2009

EFFECTS OF MINDFULNESS AND MEDITATION EXPERIENCE ON COGNITIVE AND EMOTIONAL FUNCTIONING AND EGO DEPLETION

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ABSTRACT OF DISSERTATION

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The Graduate School
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A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the College of Arts and Sciences at the University of Kentucky

By
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Lexington, KY

Director: Dr. Ruth A. Baer, Professor of Psychology

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Mindfulness is increasingly recognized as an important phenomenon both clinically and empirically, with mindfulness-based interventions demonstrated to be efficacious across a wide variety of patient populations and disorders (i.e., Baer, 2003). Though debate regarding the exact definition of mindfulness continues, generally accepted definitions involve the common elements of intentionally directing attention toward the present moment and adopting an accepting, nonjudgmental, and/or nonreactive orientation, intent, or attitude (i.e., Baer et al., 2006; Bishop et al., 2004). Several testable predictions in the cognitive and emotional domains were derived from the operational definition of mindfulness provided by Bishop et al. (2004). Recent empirical work (i.e., Chambers, Lo, & Allen, 2008; Valentine & Sweet, 1999) has supported Bishop et al.'s predictions, providing initial validation of their operationalization of mindfulness. However, most work on the effects of meditation practice and the mindfulness construct has relied on self-report methodology. The current work transcended past research by using behavioral methods to investigate the effects of meditation practice, correlates of trait mindfulness, and validity of current conceptualizations of mindfulness. Additionally, the current work investigated relationships between meditation, mindfulness, and self-regulation using behavioral methods. This investigation was warranted as recent theoretical work suggested that increased self-control abilities may be the primary mechanism by which mindfulness-based interventions work and that higher levels of trait mindfulness may appear to be related to enhanced well-being due to the unmeasured third variable of enhanced self-regulatory abilities (Masicampo & Baumeister, 2007). Ninety-eight individuals (33 meditators, 33 age-matched nonmeditating controls, and 32 students) completed self-report and behavioral measures of attention, learning, memory, cognitive and emotional biases, and self-regulation in individual sessions. Results demonstrated that meditation practice related to few of the measured constructs, with significant group differences detected between the meditators and nonmeditators in short-term memory, long-term memory, and self-regulation only. Self-reported trait mindfulness in the nonmeditators related only to self-reported psychological well-being. These results stand in stark contrast to most of the current literature on meditation and mindfulness. The research raises more questions about the effects of meditation practice and conceptualization of mindfulness than it answers, though multiple interpretations of the data are possible.

KEYWORDS: Meditation, mindfulness, behavioral measures, neurocognition, self-regulation

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ACKNOWLEDGMENTS

My dissertation, as with all aspirations in my life, benefited from the support and assistance I have been blessed to receive from my beloved family. To my husband, Dustin, I would like to thank you for your love, friendship, endless entertainment, patience, acceptance, encouragement, and care for my well-being, as well as for the meaning and happiness you bring to life each and every day. You have changed how I see the world. Innumerable thanks also to my parents, Rod and Martha, and my sister, Liz, for being your wonderful selves, filling my life with love, friendship, and laughter through all our shared times, supporting me through hard times, and demonstrating that life is all about the journey. I know I can count on you all for absolutely anything. I would also like to acknowledge Elliot and Poe who entertain me immensely and provide love on a daily basis. Without my family, I would not be who I am today, and accomplishments would lose their meaning.

This project also benefited from the insights and direction of several people. I am indebted to my advisor, Dr. Ruth Baer, who provided intellectual stimulation and instruction, encouragement, and support through every stage of graduate school and this project. She is an excellent mentor because she takes a personal interest in the success and well-being of her students. I would also like to thank the other faculty on my Dissertation Committee: Dr. Michael Andrykowski, Dr. Lawrence Gottlob, and Dr. Sherry Warden. Each provided insights that helped to guide the project to its completion.

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Chapter One

Introduction

The mindfulness construct has recently received significantly increased attention in both the clinical and empirical domains. Mindfulness developed out of eastern spiritual traditions that suggest that mindfulness can be cultivated through regular meditation practice and that the development of mindfulness will likely result in reduced suffering and increases in positive personal qualities, such as awareness, insight, wisdom, compassion, and equanimity (Goldstein, 2002; Kabat-Zinn, 2000). Non-religious adaptations of traditional mindfulness practices have been incorporated into a variety of psychological interventions that conceptualize mindfulness as a set of skills that can be learned and practiced to reduce suffering and increase well-being. These interventions include dialectical behavior therapy (DBT; Linehan, 1993a, 1993b), mindfulness-based stress reduction (MBSR; Kabat-Zinn, 1982, 1990), mindfulness-based cognitive therapy (MBCT; Segal, Williams, & Teasdale, 2002), acceptance and commitment therapy (ACT; Hayes, Strosahl, & Wilson, 1999), relapse prevention for substance abuse (Marlatt & Gordon, 1985; Parks, Anderson, & Marlatt, 2001), and variants of these approaches. Interventions incorporating mindfulness have been shown to be efficacious across a wide variety of patient populations and disorders, including both psychological and medical disorders (Baer, 2003; Grossman, Niemann, Schmidt, & Walach, 2004; Kabat-Zinn et al., 1992; Kenny & Williams, 2007; Kutz et al., 1985; Ramel, Goldin, Carmona, & McQuaid, 2004; Miller, Fletcher, & Kabat-Zinn, 1995; Semple, Reid, & Miller, 2005).

