plausible that inhibiting a familiar response of naming colors is quite demanding in comparison to the novelty of inhibiting responses to arbitrarily response-matched letters.

Certain demographic features correlated with attention. However, these correlations were sparse and unpredictable across the attentional variables, and thus unlikely to have influenced the main findings of the study. This lack of significance was not surprising given the relatively homogenous student population and prerequisite that participants all score within the two main grouping variables.

The inability to broadly and completely support the relationship between mindfulness and attention is similar to results of past research. As discussed earlier, Schmertz (2006) found mixed evidence supporting a relationship between self-reported DM and selectivity, although the author was unable to support relationships between DM and set-switching. Hodgins and Adair (2010) revealed a relationship between meditation experience and selectivity as well, along with set-switching, but findings were again mixed and not specific to DM. Semple's 2012 findings suggested that MBM was able to improve sustained attention, but not inhibition. Giommi et al., (2001) findings remain the most robust with regard to finding relationships between attention and mindfulness, supporting significant correlations between sustained attention, set-switching, and inhibition/selectivity in individuals trained in MBM. Although notable, Giommi's work included just 25 participants and did not actually measure DM or whether MBM practice increased measurable levels of mindfulness, rendering the results only hypothetically related to the actual construct of mindfulness.

Galla, Hale, Shrestha, Loo, and Smalley (2012) also examined self-report mindfulness and attention using an earlier version of the CCPT-II (CCPT: Conners, 1994), and a form of the Stroop test (Golden, 1978) similar to the D-KEFS Color Word Interference Test. As with previously published work, the investigators showed mixed relationships between certain aspects of mindfulness (mindful observation) and attentional features of sustained attention and inhibition and set-switching, but not for other aspects of mindfulness (acting with awareness) that had been found in other studies (e.g., Josefsson & Browberg, 2010; Moore & Malinowski, 2009) and predicted to be significant. These findings raise notable questions about whether mindfulness as a whole can be discussed as related to attention, or whether it is only certain

facets of mindfulness (e.g., observing/awareness). It is also unclear exactly why findings even within the same domain of mindfulness have been inconsistent with regard to specific findings.

There have been notable advancements that offer encouraging data to suggest a relationship between attention and mindfulness exist (e.g., van der Oord, Bogels, & Peijnenburg, 2012). Although various authors have discussed attention as an inherent and major component of mindfulness (e.g., Brown & Ryan, 2003), there seems to have been relatively little investigation demonstrating that existing measures of mindfulness are actually correlated with measures of attention. Previously described research has demonstrated some support that mindfulness is related to certain measured attentional abilities (e.g., Schmertz, 2006). However, unlike these previous studies, the current study utilized a pre-assessment mindfulness grouping when measuring attention in an attempt to enhance statistical detection of significant relationships. The present study appears to have been the only study to utilize a double-blind approach to minimize experimenter and responder biases.

Taken together, the present study and earlier attention studies indicate that mindfulness may be most related to selectivity, inhibition, and set-switching. Caution must be taken, however, in interpreting these findings as even consistency among studies may be considered preliminary at best. None of the previous research, including the present study, have completely replicated one another. Given the varied differences in measures of attention, mindfulness, samples, and designs, it remains difficult to draw broad or general conclusions. Nonetheless, it is encouraging that each study discussed thus far has demonstrated significant correlations between attention and mindfulness, suggesting that there is indeed a measurable relationship.

Limitations

A major limitation of the present study was its use of self-report as the only measure of mindfulness. As discussed by Thompson and Waltz (2007), it remains unclear whether traditional MBM is the same as or similar to DM, and whether MBM (as measured by self-report) actually increases mindfulness outside of the meditation. The MAAS is also a unifactorial measure of mindfulness, and may lack the specificity to show clear relationships between facets of DM and specific forms of attention as detected by Galla and colleagues (2012) using the KIMS. If mindfulness must be measured as a small collection of constructs independently related to attention, it may bring us back to larger questions of what mindfulness is, and if it would be more accurate to avoid using an "umbrella term" when describing such different abilities.

