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THE RELATION BETWEEN SELF-REPORT MINDFULNESS AND PERFORMANCE ON TASKS OF ATTENTION

by

STEFAN K SCHMERTZ

Under the direction of Page Anderson

ABSTRACT

The present study examined the relation between self-report mindfulness and performance on tasks measuring abilities for three aspects of attention: sustained, selective, and attention switching. Because attention regulation has been described as a core component of mindfulness, and past research suggests that experience with mindfulness meditation is associated with improved attentional skills, the present study predicted that higher self-report mindfulness would be positively related to performance on tasks of attention. Fifty undergraduate students completed self-report mindfulness questionnaires and completed a battery of attention tasks. There was mixed support for the relation between mindfulness scores and sustained attention, such that higher mindfulness scores as measured by the MAAS and CAMS-R were negatively related to target omissions on the CPT-II, but were not related to RT variability on the CPT-II or PASAT performance. Findings are discussed in the context of the measurement of self-report mindfulness, and directions for future research are considered.

IDEX WORDS: Mindfulness, Self- report, Measurement, Sustained attention, Selective attention, Attention switching

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by

STEFAN K SCHMERTZ

A Thesis submitted in Partial fulfillment of the Requirements for the Degree of

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Georgia State University

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The Relation Between Self-Report Mindfulness and Performance on Tasks of Attention

Mindfulness has been defined as, "the awareness that emerges through paying attention on purpose, in the present moment, and non-judgmentally to the unfolding of experience, moment to moment" (Kabat-Zinn, 2003; p. 144), and as "deliberate non-evaluative contact with events that are here and now" (Hayes & Wilson, 2003; p. 164). The above definitions outline three notable components consistently addressed in the mindfulness literature: (1) the conscious attempt to regulate attention, (2) a focus on present experience, and (3) the maintenance of a nonjudgmental attitude toward current experience. Whereas the origins of mindfulness reside in Buddhist meditation, the techniques have been increasingly incorporated into Western mental health treatment programs. Mindfulness training is an integral part of newer cognitive and behavioral therapies such as Mindfulness Based Stress Reduction (MBSR; Kabat-Zinn, 1982), Mindfulness Based Cognitive Therapy (MBCT; Segal, Williams, & Teasdale, 2002), Dialectical Behavior Therapy (DBT; Linehan, 1993), and Acceptance and Commitment Therapy (ACT; Hayes, Strosahl, & Wilson, 1999), and it has demonstrated promise as an intervention in the treatment of chronic pain, stress, anxiety, depressive relapse, and disordered eating (Baer, 2003; Shapiro, Schwartz, & Bonner, 1998).

Recent literature has emphasized the importance of developing reliable and valid measurement of the construct of mindfulness so that research can begin to investigate the efficacy of current mindfulness interventions, mechanisms through which mindfulness may facilitate clinical change, as well as the role that mindfulness may play within multifaceted treatment programs (Strauman & Merrill, 2004; Bishop et al., 2004; Hayes & Feldman, 2004; Dimidjian & Linehan, 2003). Toward that end, several self-report instruments assessing

mindfulness recently have been developed (Baer, Smith, & Allen, 2004; Bishop et al., 2003; Brown & Ryan, 2003; Feldman et al., 2005). Although initial validation of these measures has been promising, comparisons with non-self-report instruments measuring constructs related to mindfulness may be an important step in ensuring more valid measurement in future research (Bishop et al., 2004). Because the deliberate regulation of attention is a core component of mindfulness (Kabat-Zinn, 2005; Baer, 2003; Bishop et al., 2003), and because past research has provided evidence suggesting that mindfulness meditation leads to improvements in various aspects of attention (Valentine & Sweet, 1999, Rani & Andhra, 2000; Rani & Rao, 1996; Linden, 1973), comparison of self-reported mindfulness with performance tests of attention may be an important step in validating these measures.

To contribute to the empirical literature regarding the measurement of mindfulness, the present study examined the relation between self-reported mindfulness and performance on tasks measuring abilities for three aspects of attention: sustained, selective, and attention switching ability. To build a rationale for the present study, a review of the following topics is presented: (1) a brief description of mindfulness interventions and current issues regarding mindfulness research, (2) the role of attention in mindfulness, (3) attention tasks included in the present study, and (4) development of self-report mindfulness measures.

Mindfulness Interventions

Probably the most widely recognized mindfulness intervention is MBSR, an eight to ten week program in which participants meet as a group for two hours a week for instruction and practice of mindfulness skills, and are assigned meditation exercises to be practiced daily for 45 minutes. This intervention has been used to treat chronic pain, anxiety, and other stress-related disorders. Bringing attention to the present moment is taught as a coping skill, as well as a way

to enrich one's life through increased awareness and insight into one's experience (Kabat-Zinn, 1992).

MBCT is an eight week group treatment that is largely based on the MBSR program, but is designed to prevent depressive relapse. Segal and colleagues (2002) propose that those who have experienced major depressive episodes may reinitiate patterns of depressive thinking in the face of stress or dysphoria. Mindfulness practice is taught to increase one's ability to recognize negative thoughts and emotions as transient experiences that come and go, and not necessarily as accurate reflections of reality. Thus moments of discomfort and negative thinking may be less likely to escalate into ruminative patterns and depressive symptoms.

DBT and ACT are interventions that incorporate mindfulness into multifaceted treatment programs. DBT is designed specifically for the treatment of patients with Borderline Personality Disorder. Mindfulness is incorporated with the teaching of interpersonal effectiveness, emotion regulation, and distress tolerance skills. Less emphasis is placed on regular meditation practice; exercises include mindful awareness of everyday activities such as washing the dishes or walking (Linehan, 1992).

Although meditation is not formally described in ACT, exercises are employed that encourage mindful attention to one's thoughts and emotions. Clients are taught to identify with the part of themselves that is capable of observing their own thoughts and emotions. ACT teaches this "decentered" view to encourage nonjudgmental acceptance of negative internal experience in the context of changing one's behavior in constructive ways that are of value to the client (Hayes et al., 1999). Although the above mentioned programs have shown early promise (Baer, 2003), subtle differences between these interventions highlight the need to systematically

investigate the mechanisms of action for mindfulness skills before extensive further treatment development takes place.

Methods of Action

Recent reviews (Shapiro, Carlson, Astin, & Freedman, 2006; Baer, 2003) have outlined several potential mechanisms that may explain how mindfulness skills can lead to symptom reduction and behavior change. Attention to present experience may provide the opportunity for prolonged exposure to previously avoided sensations of pain or anxiety. Nonjudgmental observation of these experiences may lead to desensitization, reducing the likelihood of fear and avoidance responses normally elicited by these sensations. As mentioned above, mindfulness interventions are thought to provide a different perspective on thoughts and emotions, in which they are viewed as transient entities that are separate from the person having them. Thoughts such as "I am a bad person", might be viewed as, "I am having the thought that I am a bad person," and thus become less threatening and distressful (Kohlenberg, Hayes, & Tsai, 1993).

Increased attention to present experience may also provide the opportunity for improved affect regulation and self-management by interrupting the automatic way in which our thought processes work throughout daily life (Kabat-Zinn, 1990). "The idea is that automatic and typical reactions now become a choice as opposed to an inevitability." (Wenk-Sormaz, 2005; p. 43) For example, someone who is stuck in traffic, instead of immediately becoming frustrated and disdainful of their situation may now realize that they have some unexpected time to spend with their child who is seated next to them (Wenk-Sormaz, 2005). Experiencing of this kind encourages cognitive flexibility and the opportunity for additional learning through clarity of experience (Shapiro et al., 2006).

Although relaxation is not a specific goal of mindfulness meditation, past research suggests that various meditation exercises are effective as relaxation techniques (Baer, 2003; Orme-Johnson, 1984). In addition, the attitude of acceptance that is taught in mindfulness may be important in encouraging participants to experience thoughts and emotions more fully, again decreasing the likelihood of avoidance behavior. Hayes (1999) describes acceptance as a way of teaching participants the ability to "carry" difficult emotions, which are an inevitable part of human experience, while working toward a fulfilling life.

Current literature has emphasized that before research continues regarding the way in which mindfulness may be beneficial, agreement should be reached on an operational definition of mindfulness, and reliable measurement developed (Bishop et al., 2004; Hayes & Feldman, 2004; Dimidjian & Linehan, 2003). Although several operational definitions have recently been proposed that are in accord with the majority of the mindfulness literature (Bishop et al., 2004; Shapiro et al., 2006), there is a consistent call to develop empirically defined components of this construct (Hayes & Shenk, 2004). Efforts to develop reliable measurement may be a valuable step toward agreement about the functional components of mindfulness (Baer et al., 2004). To further validate the self-report instruments that have been developed, the present study focused on one of the foundational components, attention.