Another limiting factor in the generalizability of the current findings is noted in Grossman's 2008 criticism of the varied types of attention used by researchers. Whereas the present study sought to encompass forms of specific attention used by previous mindfulness researchers, previous studies used slightly different verbiage (e.g., "executive attention," "attentional control," "self-regulation," "cognitive skills"). Although the use of multiple terms to describe similar or perhaps the same constructs is not unique to mindfulness (e.g., Castet, 2012; Lundy & Mason, 1994; McConkey, 2006), it is especially problematic given the relative paucity of research in this domain.

Along with varied descriptors of attention, there has also been variability in the tasks used to measure attention. For example, though many of the studies discussed earlier used a form of the Stroop task, some were computerized, others administered by a researcher (as in the present study), and overall, were different tasks that may measure slightly different abilities.

Highlighting this measurement issue, numerous researchers have found little, and at times no convergence, among multiple versions of Stroop tasks despite measuring the same phenomenon (e.g., Quero, S., Baños, R. M., & Botella, C., 2000; Ries 1997; Kindt, Merel, Bierman, & Brosschot, 1996). In a comparison study of eight different forms of the continuous performance task (the basis of the CCPT-II), Borgaro (1999) found poor convergence between the errors detected by the tasks. The author suggested that different forms of the CPT may not measure the same attentional processes driving the detected errors. These types of issues are likely to have played a role in the incongruence between investigations of mindful attention as well.

As noted earlier in this discussion, all of the participants in the present study were college students. Although this was important as the original sample used to determine mindfulness cut scores for the grouping variable was also college students, it may have limited the ability to explore differences between levels of mindfulness. For example, by the nature of their active participation in the academic process, students may not represent individuals suffering from particularly debilitating types of attentional problems (e.g., failing to fulfill personal and scholastic obligations). Indeed, although ADHD status was measured, it was not a significant contributor to performance. Students with various types of difficulties likely needed for academic success such as minor difficulty in sustained attention may have developed adequate compensatory mechanisms (Reis, McGuire, & Neu, 2004). For similar reasons related to the homogeneity of college students, the present sample may have lacked sufficient variations of mindfulness to adequately measure the complete range of possible MAAS scores. Though normed on a large sample of students at the same university, the upper quartile cut-scores used to determine the high-mindfulness grouping were slightly less than one standard deviation from the normative college sample reported by the measure's authors (Brown & Ryan, 2003). Another

limiting factor of the sample may be the strong representation of White females compared to males and other races, particularly as females are consistently found to have lower levels of non-mindful behaviors such as impulsivity and related deficits in attention (Hasson & Fine, 2012).

Treatment Implications

If replicable, the most clinically useful implication of the present study is the demonstration that mindfulness is positively correlated with one's ability to respond selectively in favor of the direction instructed, while inhibiting a learned response. Inhibitory abilities have been reported as particularly active in non-meditators able to act with awareness (a central component of mindfulness), and inhibition can promote psychological wellbeing by decreasing the influence of unwanted emotional reactions (Lee & Chao, 2012). Potentially, mindfulness training could be effective for individuals who lack these types of attentional qualities or exhibit behavior consistent with impulsivity. Previous work has already established a connection between DM and impulsivity (Peters, Erisman, Upton, Baer, & Roemer, 2011). In the case that MBM represents a unique skill somehow different from DM, the present findings highlight a link between DM and directly measurable and potentially adjustable behavior.

Acceptance and commitment therapy (ACT) represents a useful method of increasing awareness and related purposeful action as espoused by mindful traditions (Hayes, Pistorello, & Levin, 2012). ACT may prove useful in improving mindful attention without the requirement of meditation (particularly in the case that MBM is unrelated to DM as measured in the present study). ACT has been demonstrated as an effective technique for decreasing impulsive behavior such as substance abuse (Hayes et al., 2004) similar to the gains observed through traditional MBM (Witkiewitz, 2005). Alternatively, a reversed direction of influence may be possible wherein attention-boosting exercises may be useful in increasing overall levels of mindfulness.