Mindfulness and Attention

The role of attention in mindfulness is most clearly evident in the various exercises involved in mindfulness training. Most often, the first step is the practice of focusing one's attention on a single aspect of one's field of awareness, most commonly one's breath. The participant will typically be instructed to focus on sensations associated with normal breathing. When attention inevitably wanders to other perceptions or thoughts, participants are encouraged

to observe the content of the distraction without judgment, and gently bring their attention back to their breathing as a way of refocusing attention to present experience. Throughout the practice of mindfulness, a non-judgmental attitude is cultivated in order to discourage judgmental thoughts that may serve as a distortion of simple awareness of present experience. Concentrative focus on specific aspects of present experience may lead to meditation that has a broader focus, in which one engages in observing whatever comes into the field of awareness (Kabat-Zinn, 2005). Importantly, each of the different forms of meditation involves bringing attention to the present moment. Some forms focus on a specific idea or sensation, such as breathing, whereas others try to stay receptive to all aspects of current experience. These exercises are performed in order to increase one's attention to and awareness of present experience, not only during meditation exercises, but throughout daily life (Kabat-Zinn, 2005; Linehan, 1992).

Although cognitive psychology delineates many different aspects of attentional abilities, recent literature (Bishop et al., 2004; Shapiro et al., 2006) suggests three areas that may be associated with mindfulness skills: a) *sustained attention*; defined as the capacity to maintain vigilance over time (Posner & Rothbart, 1992), b) *selective attention*; the ability to select salient information for additional cognitive processing (Treisman, 1969), and c) *switching*; the ability to switch the focus of one's attention from one object or mental set to another (Posner, 1980).

Sustained attention is thought to be associated with mindfulness practice in that vigilance is required to maintain focus on present experience. Valentine and Sweet (1999) found that experienced meditators performed better than controls on the Wilkins' counting test, a task of sustained attention which requires counting the number of "auditory bleeps" in a series. As the trials proceed, there are increasingly shorter intervals separating the tones, requiring more focused, continuous attention to discern. These findings suggest that meditation may improve

one's performance on tasks requiring sustained attention, presumably through practice in maintaining focus on present experience. In addition, more experienced meditators scored higher than those with less experience, suggesting that meditation may continue to improve sustained attention the longer one practices.

In the practice of formal meditation or daily mindful activity, one must choose to focus on present moment experience. Although all thoughts or sensations that arise during mindfulness practice are regarded as "objects of observation," *selective attention* is required to inhibit further engagement in habitual thought processes so that attention can be reoriented to the present moment (Bishop et al., 2004). Early research found that children ages 8-11 who underwent 18 weeks (twice weekly) of focused breathing meditation were better able to focus attention and ignore distracting stimuli than classroom peers (Linden, 1973). Rani and Rao (2000) found that experienced transcendental meditators (those who practice "cognitive exercise of internal attention") performed better than controls on the Stroop task, a test of selective attention that requires one to inhibit the automatic response of reading when the required task is to instead name the color in which words are printed. Alexander et al. (1989) found that elderly participants trained in meditation over 12 weeks (practiced twice daily for 20 minutes) performed better on the Stroop task than those trained in a creative word production task, and those in a no-training group. These results suggest that mindfulness meditation taught in a structured, time-limited treatment setting may also lead to improved selective attention ability and that the effects of mindfulness training on attention can be differentiated from the effects of other mental activities on attention.

In another study examining selective attention and mindfulness training, Wenk-Sormaz (2005) assigned 120 undergraduates without previous meditation experience to one of three

attention task groups: (1) meditation on the breath, (2) a mnemonic learning task, and (3) a "rest" group instructed to let their minds wander. Participants were given the Stroop task before and after the 20 minute attention task. The meditation group showed significantly improved Stroop performance, whereas the learning task group and the rest group did not. These results suggest that by improving one's selective attention skill, meditation has the ability to reduce habitual responding (i.e. word reading) in the short term, even when the intervention is very brief (Wenk-Sormaz, 2005).

The ability to *switch attention* from one mental set to another may be important in orienting attention to the present moment in mindful practice (Bishop et al., 2004). This skill allows one to disengage from thought processes that may serve as distractions from present focused attention. Rani and Rao (1996) found that children (ages 9-11) who practiced transcendental meditation as part of their school curriculum demonstrated greater attention regulation capacity as measured by the Star Counting Test than age and sex matched controls. This task requires one to count a series of "stars" (*s) while switching from counting forward to counting backward throughout each series. Attention regulation is thought to be measured through the ability to switch one's mental set throughout the task to arrive at the correct answer. Similar results were obtained from college students who meditated regularly compared to non-meditating controls, but only when testing occurred soon after meditating (Rani & Rao, 2000). Because measurement soon after meditation was not necessary in order to see a significant difference between groups on a selective attention task included in this study, the authors suggest that improved attention ability may be stable for some processes and transitory for others, such as attention switching.

In summary, the small group of research studies that has examined the relation between meditation and attention task performance has found that those who practice meditation perform better on various aspects of attention than those without meditation experience (Alexander et al., 1989; Rani & Rao, 1996 & 2000; Valentine & Sweet, 1999; Wenk-Sormaz, 2005). Thus, these studies suggest that performance on attention tasks should be positively related to self-reported measures of mindfulness.

Attention Tasks

Although a detailed examination of current research regarding the delineation of different aspects of attention is beyond the scope of this paper, it is worth noting that aspects of attention are thought to operate in a hierarchical manner such that certain higher order functions are required to perform lower order tasks of attention (Mapou, 1995). For example Cohen and colleagues (1993) describe a model of attention in which one must maintain attention (sustained attention) in order to engage faculties of selective attention. Likewise, the process of selecting a stimulus on which to focus (selective attention) and switching one's attention from a previous stimulus or mental set (attention switching) are likely intertwined (Cohen et al., 1993). Therefore tasks designed to measure the different aspects of attention inherently contain some overlap, making it difficult to individually measure any one component of attention ability. With these constraints in mind it is important to examine the tasks included in the present study and how they have been proposed to measure sustained, selective, and attention switching ability.

Performance Tests of Sustained Attention

Conners' Continuous Performance Test – II (CPT-II). The CPT-II (Conners, 2002) is a widely used computer administered test of sustained attention in which letters appear one at a time on the computer monitor, and participants are required to press the "space" bar for each

letter except for “X.” Participants are asked to respond as quickly and as accurately as possible. The task, which runs for about 14 minutes, requires sustained vigilance to press for each letter other than “X,” as well as to inhibit responding when “X” appears. This test produces standardized T-scores based on the age and gender of the participant. Two scores that are often associated with sustained attention are a) Omissions; the number of times the participant failed to respond to a target letter (higher T-scores indicate a greater number of omissions), and b) Hit RT Standard Error; the consistency of response time (in milliseconds) to targets throughout the task (higher T-scores indicate a greater variability of reaction times) (Riccio, & Reynolds, 2003).

The Paced Auditory Serial Addition Test (PASAT). The PASAT (Gronwall & Sampson, 1974) is a measure of sustained attention that requires participants to sum 60 pairs of digits derived from a sequence of digits such that each is added to the digit immediately preceding it. For example if the participant is presented with the series 2-6-9-5-3, the participant would begin responding as soon as the examiner said “six” and the correct responses would be, “8-15-14-8.” Typically, four sets of 61 digits are included in this task in which the digits are presented at increasingly shorter intervals during each set (2.4, 2, 1.6, and 1.2 seconds respectively). Sustained attention is required to maintain focus during this difficult task. Participants who are able to maintain their attention and quickly refocus after a lapse of attention will presumably provide more correct responses across the four trials. Because this test requires precise presentation, computer or audio tape administration is used. Scores are calculated as the percentage of total correct responses across all four sets. Although the task may also require the use of working memory skill, factor analysis has shown that the PASAT is more highly correlated with other tests of attention than with tests of working memory (Larrabee & Curtiss, 1995). Because both the CPT and the PASAT require sustained attention to current experience

for optimal performance, these tasks should provide a good test of the sustained attentional ability thought to be associated with mindful attention.