Muraven, Baumeister, & Tice (1999) demonstrated the ability to build self-control strength through repeated tasks involving taxes on self-control resources (such as exercising regularly across time). Muraven and Baumeister (2000) have also found that self-control depletion in a particular area (such as vigilance) also results in depleted self-control in other areas such as eating (2000). These findings may be useful in attention in that they point towards the possibility that improving certain types of attention (such as tasks that require inhibition as described in the present study) may result in benefits that generalize to multiple related domains within mindful attention.

As the MAAS takes just minutes to administer, it may also have value as a brief screener. Specifically, it could be used to determine those individuals who may most benefit from MBM training in a much more time and cost-sensitive manner than administering the actual measures of attention correlated with MAAS scores. In a similar vein, the MAAS can be useful for measuring progress through a MBM program as well as other treatments that may be aimed at changing features related to DM. It is important to note, as discussed earlier, that DM and MBM are not yet clearly related. Therefore, the use of MBM or other programs to boost DM must be carefully evaluated.

Future Directions

More investigation is needed to definitively identify exactly what type of attention is related to DM. The current literature would be well-served by replication studies to clarify which attentional features are reliably correlated with mindfulness. Although identifying potential methodological flaws in previous research and rectifying them in subsequent investigations is clearly logical, this method is also limiting in that there is little opportunity to establish a foundation of even one or two verified types of attentional correlates upon which to

build. Increasingly apparent through the present and previous studies on mindfulness and attention, it is important to use the same measures of attention and forms of administration, and more generally to arrive at some consensus on what types of attention are measured by these tests.

Another useful direction to pursue would be to pursue the goal of a more behaviorally verified measure of mindful attention. Although the present study used three measures of standardized behavioral tasks to measure attention, there may be more naturalistic methods to measure attention. For example, measuring students' ability to read and accurately recall a passage on their laptop while an interesting website or video is available on the other side of the screen may be a useful measure of selectivity. Or in a more MBM-related example, one could ask meditators to press a key/counter every time their mind wanders from their breath during a breathing meditation as a measure of sustained attention.

Perhaps most informative (and onerous) would be a study that incorporated naturalistic forms of attentional abilities while also addressing the issue of measuring mindfulness and the relationship between MBM and DM. This "trifecta" study could take the form of administering the MAAS to a sample of participants, asking them to complete a traditional MBM course (e.g., Mindfulness-based Stress Reduction (MBSR): Kabat-Zinn, 1994), and re-administering the MAAS after completion to detect measurable improvements in mindfulness expected from MBM training. Concurrent with the pre- and post-test administrations of the MAAS, a behavioral measure of mindful attention such as one discussed above could be employed. This behavioral task could verify that expected increases in mindfulness also bring improvements in behaviors supposedly correlated with mindful attention. Regardless of particular methodology, it

seems that mindful interventions will continue to proliferate and increase in specificity and efficiency.

As with any rapidly growing phenomenon, it remains prudent to remain *mindful* of how much we still stand to learn about the relationship between mindfulness and its most core components. The present study has delineated a clear relationship between mindfulness and inhibition and set-switching. This contribution adds to a modest yet growing body of literature that supports the implication that specific aspects of attention are particularly active within the construct of mindfulness. Moreover, as we grapple with these core questions, we strengthen both DM and MBM as specific and sensitive methods with which to improve the human experience.

References

Anderson, N. D., Lau, M. A., Segal, Z. V., & Bishop, S. R. (2007). Mindfulness-based stress reduction and attentional control. *Clinical Psychology and Psychotherapy, 14*, 449-463.

Baer, R. A., Smith, G. T., & Allen, K. B. (2004). Assessment of mindfulness by self-report: The Kentucky Inventory of Mindfulness Skills. *Assessment, 11*, 191-206.

Bishop, S. R., Lau, M., Shapiro, S. L., Carlson, L., & Anderson, N. D. (2004). Mindfulness: a proposed operational definition. *Clinical Psychology: Science and Practice, 11*, 230-241.

Block, Y., Fixman, M., Maoz, H., Bloch, A. M., Levkovitz, Y., Ratzoni, G., Aviram, S., & Gal, G. (2012). Can computerized cognitive tests assist in the clinical diagnosis of Attention-Deficit Hyperactivity Disorder? *Neuropsychiatry and Clinical Neurosciences, 24*, 111-114.

Bowen, S. & Marlatt, A. (2009). Surfing the urge: Brief mindfulness-based intervention for college student smokers. *Psychology of Addictive Behaviors, 23*, 666-671.

Brown, K. W. & Ryan, R. M. (2003). The benefits of being present: Mindfulness and its role in psychological well-being. *Personality and Social Psychology, 84*, 822-848.

Brown, K. W., Ryan, & Creswell, J. D. (2007). Mindfulness: Theoretical foundations and evidence for its salutary effects. *Psychological Inquiry, 18*, 211-237.

Castet, E. (2012). Quantifying eye stability during a fixation task: A review of definitions and methods. *Seeing and Perceiving, 25*, 449-469.

Chiesa, A. & Serretti, A. (2011). Mindfulness-based interventions for chronic pain: A systematic review of the evidence. *Alternative and Complementary Medicine, 17*, 83-93.

Conners, C. K. (1994). *The Continuous Performance Test (CPT): Use as a diagnostic tool and measure of treatment outcome.* Los Angeles: American Psychological Association.

Conners, C. K. (2002). *Continuous performance test II technical guide and software manual.* Toronto: Multi-Health Systems.

Delis, D., Kaplan, E., & Kramer, J. (2001). *Delis-Kaplan Executive Function Scale.* San Antonio, TX: The Psychological Corporation.

Duncan, L. G. & Bardacke, N. (2010). Mindfulness-Based Childbirth and Parenting Education: Promoting family mindfulness during the perinatal period. *J Child Fam Stud, 19*, 190-202.

Elliott, R. & Dolan, R. J. (1999). Differential neural responses during performance of matching and nonmatching to sample tasks at two delay intervals. *Neuroscience, 19*, 5066-5073.

Feldman, G., Hayes, A., Kumar, S., Greeson, J., & Laurenceau, J. (2007). Mindfulness and emotion regulation: The development and initial validation of the Cognitive and Affective Mindfulness Scale-Revised (CAMS-R). *Psychological and Behavioral Assessment, 29*, 177-190.

Fitzpatrick, L., Simpson, J., Smith, A. (2010). A qualitative analysis of mindfulness-based cognitive therapy (MBCT) in Parkinson's disease. *Psychology and Psychotherapy, 83*, 179-192.

Fjorback, L. O., Arendt, M., Ørnbøl, E., Fink, P., & Walach, H. (2011). Mindfulness-based stress reudction and mindfulness-based cognitive therapy - a systematic review of randomized controlled trials. *Acta Psychiatr Scand, 124*, 120-119.

Galla, B. M., Hale, T. S., Shrestha, A., Loo, S. K, Smalley, S. L. (2012). The disciplined mind: Associations between the Kentucky Inventory of Mindfulness Skills and attention control. *Mindfulness, 3*, 95-103.

Giommi, F., Barendregt, H., Oliemeulen, L., van Hoof, J., Tinge, J., Coenen, A., & van Dongen, M. (2001). *Mindfulness-based Attention Training as an effective component in treatment emotional disorders: A comparison study.* Unpublished manuscript, Nijmegen University, Nijmegen, The Netherlands.

Golden, C. J. (1978). *Stroop Color and Word Test: a manual for clinical and experimental uses*. Wood Dale, IL: Stoelting.

Goldin, P. R. & Gross, J. J. (2010). Effects of Mindfulness-Based Stress Reduction (MBSR) on emotion regulation in social anxiety disorder. *Emotion, 10*, 83-91.