Performance Tests of Selective Attention

The Stroop task. The Stroop task has been widely used as a measure of selective attention (MacLeod, 1991). This task measures attention through one's ability to inhibit the automatic response of reading when the required task is to name the color in which words are printed (MacLeod, 2005; Galotti, 1999). John Ridley Stroop's (1935) original research found that it took longer to name colors of incongruent color-word combinations (e.g., the word red written in green ink, say "green") than it did to name the colors of colored shapes (e.g., for a red rectangle, say "red"). The differential latency to name the color between the two conditions is known as the Stroop effect. This research introduced the notion of "automaticity" which states that the more one practices a task, such as reading or driving, the less attention it takes to perform it (Galotti, 1999). Because most literate adults have so much practice reading, it has become an automatic response. In fact, reading is so well practiced and requires so little attention that when confronted with written stimuli, not-reading becomes difficult (Galotti, 1999). When asked to name the color of incongruent color-word combinations participants must invest attention into this unfamiliar task in order to inhibit the automatic response of reading and select the salient information (ink color) for further processing. Shorter color-naming latency and fewer color-naming errors are associated with greater selective attention abilities.

The Stroop task may be especially effective as an objective measure of mindfulness because mindful attention requires a similar investment of attention in aspects of experience that are often ignored. For example, the Stroop task, in which one is required to focus attention on the infrequently performed task of naming the color in which words are printed, is an experimental

paradigm that nicely parallels the clinical application of mindfulness training in which one is instructed to focus attention on typically overlooked sensations, such as breathing (Wenk-Sormaz, 2005; Alexander et al., 1989).

The present study included two variations of the Stroop (1935) task to measure selective attention; a) the Delis-Kaplan Executive Functioning System (D-KEFS), Color-Word Interference Test, and b) a computer administered, cued, single-trial version of the Stroop task. The D-KEFS Color-Word Interference Test is similar to the traditional Stroop task in that separate blocks of like trials are performed for each condition. Condition 1 (Color Naming) consists of the basic naming of color patches, Condition 2 (Word Reading) is the basic reading of color-words printed in black ink, Condition 3 (Inhibition) requires color naming of incongruent color words, and Condition 4 (Inhibition/Switching) requires one to switch back and forth between reading and naming the ink color of incongruent color words. Performance is measured in the rate (in seconds) and accuracy with which participants complete the 50 trials that are included in each condition. Standardized Stroop interference scores based on age and gender are calculated. Standardized scores are also calculated for the number of color naming errors made on the Inhibition condition. If there is a significant relation between this task and self-report mindfulness, it may be interesting to examine how mindfulness scores correspond with performance on this nationally standardized test of attention ability.

A computerized, cued, single-trial version of the Stroop (Cohen et al., 1999; Seignourel et al., 2005) was also included to provide a more sensitive measurement of selective attention, as well as provide a more ecologically valid comparison of the skills required in mindful activity in daily life. In this task trials are presented individually and participants receive an audio cue prior to each trial to either read the word or name the ink color in which the word is printed. Task

instruction (word reading or color naming) varies randomly across trials. Presentation in this format requires one to select the appropriate salient material for further processing based on the context of the instructions for each specific trial. This may provide a more valid measure of the manner in which one is required to select present moment related information based on contextual cues throughout daily life. Because mean reaction times used to calculate Stroop interference scores are measured in milliseconds, this task is likely to be more sensitive to individual differences than the D-KEFS Color-Word Interference Test or other traditional Stroop tasks that are not computer administered.

Performance Tests of Switching Attention

Delis-Kaplan Executive Functioning System (DKEFS), Color-Word Interference Test. Condition 4 of the D-KEFS (Inhibition/Switching) requires one to switch back and forth between reading and naming the ink color of incongruent color words. In an attempt to isolate the attention switching component of this task the D-KEFS provides an Inhibition/Switching vs. Inhibition contrast score for which performance on the Inhibition condition is factored out of performance on the Inhibition/Switching condition. Standardized scores are also calculated for the number of color naming or reading errors made on the Inhibition/Switching condition. Participant's ability to switch their focus back and forth from reading the word to naming the ink color may provide a good measure of the ability needed to reorient attention to present experience in mindfulness.

In summary, these tasks are designed to measure three aspects of attention regulation thought to be associated with mindfulness skills and that past research suggests are associated with meditation experience. Therefore, performance on these tasks should be related to self-reported measures of mindfulness, which are reviewed next.

Measuring Mindfulness by Self-Report

Indicative that mindfulness scholars consider the regulation of attention to present experience as a core component of mindfulness, each self-report instrument developed thus far has included items assessing one's subjective experience of attention to, and awareness of present experience either in a meditation setting or throughout daily life. The proposed study will use three measures that have been designed to measure levels of mindfulness in the general population: the Mindful Awareness Assessment Scale (MAAS; Brown & Ryan, 2003), the Kentucky Inventory of Mindfulness Skills (KIMS; Baer et al., 2004), and the Cognitive and Affective Mindfulness Scale, Revised (CAMS-R; Feldman & Hayes, 2004). Not discussed here are the Freiburg Mindfulness Inventory (Buchheld, Grossman, & Walach, 2001) which was designed for use with experienced meditators only, and the Toronto Mindfulness Scale (Bishop et al., 2003) which was designed to assess the degree to which one is able to reach a mindful state during a meditation exercise.

MAAS

The MAAS is a 15-item, single factor instrument that measures one's tendency to function on "automatic pilot" without attention to present experience (See Appendix B). Typical items that are rated on a six-point likert scale (almost always – almost never) include, "I forget a person's name almost as soon as I've been told it for the first time," and "I could be experiencing some emotion, and not be conscious of it until some time later." The authors note that other aspects of mindfulness, such as maintaining a nonjudgmental attitude, or proposed consequences of mindfulness, such as calmness and emotional well-being, are not addressed because they felt that present-centered attention and awareness were the "foundational" components of mindfulness. Although they acknowledge that acceptance is important in mindfulness, they feel

that it is an understood quality necessary to pay full attention to the present moment (Brown & Ryan, 2004). In addition, during assessment of criterion validity for the MAAS, Brown and Ryan (2001; as cited in Brown & Ryan, 2004) found that items related to a non-judgmental attitude such as, "I don't like feelings of fear and anger, so I don't allow myself to experience them," did not add any explanatory information to the measure.

As part of their validity assessment, Brown and Ryan (2003) compared MAAS scores from general-community adults to those from members of a community Zen center. Participants currently practicing meditation had significantly higher scores than those from the general-community sample. In addition, the number of years of meditation practice was positively associated with MAAS scores. These findings suggest that those practicing meditation report increased attention to and broader awareness of present experience in daily life as measured by the MAAS.

KIMS

The KIMS is a 39-item instrument that measures mindfulness based on the four components addressed in Linehan's model associated with Dialectical Behavior Therapy (DBT) (See Appendix C). The four factors are (1) *observe*; the tendency to observe or notice more subtle stimuli in one's environment, (2) *describe*; the ability to describe thoughts and feelings as they arise, (3) *act with awareness*; the tendency to focus undivided attention to current activity, and (4) *accept without judgment*; the tendency to allow experiences to occur without judging them as negative or positive (Baer et al., 2004). Although there appears to be some overlap among these factors, the *act with awareness* factor most directly captures the regulation of attention to present experience that has been discussed as foundational to mindfulness. Therefore, it is this factor score that one would expect to be positively associated with

performance on an attention task. Items that load on this factor include, “When I am reading, I focus all my attention on what I’m reading,” and “When I do things, my mind wanders off and I’m easily distracted” (reverse scored). Furthermore, Baer and colleagues (2004) examined the correlations between KIMS scores and the MAAS in a sample of 115 undergraduates. The MAAS was strongly positively correlated with the *act with awareness* scale of the KIMS, and moderately positively correlated with the *Describe*, and *Accept without Judgment* scales. No significant relation was observed between MAAS scores and the *Observe* scale of the KIMS.