Gronwall, D. & Sampson, H. (1974). *The psychological effects of concussion.* Auckland: Oxford University Press.

Grossman, P. (2008). On measuring mindfulness in psychosomatic and psychological research. *Psychosomatic Research, 64*, 405-408.

Hasson, R. & Fine, J. G. (2012). Gender differences among children with ADHD on continuous performance tests: A meta-analytic review. *Attention Disorders, 16*, 190-198.

Hayes, S. C., Pistorello, J., & Levin, M. E. (2012). Acceptance and commitment therapy as a unified model of behavior change. *Counseling Psychologist, 40*, 976-1002.

Hayes, S. C., Wilson, K. G., Gifford, E. V., Bissett, R., Piasecki, M., Batten, S. V., Byard, M., & Gregg, J. (2004). A randomized controlled trial of twelve-step facilitation and acceptance and commitment therapy with polysubstance abusing methadone maintained opiate addicts. *Behavior Therapy, 35*, 667-688.

Hodgins, H. S. & Adair, K. C. (2010). Attentional processes and meditation. *Consciousness and Cognition, 19*, 872-878.

Homack, S., Lee, D., & Riccio, C. A. (2005). Test Review: Delis-Kaplan Executive Function System. *Clinical & Experimental Neuropsychology, 27*, 599-609.

Huang-Pollock, C., Karalunas, S. L., Tam, H., & Moore, A. N. 2012. Evaluating vigilance deficits in ADHD: A meta-analysis of CPT performance. *Abnormal Psychology, 121*, 360-371.

Josefsson, T. & Broberg, A. (2010). Mediators and non-mediators on sustained and executive attentional performance. *Mental Health, Religion and Culture, 14*, 291-309.

Kabat-Zinn, J. (1994). *Wherever you go, there you are: Mindfulness meditation in everyday life.* New York, NY: Hyperion.

Kabat-Zinn, J. (2003). Mindfulness-based intervention in context: Past, present, and future. *Clinical Psychology: Science and Practice, 10*, 144-156.

Kabat-Zinn, J., Lipworth, L., & Burney, R. (1985). The clinical use of mindfulness meditation for the self-regulation of chronic pain. *J Behav Med, 8*, 163-190.

Kabat-Zinn, J., Massion, A. O., Kristeller, J. K., Peterson, L. G., Fletcher, K. E., Pbert, L., Lenderking, W. R., & Santorelli, S. F. (1992). Effectiveness of a meditation-based stress reduction program in the treatment of anxiety disorders. *Am J Psychiatry, 149*, 936-943.

Kabat-Zinn, J., Wheeler, E., Light, T., Skillings, A., Scharf, A., Cropley, T. G., Hosmer, D., & Bernhard, J. D. (1998). Influence of mindfulness meditation-based stress reduction intervention on rates of skin clearing in patients with moderate to severe psoriasis undergoing phototherapy (UVB) and photochemotherapy (PUVA). *Psychosomatic Medicine, 60*, 625-632.

Kimbrough, E., Magyari, T., Langenberg, P., Chesney, M., & Berman, B. (2010). Mindfulness intervention for child abuse survivors. *Clinical Psychology, 66*, 17-33.

Kindt, M., Bierman, D., & Brosschot, J. F. (1996). Stroop versus Stroop: Comparison of a card format and a single-trial format of the standard color-word Stroop task and the emotional Stroop task. *Personality and Individual Differences, 21*, 653-661.

Kovner, R., Budman, C., Frank, Y., Sison, C., Lesser, M., & Halperin, J. (1998). Neuropsychological testing in adult attention deficit hyperactivity disorder: A pilot study. *Neuroscience, 96*, 225-235.

Lakey, C. E., Campbell, W. K., Brown, K. W., & Goodie, A. S. (2007). Dispositional mindfulness as a predictor of the severity of gambling outcomes. *Personality and Individual Differences, 43,* 1698-1710.

Lee, Y. & Chao, H. (2012). The role of active inhibitory control in psychological well-being and mindfulness. *Personality and Individual Differences, 53*, 618-621.

Lengacher, C. A., Johnson-Mallard, V., Post-White, J., Moscoso, M. S., Jacobsen, P. B., Klein, T. W., Widen, R. H., Fitzgerald, S. G., Shelton, M. M., Barta, M., Goodman, M., Cox, C. E., & Kip, K. E. (2009). Randomized controlled trial of mindfulness-based stress reduction (MBSR) for survivors of breast cancer. *Psycho-Oncology, 18*, 1261-1272.

Lopez, B. R., Lincoln, A. J., Ozonoff, S., & Lai, Z. (2005). Examining the relationship between executive functions and restricted, repetitive symptoms of autistic disorder. *Autism & Developmental Disorders, 35*, 445-460.

Lundy, M. & Mason, S. (1994). Women's health care centers: Multiple definitions. *Social Work in Health Care, 19*, 3-4.

McConkey, K. M. (2006). On finding the balanced path of hypnosis definition. *Clinical Hypnosis, 48*, 2-3.

Miller, J. J., Fletcher, K., & Kabat-Zinn, J. (1995). Three-year follow-up and clinical implications of a mindfulness meditation-based stress reduction intervention in the treatment of anxiety disorders. *General Hospital Psychiatry, 17*, 192-200.

Moore, A. & Malinowski, P. (2009). Meditation, mindfulness and cognitive flexibility. *Consciousness and Cognition, 18*, 176-186.

Muraven M. & Baumeister, R. F. (2000). Self-regulation and depletion of limited resources: Does self-control resemble a muscle? *Psychological Bulletin, 126*, 247-259.

Orsillo, S. M., Roemer, L., Lerner, J. B., & Tull, M. T. (2004). Acceptance, mindfulness, and cognitive-behavioral therapy: Comparisons, contrasts, and application to anxiety. In S. C. Hayes (Ed.), *Mindfulness and acceptance: Expanding the cognitive-behavioral tradition* (66-95). New York, NY: The Guilford Press.

Pallant, J. (2007). *SPSS Survival Manual* (3rd ed.). New York, New York: McGraw-Hill.

Peters, J. R., Erisman, S. M., Upton, B. T., Baer, R. A., & Roemer, L. (2011). A preliminary investigation of the relationships between dispositional mindfulness and impulsivity. *Mindfulness, 2*, 228-235.

Petersen, S. E., Van Mier, H., Fiez, J. A., & Raichle, M. E. (1998). The effects of practice on the functional anatomy of task performance. *National Academy of Sciences, 95*, 853-860.

Philip, A. & Correia, C. J. (2010, November). *The role of dispositional mindfulness in alcohol-related problems.* Poster session presented at the annual conference of the Association for Behavioral and Cognitive Therapies, San Francisco, CA.

Posner, M. I. (1980). Orienting of attention. *The Quarterly Journal of Experimental Psychology, 32*, 3-25.

Mirksy, A. F. (1996). Disorders of attention: A neuropsychological perspective. In G. R. Lyon & N. A. Krasnegor. (Eds.), *Attention, memory, and executive function* (71-95). Baltimore, MD: Paul H Brookes Publishing.

Quero, S., Baños, R. M., & Botella, C. (2000). Cognitive biases in panic disorder: A comparison between computerized and card Stroop task. *Psicothema*, *12*(2), 165-170.

Rapgay, L. & Bystrisky, A. (2009). Classical mindfulness: An introduction to its theory and practice for clinical application. *Annals of the New York Academy of Sciences, 1172*, 148-162.

Reis, S. M., McGuire, J. M., & Neu, T. W. (2004). Compensation Strategies Used by High-Ability Students With Learning Disabilities Who Succeed in College. In S. Baum (Ed.), *Twice-exceptional and special populations of gifted students* (pp. 13-34). Thousand Oaks, CA: Corwin Press.