CAMS-R

The CAMS-R is a 12-item, single factor instrument that derives its higher-order construct of mindfulness from four components: a) the regulation of attention, b) orientation to present experience, c) awareness of experience, and d) acceptance/non-judgment towards experience (See Appendix D). The CAMS-R uses non-specialized language with the aim of measuring mindfulness in the general population. Typical items that are rated on a four-point likert scale (rarely/not at all – almost always) include, “I am able to pay close attention to one thing for a long period or time,” “I am able to accept the thoughts and feelings that I have,” and “I am preoccupied by the past” (reverse scored). Although correlations between the CAMS-R and other measures of mindfulness have not been published, a sample of 613 undergraduates demonstrated that the original CAMS was strongly related to both the MAAS and the KIMS (Baer et al., 2006). The specific correlation of the CAMS to the *act with awareness* scale of the KIMS was not reported. Although the CAMS-R is a single factor instrument that includes items assessing acceptance and non-judgment of present experience, three of the four components (the regulation of attention, orientation to present experience, and awareness of experience) all overlap with the philosophy invoked in the design of the MAAS and the *act with awareness* scale of the KIMS; to

assess one's tendency to pay attention to, and be aware of, current experience. In summary, all three measures included in the present study include assessment of this core component of the practice of mindfulness that is thought to be associated with improved attention ability.

Study Objectives and Hypotheses

The purpose of the present study was to further validate several self-report instruments designed to assess mindfulness in the general population. Because the regulation of attention to present experience is consistently discussed as a core component of mindfulness, and because research suggests that mindful meditation leads to improvements in attention abilities, those scoring higher on self-report mindfulness are predicted to perform better on tasks of attention. Specifically, the following hypotheses are made:

Sustained Attention

a) On the CPT-II, the number of Omission errors (Omission T-scores) and the amount of variance in participant's reaction times (Hit RT Standard Error T-scores) will be negatively related to self-report mindfulness as measured by the MAAS, the KIMS-*act with awareness* subscale, and the CAMS-R.
b) Mindfulness scores (MAAS, KIMS-*act with awareness*, & CAMS-R) will be positively related to the percentage of correct responses on the PASAT.

Selective Attention

a) On the cued, single-trial Stroop task, latency to name the color of incongruent color-words (Stroop Interference score) and the number of color naming errors will be negatively related to self-report mindfulness scores (MAAS, KIMS-*act with awareness*, & CAMS-R).

b) On the D-KEFS Color-Word Interference test, shorter latency to name the color of incongruent color-words as indicated by higher Inhibition vs. Color Naming scaled scores, and fewer color naming errors (higher Inhibition error analysis scaled scores) will be positively related to mindfulness scores (MAAS, KIMS-*act with awareness*, & CAMS-R).

Switching Attention

a) In addition, mindfulness scores (MAAS, KIMS-*act with awareness*, & CAMS-R) will be positively related to Inhibition/Switching vs. Inhibition scaled scores and Inhibition/Switching error analysis scaled scores (fewer errors).

Methods

Participants

Participants were 51 volunteers from undergraduate introductory psychology courses at Georgia State University (GSU), who received two hours of class research credit for their participation. One participant withdrew prior to completing the self-report mindfulness measures and therefore her data were excluded reducing the number of participants to 50. Comprising an ethnically diverse sample, 25 (50%) self-identified as Caucasian, 11 (22%) as African American, 9 (18%) as Asian, 1 (2%) as Hispanic, 1 (2%) as West Indian, 1 (2%) as Iranian, and 2 (4%) as being biracial. Their mean age was 20.34 (range = 18 – 35), 41 (82%) were female and 48 (96%) had never been married. The sample reported little meditation experience with 9 participants having had some previous exposure to meditation, and 7 who currently practiced. However of these 7, only two reported any consistent practice (twice a week for the past eight months, & 60 minutes a week for the past four months). Those with meditation experience (n = 9) did not differ

from non-mediators (n = 41) on levels of self-report mindfulness. The GSU Institutional Review Board (IRB) monitored this research.

Materials

Self-Report Mindfulness

Mindful Attention Awareness Scale (MAAS; Brown & Ryan, 2003). The MAAS is a 15-item, single factor self-report measure assessing individual differences in the frequency of mindful states over time. Participants rate the degree to which they function without awareness in daily life. Items are rated on a six-point likert scale (1 = almost always to 6 = almost never). Authors report internal consistency alphas ranging from .82 to .87. Test-retest reliability analysis with a sample of undergraduates revealed average item scores of 3.78 at time one, and 3.77 at time two (after four weeks) were not significantly different, t(59) = .11. As mentioned above, meditators score higher on the MAAS than non-meditators. Scores for this instrument range from 15 to 90.

Kentucky Inventory of Mindfulness Skills (KIMS; Baer et al., 2004). The KIMS is a 39-item self-report measure of mindfulness skills on which participants rate how often each statement is generally true for them using a five-point likert scale (1 = never or very rarely true, to 5 = very often or always true). The items load on four factors; observing, describing, acting with awareness, and accepting without judgment. Only the *act with awareness* subscale was used for the present study. The authors report adequate internal consistency, with an alpha level of .76 for the *act with awareness* subscale. Scores on this subscales range from 10 to 50.

Cognitive and Affective Mindfulness Scale – Revised (CAMS-R; Feldman et al., 2005). The CAMS-R is a 12 item, single factor measure of mindfulness skills on which participants rate how often each statement applies to them using a four-point likert scale (1 = rarely/not at all, to 4

= almost always). Items are designed to assess four components thought to comprise the overall construct of mindfulness; the regulation of attention, orientation to present experience, awareness of experience, and acceptance/non-judgment towards experience. Authors report internal consistency alphas ranging from .76 to .85. Scores on this measure range from 12 to 48.

Sustained Attention Tasks

Conners' Continuous Performance Test II (CPT-II; Conners', 2000). In this version of the CPT letters are presented sequentially on a computer monitor and participants are instructed to press the "space" bar for every letter other than the letter "X." The task includes six blocks, each with three 20-trial sub-blocks. Within the six blocks, each sub-block employs a different inter-stimulus interval (ISI): 1, 2, or 4 seconds. The order of the sub-blocks varies across the six main blocks of the task. Each letter is displayed for 250 milliseconds. This version of the CPT-II was run using PsychManager software on a Windows Personal Computer (PC) (Multi-Health Systems Inc., 2000). Participant's scores of sustained attention were calculated from the number of target omissions (CPT II-Omissions) and variability (CPT II-Hit RT Std. Error) of reaction times (milliseconds) across the six blocks of the task. Higher T-scores indicate poorer performance on both scales.

Paced Auditory Serial Addition Test (PASAT; Gronwall & Sampson, 1974). For this task, participants are required to add adjacent pairs of digits from a string of single digits that are presented orally via audio tape, such that each digit is added to the one immediately preceding it. Participants are required to report the sums aloud as the digits are being read. A researcher was present to record all responses. This task consists of four blocks of 61 digits. The intervals between digits decrease as the blocks proceed (2.4, 2, 1.6, and 1.2 seconds respectively). A

practice string of 10 digits precedes task administration. Scores are calculated as the percentage of total correct responses across all four sets.

Selective Attention Tasks

Computerized, Cued, Single-trial Stroop Task (Cohen et al., 1999). For this version of the Stroop task, participants were presented with an auditory instructional cue to either read the word ("word") or name the ink color in which the word was printed ("color") prior to each trial. Following a one second interval, the stimulus was presented, and remained on the screen until the participant responded. A one second inter-trial interval preceded the subsequent trial instructions. Participants were instructed to respond as quickly and as accurately as possible. Reaction times (RTs) were determined by a voice-activated PST Serial Response Box, model #200a (19,200 baud standard communications with a transmission rate of 1,600 characters per second). The examiner was present in order to record the participant's responses and verify accuracy. This task included four different conditions that were randomly intermixed throughout the test; a) a reading condition in which the stimuli were color-words displayed in white, b) a reading condition in which the stimuli were incongruent color-words, c) a color-naming condition in which the stimuli were four colored Xs, and d) a color-naming condition in which the stimuli were incongruent color-words. The task consisted of 12 practice items (three of each condition), followed by 180 trials (45 trials per condition).The different color words and color-word combinations were evenly distributed throughout each condition. The stimulus colors and words were red, blue, and green. The trial stimuli appeared in the middle of the screen on a black background and words were printed in lowercase except for the string of Xs that were capital letters. The stimuli were created using Microsoft PowerPoint software (44 point courier new font) and presented on a PC using E-Prime software (display refresh rate range = 74.966 - 75.006

Hz). Cued Stroop interference scores were determined by subtracting participant's average latency (in milliseconds) to name the color of the strings of Xs (control condition) from their average latency to name the color of incongruent color-words. Incorrect responses were removed from the average latency calculations and counted (Cued Stroop errors). Word-reading data was not included as it was not of primary interest for the present study.

Delis-Kaplan Executive Functioning System (D-KEFS), Color-Word Interference Test (Delis, Kaplan, & Kramer, 2001). The Inhibition vs. Color Naming contrast score and the Inhibition Error Analysis score from this task were used as measures of selective attention ability in the present study. The Inhibition vs. Color Naming contrast score is a standardized scaled scores based on age and gender derived by factoring out performance on the Color Naming condition from performance on the Inhibition condition. The Inhibition Error Analysis score is derived from the number of color naming errors made on the Inhibition condition of this task. Higher scaled scores (ss) indicate shorter latency to name the color of incongruent color words and fewer color naming errors.

Attention Switching Task

Delis-Kaplan Executive Functioning System (D-KEFS), Color-Word Interference Test (Delis, Kaplan, & Kramer, 2001). The Inhibition/Switching vs. Inhibition contrast score and the Inhibition/Switching Error Analysis score from this task were used as measures of attention switching ability in the present study. The Inhibition/Switching vs. Inhibition contrast score is a standardized scaled scores based on age and gender derived by factoring out performance on the Inhibition condition from performance on the Inhibition/Switching condition. The Inhibition/Switching Error Analysis score is derived from the number of color naming errors

made on the Inhibition/Switching condition of this task. Higher scaled scores (ss) indicate shorter latency to complete the Inhibition/Switching condition, and fewer reading/color naming errors.

Procedure

Participants were recruited using Sona Systems, a website through which members of introductory psychology classes at GSU were able to get information regarding this study and sign up for available research appointment times. Participants were tested individually and all study visits were conducted in an assessment room of the GSU Psychology Clinic. Testing took approximately one hour and fifteen minutes for each participant.

Upon arriving, participants were provided with informed consent information and given the opportunity to ask any questions they may have. Half of the participants completed the demographic and self-report mindfulness forms first, and the other half began the study visit with the attention tasks. Both the order of the mindfulness measures and the attention tasks were counterbalanced across participants.

A brief practice period preceded each attention task to assure that the participants understood the instructions. For the cued Stroop task this also allowed participants to become familiar with the microphone, and to assure that the voice-activated relay was working properly. The microphone was positioned approximately 4” to 6” from participant’s mouths and they were asked to, “speak up, and try and avoid preceding their response with any other sound.”

Data Analysis

The Statistical Package for the Social Sciences, Version 14.0 (SPSS) was used to store and analyze data. Individual Linear regression analyses were used to examine the relation between self-report mindfulness scores and performance on the attention tasks, specifically to test the hypothesis that higher self-report mindfulness scores would be related to better

performance on tasks of attention. Attention task scores (DVs) were regressed onto self-report mindfulness scores (IVs). Prior to any analyses, data were inspected for errors, excessive missing cases, and outliers, defined as scores greater or less than three standard deviations from the mean. One outlier was removed from the D-KEFS Inhibition Errors scaled score. The scaled score of 1 fell 3.28 standard deviations below the mean. Two outliers were identified from the CPT-II Omissions T-scores. The T-scores of 70.98 and 71.8 fell 3.54 and 3.66 standard deviations above the mean respectively. For the cued Stroop task, only data from the color naming conditions were included in the present analysis. These data were examined for outliers in order to remove anticipations (RTs that were less than 300ms) and lapses in attention (RTs greater than 1500 ms) as recommended by Macleod (2005). Three data points were removed from the control condition (<1%), and 16 were removed from the incongruent color naming condition (<1%). In addition, participant errors and technical errors (instances when the microphone did not register the participant's initial response) were removed from the cued Stroop data prior to calculating Stroop interference scores. Eight participant errors were made during the control condition (<1%), and 187 during the incongruent color naming condition (8.31%). There were 18 technical errors during the control condition (<1%), and 20 during the incongruent color naming condition (<1%). Due to administrator error, one participant did not complete the CAMS-R, and one participant's CPT-II data was invalid due to participant error. These participant's data were excluded from relevant analyses.

With the goal of obtaining the best linear unbiased estimates, the assumptions of regression were tested according to the guidelines provided by Field (2005). Several variables failed to meet the assumptions of normality (CPT-II Omissions T-score, the number of errors from the cued Stroop task, the D-KEFS Inhibition Error Analysis score, & the D-KEFS

Inhibition/Switching Error Analysis score). Log transformations were performed and parallel analyses were performed on both the raw scores and transformations of the raw scores. Because the analyses revealed comparable results, the analyses of untransformed scores are reported.

Results

Descriptive statistics for all variables are presented in Table 1. Relations among the mindfulness questionnaires can be seen in Table 2. All were significantly positively correlated with each other suggesting that each questionnaire is measuring a similar aspect of the construct of mindfulness. Table 3 outlines the relations between the different attention tasks. All significant correlations were in the expected direction except for the relationship between the Switching vs. Inhibition scaled scores and the Inhibition scaled scores of the D-KEFS. This negative relationship implies that for this sample those who performed better on selective attention tended to score lower on the task of attention switching ability. Results from the individual regression analyses examining the relationship between self-report mindfulness and performance on tasks of sustained, selective, and switching attention are presented in Tables 4, 5, and 6 respectively.

Table 1

Descriptive Information for the self-report mindfulness measures and the attention tasks

Variable	Descriptive Statistics			
Self-report mindfulness	Mean	SD	Min	Max
MAAS	55	9.36	36	69
KIMS – act with awareness scale	27.84	5.16	18	39
CAMS-R	31.18	3.94	25	42
Sustained attention				
PASAT %	52.35	12.85	29.17	75.83
CPT-II Omissions T-scores	46.07	4.46	40.86	62
CPT-II Hit RT Std. Error T-scores	48.05	9.11	23.85	67.31
Selective attention				
Cued Stroop Interference scores	158.98	52.7	54.91	280.99
Cued Stroop Color Naming Errors	3.74	3.42	0	13
D-KEFS Inhibition vs. Color Naming SS	11.08	1.83	6	16
D-KEFS Inhibition Error SS	10.18	2.45	3	13
Attention switching				
D-KEFS Inhibition/Switching vs. Inhibition	9.96	2.14	4	16
D-KEFS Inhibition/Switching Error SS	10.62	1.77	6	13

Note. MAAS = Mindful Attention Awareness Scale; KIMS = Kentucky Inventory of Mindfulness Scale; CAMS-R = Cognitive Affective Mindfulness Scale Revised; PASAT % = Paced Auditory Serial Addition Test percentage score; CPT-II = Continuous Performance Test – II; D-KEFS = Delis-Kaplan Executive Functioning System; SS = scaled score.

Table 2

Intercorrelations among Mindfulness Questionnaires

	KIMS act with awareness	CAMS-R
MAAS	.30*	.42**
KIMS act with awareness	1	.42**

Note. MAAS = Mindful Attention Awareness Scale; KIMS = Kentucky Inventory of Mindfulness Scale; CAMS-R = Cognitive Affective Mindfulness Scale Revised.

$^{*}p < .05$, $^{**}p < .01$

Table 3

Intercorrelations among the tasks of sustained, selective, and attention switching tasks

Variables	1	2	3	4	5	6	7	8	9
Sustained attention									
PASAT$_1$	1	-.12	-.40**	-.21	-.21	.16	.10	-.22	-.07
CPT-II Omissions$_2$		1	.14	.08	.24	-.11	-.16	.06	.12
CPT-II Hit RT Std. Error$_3$			1	-.02	-.09	-.10	-.01	.15	.13
Selective attention									
Stroop Interference scores$_4$				1	.16	.17	.05	.17	.36*
Stroop Errors$_5$					1	-.07	-.36*	.04	-.05
D-KEFS Inhibition$_6$						1	.28	-.5**	-.06
D-KEFS Inhibition Errors$_7$							1	-.23	.20
Attention switching									
D-KEFS Switching$_8$								1	.34*
D-KEFS Switching Errors$_9$									1

Note. PASAT = Paced Auditory Serial Addition Test percentage score; CPT-II = Continuous Performance Test – II; D-KEFS = Delis-Kaplan Executive Functioning System.

$^{*}p < .05$, $^{**}p < .01$

Sustained Attention

There was a significant association between the number of target omissions from the CPT-II (Omissions T-score) and self-report mindfulness as measured by the MAAS, $t(46) = -3.94$, $p < .001$, and the CAMS-R, $t(45) = -3.49$, $p < .01$, such that those scoring higher on self-report mindfulness had fewer target omissions than those scoring lower on mindfulness. However, the act with awareness subscale from the KIMS was not significantly associated with target omissions from the CPT-II, $t(46) = -1.40$, $p = .15$. Because of the large number of regression analyses conducted a Bonferroni correction was applied bringing the significant *p* value to .005. The *p* values obtained remained significant as both were at or less than .001.