Reitan, R. M., & Wolfson, D. (1985). *The Halstead-Reitan Neuropsychological Test Battery*. Tucson, AZ: Neuropsychology Press.

Rensink, R. A., O'Regan, J. K., & Clark, J. J. (1997). To see or not to see: The need for attention to perceive changes in scenes. *Psychological Science, 8*, 368-373.

Ries, B. J. (1997). Stroop interference: A comparison of dental phobia Stroop tests. *Dissertation Abstracts International, 58*, 4-B.

Rushworth, M. F., Passingham, R. E., & Nobre, A. C. (2005). Components of attentional set-switching. *Exp Psychol, 52,* 83-98.

Schmertz, S. K. (2006). *The relationship between self-report mindfulness and performance on tasks of attention* (Master's thesis). Retrieved from http://digitalarchive.gsu.edu/psych_theses/30.

Schmertz, S. K., Anderson, P. L., & Robins, D. L. (2009). The relation between self-report mindfulness and performance on tasks of sustained attention. *Psychopathology and Behavioral Assessment, 21*, 60-66.

Semple, R. J. (2010). Does mindfulness meditation enhance attention? A randomized controlled trial. *Mindfulness, 1*, 121-130.

Seo, E. H., Lee, D. Y., Choo, I., H., Kim, S. G., Kim, K. W., Youn, J. C., Jhoo, J. H., & Woo, J. I. (2008). Normative study of the Stoop Color and Word Test in an educationally diverse elderly population. *Int J Geriatr Psychiatry, 23*, 1020-1027.

Singh, N. N., Singh, A. N., Lancioni, G. E., Singh, J., Winton, A. S. W., & Adkins, A. D. (2009). Mindfulness training for parents and their children with ADHD increases the children's compliance. *J Child Fam Stud, 19*, 157-166.

Simons, D. J. & Chabris, C. F. (1999). Gorillas in our midst: Sustained inattentional blindness for dynamic events. *Perception, 28*, 183-193.

Smalley, S. L., Loo, S. K., Hale, T. S., Shrestha, A., McGough, J., Flook, L., & Reise, S. (2009). Mindfulness and Attention Deficit Hyperactivity Disorder. *Clinical Psychology, 65*, 1087-1098.

Stevens, J. P. (2009). *Applied multivariate statistics for the social sciences* (5th ed.). Mahwah, NJ: Routledge Academic.

Tabachnick, B. G. & Fidell, L. S. (2006). *Using multivariate statistics (*5th ed.). Boston, MA: Allyn & Bacon.

Tatsuoka, M. M. (1971). *Multivariate analysis: Techniques for educational and psychological research*. New York, NY: Wiley.

Van der Elst, W., Van Boxtel, M. P. J., Van Breukelen, G. J. P., & Jolles, J. (2006). The Stroop Color-Word Test: Influence of age, sex, and education; and normative data for a large sample across the adult age range. *Assessment, 13*, 62-79.

Van der Oord, S., Bogels, S. M., Peijnenburg, D. (2012). The effectiveness of mindfulness training for children with ADHD and mindful parenting for their parents. *J Child Fam Stud, 21*, 139-147.

Van Vugt, M. K. & Jha, A. (2011). Investigating the impact of mindfulness meditation training on working memory: A mathematical modeling approach.

Way, B. M., Creswell, J. D., Eisenberger, N. I., & Lieberman, M. D. (2010). Dispositional mindfulness and depressive symptomatology: Correlations with limbic and self-referential neural activity during rest. *Emotion, 10*, 12-24.

Weber, E. U. & Johnson, E. J. (2009). Mindful judgement and decision making. *Annual Review of Psychology, 60*, 53-85.

Wecker, N. S., Kramer, J. H., Hallam, B. J., & Delis, D. C. (2005). Mental flexibility: Age effects on switching. *Neuropsychology, 19*, 245-352.

Weinfurt, K. P. (2004). Multivariate analysis of variance. In L. G. Grimm & P. R. Yarnold (Eds.), *Reading and understanding multivariate statistics* (9th ed.; 66-95). Washington, DC: American Psychological Association.