There were no significant associations between participant's RT variability on the CPT-II (Hit RT Std. Error) and self-report mindfulness, MAAS: $t(48) = -.44$; KIMS act with awareness: $t(48) = -.95$; CAMS-R: $t(47) = -.01$, all *p*s ≥ .35. Similarly there were no significant associations between the percentage of correct responses from the PASAT and self-report mindfulness, MAAS: $t(49) = -.58$; KIMS act with awareness: $t(49) = 1.65$; CAMS-R: $t(48) = 1.48$, all *p*s ≥ .11. Thus, results from the tasks designed to measure sustained attention are mixed. Sustained attention as measured by target omissions from the CPT-II was significantly associated with self-report mindfulness as measured by the MAAS and the CAMS-R, but not the act with awareness subscale from the KIMS. Results suggest that there is not a significant association between self-report mindfulness and sustained attention as measured by either RT variability on the CPT-II or PASAT performance.

Table 4

Results of the Individual Regression Analyses Exploring the Relationship between Self-Report Mindfulness and Tasks of Sustained Attention

Regression Analysis	R^2	b	SE_b	β	t
PASAT %					
MAAS	.01	-.11	.2	-.08	-.58
KIMS – act with awareness scale	.05	.58	.35	.23	1.65
CAMS-R	.05	.69	.47	.21	1.48
CPT-II Omission T-scores					
MAAS	.26	-.23	.06	-.51	-3.94**
KIMS – act with awareness scale	.05	-.18	.12	-.21	-1.47
CAMS-R	.22	-.53	.15	-.47	-3.49**
CPT-II Hit RT Std. Error T-scores					
MAAS	.00	-.06	.14	-.07	-.44
KIMS – act with awareness scale	.02	-.24	.26	-.14	-.95
CAMS-R	.00	< -.01	.34	< -.01	-.01

Note. MAAS = Mindful Attention Awareness Scale; KIMS = Kentucky Inventory of Mindfulness Scale; CAMS-R = Cognitive Affective Mindfulness Scale Revised; PASAT % = Paced Auditory Serial Addition Test percentage score; CPT-II = Continuous Performance Test – II.

**$p \leq .001$

Selective Attention

Verification of the Stroop effect. Paired samples t-tests revealed a robust Stroop effect for both the cued Stroop task as well as the D-KEFS Color-Word Interference test (measured using raw data, not scaled scores), Participants had significantly longer RTs in the incongruent color naming condition than in the control condition, $t(49) = -21.33$, $p < .001$, and took longer to complete the Inhibition condition of the D-KEFS than the control condition of this task, $t(49) = -19.92$, $p < .001$. In addition participants made significantly more color naming errors on the

incongruent color naming portions than the control conditions of these tasks, cued Stroop: $t(49) = -7.45$; D-KEFS: $t(49) = -5.23$, both $ps < .001$.

Cued Stroop interference scores were not significantly associated with self-report mindfulness, MAAS: $t(49) = .96$; KIMS act with awareness: $t(49) = 1.3$; CAMS-R: $t(48) = .41$, all $ps \geq .2$. The number of errors made during the incongruent color naming condition of the cued Stroop task was also not associated with self-report mindfulness, MAAS: $t(49) = .32$; KIMS act with awareness: $t(49) = .45$; CAMS-R: $t(48) = -.07$, all $ps \geq .66$.

Similarly, participants' performance on the D-KEFS Color-Word Interference test was not associated with self-report mindfulness. Inhibition vs. Color Naming scores, were not associated with mindfulness scores, MAAS: $t(49) = 1.64$; KIMS act with awareness: $t(49) = 1.97$; CAMS-R: $t(48) = -1.39$, all $ps \geq .11$ except for the act with awareness subscale which approached significance, $p = .054$. Color naming errors (Inhibition Error Analysis scores) also failed to significantly predict mindfulness scores MAAS: $t(49) = -1.05$; KIMS act with awareness: $t(49) = .17$; CAMS-R: $t(48) = .23$, all $ps \geq .3$. Results do not support a significant relationship between self-reported mindfulness and selective attention as measured by a cued Stroop task, or the D-KEFS Color-Word Interference test.

Table 5

Results of the Individual Regression Analyses Exploring the Relationship between Self-Report Mindfulness and Tasks of Selective Attention

Regression Analysis	R^2	b	SE_b	β	t
Cued Stroop Interference scores					
MAAS	.02	.77	.81	.14	.96
KIMS – act with awareness scale	.03	1.88	1.45	.18	1.3
CAMS-R	<.01	.8	1.95	.06	.41
Cued Stroop Color Naming Errors					
MAAS	<.01	.02	.05	.05	.32
KIMS – act with awareness scale	<.01	.04	.1	.07	.45
CAMS-R	<.01	<.01	.13	-.01	-.07
D-KEFS Inhibition vs. Color Naming SS					
MAAS	.05	.05	.03	.23	1.64
KIMS – act with awareness scale	.08	.1	.05	.27	1.97
CAMS-R	.04	.09	.07	.2	1.39
D-KEFS Inhibition Error SS					
MAAS	.02	-.04	.04	-.15	-1.05
KIMS – act with awareness scale	<.01	.01	.07	.03	.17
CAMS-R	<.01	.02	.09	.04	.23

Note. MAAS = Mindful Attention Awareness Scale; KIMS = Kentucky Inventory of Mindfulness Scale; CAMS-R = Cognitive Affective Mindfulness Scale Revised; D-KEFS = Delis-Kaplan Executive Functioning System.

Attention Switching

No significant association was observed between participant's performance on the Inhibition/Switching condition of the D-KEFS (Inhibition/Switching vs. Inhibition contrast score) and self-report mindfulness, MAAS: $t(49) = .06$; KIMS act with awareness: $t(49) = -.61$; CAMS-R: $t(48) = .5$, all ps ≥ .55. Participant's errors on this condition of the D-KEFS

(Inhibition/Switching Error Analysis score) also were not significantly associated with self-report mindfulness, MAAS: $t(49) = 1.02$; KIMS act with awareness: $t(49) = -1$; CAMS-R: $t(48) = .07$, all $ps \geq .31$. Results suggest that there is not a significant association between self-report mindfulness and attention switching ability as measured by the Inhibition/Switching vs. Inhibition contrast score, or the Inhibition/Switching Error Analysis score from the D-KEFS.

Table 6

Results of the Individual Regression Analyses Exploring the Relationship between Self-Report Mindfulness and Attention Switching Tasks

Regression Analysis	R^2	b	SE_b	β	t
D-KEFS Inhibition/Switching vs. Inhibition					
MAAS	<.01	<.01	.03	.01	.06
KIMS – act with awareness scale	.01	-.04	.06	-.09	-.61
CAMS-R	.01	.04	.08	.07	.5
D-KEFS Inhibition/Switching Error SS					
MAAS	.02	.03	.03	.15	1.02
KIMS – act with awareness scale	.02	-.05	.05	-.14	-1
CAMS-R	<.01	.01	.07	.01	.07

Note. MAAS = Mindful Attention Awareness Scale; KIMS = Kentucky Inventory of Mindfulness Scale; CAMS-R = Cognitive Affective Mindfulness Scale Revised; D-KEFS = Delis-Kaplan Executive Functioning System.

Discussion

The current study sought to further validate the recently developed self-report mindfulness measures by exploring the relation between participants' mindfulness scores and their performance on tasks of attention. The results did not support the hypotheses that self-report mindfulness would be related to performance on tasks of selective attention, or attention switching ability. There was mixed support for the relation between mindfulness scores and

sustained attention performance tasks, such that higher mindfulness scores were negatively related to target omissions on the CPT-II, but were not related to RT variability on the CPT-II or PASAT performance. This section places these findings in the context of the measurement of self-report mindfulness, addresses null findings, and discusses limitations and directions for future research.