Witkiewitz, K., Marlatt, G. A., & Walker, D. (2005). Mindfulness-based relapse prevention for alcohol and substance use disorders. *Cognitive Psychotherapy, 3*, 211-228.

Wodka, E. L., Mostofsky, S. H., Prahme, C., Gidley Larson, J. C., Loftis, C., Denckla, M. B., & Mahone, M. (2008). Process examination of executive function in ADHD: Sex and subtype effects. *Clinical Neuropsychologist, 22*, 826-841.

Appendix of Tables

Table 1
Frequencies and Percentages for Participant Demographics

Demographic	*n*	%
Gender		
Male	42	31
Female	95	69
Race/Ethnicity		
American Indian/Alaska Native	2	1
Asian	1	1
Black/African American	18	13
Hispanic/Latino	3	2
White	111	81
None of the above	2	1
Grade level		
Freshman	21	15
Sophomore	36	26
Junior	32	23
Senior	47	34
Other	1	1
Residence		
Off campus house or apartment	104	76
With parents/guardian	2	1
Fraternity or sorority house	6	4
Campus dorm	23	17
Other	2	1
ADHD status		
Never diagnosed	109	80
Diagnosed; no medication	8	6
Diagnosed; takes medication	20	15
Colorblindness		
Diagnosed with color blindness/insensitivity	5	4
Not diagnosed	132	96
Movement		
Difficulty moving arms, hands or fingers	2	1

No difficulty	135	99
Group		
Low mindfulness	73	53
High mindfulness	64	47

Table 2

Means and Standard Deviations for Participant Characteristics

Characteristic	*M*	*SD*
Age	20.79	2.87
High school GPA	3.63	0.40
College GPA	3.09	0.57

Table 3

Means and Standard Deviations for Variables of Attention

Variable	*M*	*SD*
HITRTBL	47.92	7.54
OMIS	46.50	5.39
COMIS	52.17	9.97
TMSS	9.54	2.36
COL4SS	11.13	2.39
TMSSe	10.82	1.64
COLeSS4	10.45	2.00

Table 4
Results for MANCOVA and ANCOVAs on Attention by Group

Source	MANCOVA *F* (7, 115)	ANCOVA (1, 121)						
		HITRTBL	OMIS	COMIS	TMSS	COL4SS	TMSSe	COLeSS4
Group	3.36**	0.05	9.49**	12.69**	2.00	0.15	2.97	3.13
Race	1.97	3.06	0.09	2.12	9.08	0.51	2.74	0.90
Residence	2.60*	2.89	0.02	4.79*	0.18	5.77*	0.04	4.67*

Note. * $p < 0.05$. ** $p < 0.01$.

Table 5
Means and Standard Deviations by Group

	Low mindfulness		High mindfulness	
	M	*SD*	*M*	*SD*
HITRTBL	48.04	7.69	47.76	6.81
OMIS**	47.66	5.32	45.22	3.14
COMIS**	54.61	9.80	48.50	9.32
TMSS	9.85	2.27	9.25	2.43
COL4SS	11.03	2.24	11.19	2.26
TMSSe	11.12	1.61	10.63	1.59
COLeSS4	10.76	1.84	10.14	2.09

Note. ** $p < 0.01$.

Table 6
Preliminary MANOVAs for Potential Covariates

Group	*F*	*p*
Sex	1.42	.206
Race	2.25	.035
Education	0.71	.861
ADHD status	1.39	.217
Residence	2.58	.017

Table 7
Preliminary Correlations

	Age	HS GPA	College GPA
HITRTBL	-.24**	-.02	-.04
OMIS	.06	-.11	.00
COMIS	-.11	.06	-.06
TMSS	-.15	.18*	-.06
COL4SS	-.03	.22**	.12
TMSSe	.02	.10	-.04
COLeSS4	.00	.23**	.19*

Note. * $p < 0.05$. ** $p < 0.01$.