The primary finding from this study is a negative relationship between the number of target omissions on the CPT-II and participants' mindfulness scores as measured by the MAAS and the CAMS-R. Consideration of the requirements of this attention task is helpful in the interpretation of these results. On this task, to allow a target letter to pass without responding (target omissions) may be indicative of a more exaggerated lapse in attention, which may better account for participant's subjective experience of being unaware of present experience (i.e. lower self-report mindfulness scores). Baer and Colleagues (2006) note that the MAAS in particular seems to emphasize "an element of mindfulness related to dissociation and absent-mindedness." Thus, participants who score higher on the CAMS-R and the MAAS may be more likely to display lapses in attention such as those measured by target omissions from the CPT-II. This may be particularly true for a sample without mediation experience that has not been socialized to the level of focused attention associated with mindfulness. Qualitatively, the experimenter noted that participants were often able to report that they missed pressing for a number of targets, or pressed when they should not have. This may mirror their ability to report lapses in attention, thus accounting for the significant association between self-report mindfulness and performance on this task.

Notably a relation was not observed between CPT-II omissions and the *act with awareness* subscale from the KIMS. This is unexpected given that this subscale was correlated

with both the MAAS and the CAMS-R, with Pearson's *r*s of .30 and .42 respectively. An examination of individual items does not suggest any large discrepancy in approaches to measurement. For example, several items from the MAAS and the KIMS closely mirror each other; "I drive on 'automatic pilot' without paying attention to what I'm doing," (KIMS *act with awareness*) and "I drive places on 'automatic pilot' and then wonder why I went there." (MAAS) In fact, if any discrepancy exists, one would expect to find it between the CAMS-R and the other measures, because the CAMS-R includes items measuring one's tendency to be accepting of present experience. However, the KIMS *act with awareness* subscale does include items that appear more sensitive to capturing one's experience of highly focused attention (e.g. "When I'm doing something, I'm only focused on what I'm doing, nothing else"; KIMS item 7) as opposed to the MAAS and CAMS-R, many of whose items appear to be focused on absent-mindedness.

It also may be significant that past research has found stronger relations among mindfulness measures than were observed in the present study. In a sample of 115 undergraduates, the KIMS *act with awareness* subscale was correlated with the MAAS at .57 (Baer et al., 2004). In fact, in the afore mentioned study three of the four KIMS subscales were positively correlated with MAAS scores, whereas only the *act with awareness* subscale was significantly related to MAAS scores in the present study. This discrepancy may be the result of the smaller sample size used in the present study (n = 50). The weaker correlations among self-report mindfulness measures observed in the present study, may explain in part the lack of relation between target omissions and the KIMS *act with awareness* subscale.

Mindfulness scores were not related to sustained attention as measured by the variability in participant's RTs on the CPT-II, or the percentage of correct responses on the PASAT. First, it is notable that the PASAT and the Hit RT Std. Error scores were moderately correlated with each

other (r = .40), but not related to the CPT-II omissions score (r = -.12 & .14 in the expected directions) suggesting that target omissions from this task is measuring a different aspect of sustained attention than the other tasks. As discussed above, target omissions may better represent lapses of attention. Similarly, RT variability on the CPT-II may measure a degree of focused attention ability that is required to produce consistent RTs (in milliseconds), and that may not be related to participant's self-report of subjective experience of awareness of the present moment, particularly in a sample without meditation experience. In other words, those with meditation experience may be more discriminating in how they rate their attention to present experience, whereas those without mindfulness training are more likely to recognize only gross lapses in attention and endorse accordingly. This may explain why CPT-II omissions were significantly related to self-report mindfulness (MAAS & CAMS-R), and RT variability was not.

Similar consideration of the task requirements of the PASAT may also help to understand this null finding. Although the PASAT is most largely related to attention, it is recognized as a measure of multiple cognitive functions, including working memory and processing speed (Tombaugh, 2006). Whereas sustained attention is required to maintain vigilance during this difficult task, correct responding also requires the ability to hold numerical information in working memory while simultaneously performing arithmetic. This task is a good illustration of how difficult it can be to parse out different aspects of executive functioning. For example, working memory and attention are thought to be highly related, and performance of one is likely intertwined with performance of the other. In addition Tombaugh (2006) reports that the PASAT is a highly sensitive test that is negatively impacted by low math ability. Further research conducted with this task may consider including a test such as the Math Fluency subtest from the

Woodcock Johnson-III Achievement battery to control for arithmetic ability under timed conditions.

Although findings regarding the relation between self-report mindfulness and sustained attention were mixed, results suggest that continued research is warranted in this area. Whereas these attention tasks fall under the umbrella of sustained attention, lack of correlation between performances on these tasks suggests measurement of varied sustained attention skills. Further research should focus on replicating the finding that the relation between sustained attention and self-report mindfulness is better explained in the measurement of more exaggerated lapses in attention, as may be indicated by target omissions from the CPT-II. Alternate versions of the CPT that require responding to a small ratio of targets vs. non-targets should also be considered, as they are thought to be even more sensitive to the measurement of lapses in sustained attention (Hsieh et al., 2004).

The hypotheses that self-report mindfulness would be related to selective attention and attention switching ability were not supported. This was true for performance on both the cued Stroop task as well as the Color-Word Interference test from the D-KEFS. One explanation for this null finding may reside in the restricted range of mindfulness scores obtained in the present study. The means and standard deviations for all three instruments (MAAS, KIMS *act with awareness*, & CAMS-R) were very closely matched to those obtained in other student samples (Brown & Ryan, 2003; Baer et al., 2004; & Feldman et al., 2005). As part of the validity assessment of these measures, researchers have noted that those with mediation experience score significantly higher on self-report mindfulness than do student samples (Brown & Ryan, 2003; Baer et al., 2004; & Feldman et al., 2005). This is important because past research sighting a relation between mindfulness skill and attention has reported group differences between controls

and experienced meditators. Thus, the comparisons have been between student or control samples with student self-report mindfulness scores equivalent to those in the present study, and meditation groups scoring significantly higher on self-report mindfulness. This leaves open the possibility that the previously documented relation between meditation experience and attention ability (Valentine & Sweet, 1999, Rani & Andhra, 2000; Rani & Rao, 1996; Linden, 1973) is curvilinear, such that a certain amount of experience or a certain level of mindfulness skill is necessary before actual improvements in attention take place. This is consistent with the findings of Valentine and Sweet (1999) who reported group differences between meditators and non-meditators on a sustained attention task, but further noted that amongst meditators, the amount of meditation experience was a significant predictor of task performance.

The idea that qualitative shifts may take place with the acquisition of mindfulness skills is not new. Other research has noted that certain facets of mindfulness may change as one gains meditation experience (Baer et al., 2004; Baer et al., 2006; Shapiro et al., 2006). Amongst a student sample, Baer and colleagues (2006) found that the tendency to observe more subtle stimuli in one's environment was negatively correlated with the tendency to allow experiences without judging them (acceptance). They suggested that without training in attitudes of acceptance, the tendency to observe experience is likely to be associated with judgment of this experience. When the same relationship was examined amongst a group with meditation experience, there was a positive correlation between the "observe" and "acceptance" facets of mindfulness. It is possible that just as the relation between observance and acceptance of present experience appears to change with increased mindfulness skill, so may the relation between self-report mindfulness and attention. Future work should explore the relationship between self-report

mindfulness and attention ability with a sample that includes experienced meditators in order to address the possibility of a curvilinear relationship between these variables.

The self-report measures of mindfulness included in the present study were designed to measure one's tendency to be aware of present experience over time, or what one might term as *trait* mindfulness. Some prior work has found evidence that improvements in attention ability are only achieved shortly after mindfulness meditation, or when one may be in a more mindful *state* (Rani & Rao, 2000). It is notable that prior validation of these mindfulness measures has almost exclusively involved comparisons with other self-report instruments; (i.e. comparing trait mindfulness to other traits). The exception was a follow-up study from Brown and Ryan (2003) who found that, in a student sample, 29% of the variation in state mindfulness was accounted for by trait mindfulness. Although this association between state and trait mindfulness was significant, it attributes 71% of state mindfulness variance to within-person variability. Further, this study found that state and trait mindfulness contributed independently to measures of well-being. What these findings suggest is that, within student samples, there is a considerable amount of variance in *state* mindfulness. Therefore, the *trait* measures used in the present study may not be sensitive enough to capture current mindful states that would be expected to be related to attention. This is because all previous research demonstrating a relation between mindfulness and attention has either used experienced meditators or those who have just completed a mindfulness exercise, and are in a mindful state. This begs the question as to whether mindfulness may be better conceptualized as a state in a population without meditation experience. Future research should address differences in both state and trait mindfulness as it relates to attention ability. The Toronto Mindfulness Scale (Bishop et al., 2003), which assesses

the degree to which one is able to reach a mindful state during meditation, might be useful is such a study.

The present study attempted to focus on attentional ability. Future research should also include an examination of the relation between self-report mindfulness and attentional bias. Shapiro and colleagues (2006) suggest that mindfulness involves a type of inhibition that may be capable of interrupting attentional bias processes. They describe that true experiencing of the present moment, involves "suspending" all interpretation of experience. They suggest that this may involve inhibition of "secondary elaborative processing" or the additional processing of thoughts, emotions, or sensations that occurs when interpretation of stimuli occurs. This has been termed as "cognitive inhibition" by Williams and colleagues (1996), and may be measured through tasks such as an emotional Stroop task or dot-probe paradigms. This research is complicated by the difficulty of reliably detecting attentional biases in non-clinical samples (MacLeod, 2005); therefore, clinical samples may be better suited for future studies of this kind. Additionally, it may be interesting to examine whether mindfulness training reduces attentional biases in a clinical sample. Measuring these biases pre- and post a mindfulness intervention may provide a means of comparing changes in self-report mindfulness with an objective measure of improvement in attentional bias.

In summary, this study points the way toward future work examining the association of attention and self-report mindfulness. The mixed results regarding the relation between self-report mindfulness and sustained attention suggest that this is an area in need of further study. Replication of these findings with attention to discriminating between lapses in attention and subtle variation in focused attention is a first step. Although the prediction that self-report mindfulness would be related to selective attention and attention switching ability were not

supported, further research should be conducted with a sample representing a larger range of mindfulness scores (e.g. those with mediation experience) to determine whether a curvilinear relationship exists between these variables. Work examining the association of both state and trait mindfulness with attention may help to further examine whether mindfulness is best characterized (and measured) as a state or a trait in samples without meditation experience.

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Appendix A

Demographic Information

Subject #_____ **Date:_____**

Please fill out the following information

1. Age _____

2. Date of Birth _____

3. Year/Classification in Georgia State _____

4. Place of Birth (city, state, country) _____

5. Marital status: Married_____ Single_____ Divorced_____ Separated_____

Living with someone_____ Widowed_____

6. Gender: Male _____ Female _____

7. Have you ever had formal or informal meditation training? (e.g. meditation classes, yoga, or self-help tapes or books) Yes_____ No_____

If yes, please elaborate. Please include the amount of time spent meditating (hours per week) past or current, as well as length of practice (e.g. "I have been going to yoga once a week for two hours for the past six months."): _____

_____

_____

_____

8. Your racial/ethnic origin (please check one)

African American ____

Caucasian ____

Hispanic ____

Asian American ____

Biracial/multiracial ____

Native Hawaiian or Other Pacific Islander ____

American Indian/ Alaska Native ____

Other (please specify) _____

9. Current total annual household income (check one):

Less than $5,000 ____

$5,000 – $10,000 ____

$10,000 – $20,000 ____

$20,000 – $30,000 ____

$30,000 - $50,000 ____

$50,000 - $75,000 ____

More than $75,000 ____

10. Do you wear glasses or corrective lenses? Yes_____ No_____

If yes, do you feel your vision is adequately corrected? _____

11. Do you have any history of color blindness? Yes_____ No_____

Appendix B

Mindful Attention Awareness Scale (MAAS)

Below is a collection of statements about your everyday experiences. Using the 1-6 scale below, please indicate how frequently or infrequently you have each experience. Please answer according to what *really reflects* your experience rather than what you think your experience should be.

1----------2----------3----------4----------5----------6

almost always almost never

_____1. I could be experiencing some emotion, and not be conscious of it until some time later.

_____2. I break or spill things because of carelessness, not paying attention, or thinking of something else.

_____3. I find it difficult to stay focused on what's happening in the present.

_____4. I tend to walk quickly to get where I'm going without paying attention to what I experience along the way.

_____5. I tend not to notice feelings of tension or physical discomfort until they really grab my attention.

_____6. I forget a person's name almost as soon as I've been told it for the first time.

_____7. It seems I am "running on automatic" without much awareness of what I'm doing.

_____8. I rush through activities without really being attentive to them.

_____9. I get so focused on the goal I want to achieve that I lose touch with what I am doing right now to get there.

_____10. I do jobs or tasks automatically, without being aware of what I am doing.

_____11. I find myself listening to someone with one ear, doing something else at the same time.

_____12. I drive places on “automatic pilot” and then wonder why I went there.

_____13. I find myself preoccupied with the future or the past.

_____14. I find myself doing things without paying attention.

_____15. I snack without being aware that I am eating.

Appendix C

Kentucky Inventory of Mindfulness Skills (KIMS) Bolded items load on the *Act with Awareness* sub-scale.

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

1	**2**	**3**	**4**	**5**
Never or very rarely true	**Rarely true**	**Sometimes true**	**Often true**	**Very often or always true**

_____1. I notice changes in my body, such as whether my breathing slows down or speeds up.

_____2. I'm good at finding the words to describe my feelings.

_____3. When I do things, my mind wanders off and I'm easily distracted.

_____4. I criticize myself for having irrational or inappropriate emotions.

_____5. I pay attention to whether my muscles are tense or relaxed.

_____6. I can easily put my beliefs, opinions, and expectations into words.

_____7. When I'm doing something, I'm only focused on what I'm doing, nothing else.

_____8. I tend to evaluate whether my perceptions are right or wrong.

_____9. When I'm walking, I deliberately notice the sensations of my body moving.

_____10. I'm good at thinking of words to express my perceptions, such as how things taste, smell, or sound.

_____11. I drive on "automatic pilot" without paying attention to what I'm doing.

_____12. I tell myself that I shouldn't be feeling the way I'm feeling.

_____13. When I take a shower or bath, I stay alert to the sensations of water on my body.

_____14. It's hard for me to find the words to describe what I'm thinking.

_____15. When I'm reading, I focus all my attention on what I'm reading.

_____16. I believe some of my thoughts are abnormal or bad and I shouldn't think that way.

_____17. I notice how foods and drinks affect my thoughts, bodily sensations, and emotions.

_____18. I have trouble thinking of the right words to express how I feel about things.

_____19. When I do things, I get totally wrapped up in them and don't think about anything else.

_____20. I make judgments about whether my thoughts are good or bad.

_____21. I pay attention to sensations, such as the wind in my hair or sun on my face.

_____22. When I have a sensation in my body, it's difficult for me to describe it because I can't find the right words.

_____23. I don't pay attention to what I'm doing because I'm daydreaming, worrying, or otherwise distracted.

_____24. I tend to make judgments about how worthwhile or worthless my experiences are.

_____25. I pay attention to sounds, such as clocks ticking, birds chirping, or cars passing.

_____26. Even when I'm feeling terribly upset, I can find a way to put it into words.

_____27. When I'm doing chores, such as cleaning or laundry, I tend to daydream or think of other things.

_____28. I tell myself that I shouldn't be thinking the way I'm thinking.

_____29. I notice the smells and aromas of things.

_____30. I intentionally stay aware of my feelings.

_____31. I tend to do several things at once rather than focusing on one thing at a time.

_____32. I think some of my emotions are bad or inappropriate and I shouldn't feel them.

_____33. I notice visual elements in art or nature, such as colors, shapes, textures, or patterns of

light and shadow.

_____34. My natural tendency is to put my experiences into words.

_____35. When I'm working on something, part of my mind is occupied with other topics, such as what I'll be doing later, or things I'd rather be doing.

_____36. I disapprove of myself when I have irrational ideas.

_____37. I pay attention to how my emotions affect my thoughts and behavior.

_____38. I get completely absorbed in what I'm doing, so that all my attention is focused on it.

_____39. I notice when my moods begin to change.

Appendix D

Cognitive and Affective Mindfulness Scale – Revised (CAMS-R)

People have a variety of ways of relating to their thoughts and feelings. For each of the items below, rate how much each of these ways applies to *you*.

1	2	3	4
Rarely/Not at all	Sometimes	Often	Almost Always

_____ 1. It is easy for me to concentrate on what I am doing.

_____ 2. I am preoccupied by the future.

_____ 3. I can tolerate emotional pain.

_____ 4. I can accept things I cannot change.

_____ 5. I can usually describe how I feel at the moment in considerable detail.

_____ 6. I am easily distracted.

_____ 7. I am preoccupied by the past.

_____ 8. It's easy for me to keep track of my thoughts and feelings.

_____ 9. I try to notice my thoughts without judging them.

_____ 10. I am able to accept the thoughts and feelings I have.

_____ 11. I am able to focus on the present moment.

_____ 12. I am able to pay close attention to one thing for a long period of time.