While debate over the precise definition of mindfulness continues, generally accepted conceptualizations involve the multiple common elements of intentionally directing attention toward the present moment and adopting an accepting, nonjudgmental, and/or nonreactive orientation, intent, or attitude (Bare et al., 2006; Bishop et al., 2004; Brown & Ryan, 2003; Fletcher & Hayes, 2005; Kabat-Zinn, 1990; Linehan, 1993a; Marlatt & Kristeller, 1999). Mindfulness is contrasted with states of mind in which attention is focused elsewhere, such as preoccupation with mental events outside of present experience (memories, worries, plans, etc.) or with behaving automatically and without awareness (Baer et al., 2006; Bishop et al., 2004; Brown & Ryan, 2003). Bishop et al. (2004) provided a widely cited operational definition of mindfulness and proposed several testable predictions that, if confirmed, would contribute to the validation of the mindfulness construct. Similar to many definitions in the field, this conceptualization of mindfulness includes the self-regulation of attention directed toward the immediate present and the adoption of a curious, open, and accepting orientation toward one's present moment experiences. Because mindfulness includes the self-regulation of attention, Bishop et al. (2004) predicted that increases in mindfulness should lead to increases in the specific attentional abilities of *sustained attention*, or the ability to maintain a state of vigilance over prolonged periods of time (Posner & Rothbart, 1992), *switching*, or flexibility of attention so that one can shift focus from one object to another (Posner, 1980), and *inhibition of secondary elaborative processing* of thoughts, feelings, and sensations that arise in response to a stimulus. Additionally, because mindfulness includes an open and accepting stance toward whatever one experiences, it was predicted that mindfulness practice should lead to *less experiential avoidance* and *improved affect tolerance*. Thus, mindfulness practice was hypothesized to lead to improvements in specific aspects of cognitive and emotional functioning.

Although these hypotheses were not tested by Bishop et al. (2004), multiple investigations have begun to support their assertions regarding the impact of meditation experience on attentional control. For example, Chambers, Lo, and Allen (2008) found that participation in an intensive 10-day mindfulness meditation retreat led to significant increases in self-reported mindfulness and performance-based measures of working memory and sustained attention, relative to a control group who did not receive mindfulness training. Valentine and Sweet (1999) demonstrated that individuals with meditation experience had superior performance on tests of sustained attention when compared with controls and that long-term meditators had better performance than did short-term meditators. Slagter et al. (2007) demonstrated that three months of meditation training resulted in a significantly smaller attentional blink deficit and reduced brain-resource allocation to an initial target in those receiving the training, as compared with a matched control group. The attentional blink deficit refers to an effect wherein a second target presented in close temporal proximity to an initial target in a rapid stream of events often is not seen, which is attributed to competition between the two targets for limited attentional resources. These findings all appear supportive of the notion that mindfulness practice leads to increased attentional control.

Results suggesting that meditation practice leads to increases in more specific aspects of attentional functioning have also been found. For example, Tang et al. (2007) demonstrated that five days of meditation training led to increased conflict monitoring, or an increased ability to prioritize among competing tasks and responses, which suggests superior executive attentional abilities. Similarly, Jha, Krompinger, and Baime (2007) demonstrated that experienced meditators had superior conflict monitoring relative to those without meditation experience. Jha et al. (2007) also demonstrated that participants who completed an 8-week MBSR group, which involves extensive practice of mindfulness meditation exercises, showed significant improvements in directing and limiting attention (orienting) after training, while experienced meditators who took part in a one month intensive retreat showed significant improvements in achieving and maintaining an alert state of preparedness (alerting).

Another body of literature has examined the impact of meditation experience and self-reported mindfulness skills on orientation to present moment experiences. Several mindfulness questionnaires have been developed recently, and the most comprehensive appears to be the Five Facet Mindfulness Questionnaire (FFMQ; Baer et al., 2006) which is based on a factor analysis of several independently developed mindfulness instruments. Research utilizing the FFMQ has shown that, even after controlling for demographic variables such as age, education, and mental health training, meditation experience is significantly associated with levels of self-reported mindfulness, suggesting that the practice of mindfulness meditation leads to increases in the self-reported tendency to use mindfulness skills in daily life (Baer et al., 2007; Carmody & Baer, 2008; Lykins & Baer, in press). Lykins & Baer (in press) also found that both meditation experience and total mindfulness scores from the FFMQ were significantly positively associated with openness to experience, reflection, psychological well-being, and self-compassion and negatively associated with thought suppression, fear of emotion, difficulties in emotion regulation, cognitive failures, rumination, and psychological symptoms. Significant group differences between meditators and nonmeditators were found in the expected directions for most of these variables. Mediation analyses supported the hypothesis that increases in the general tendency to be mindful mediate the relationship between meditation experience and well-being. That is, meditation practice appears to lead to increased mindfulness in daily life, which in turn facilitates psychological health. Chambers et al. (2008) found that participation in an intensive 10-day meditation retreat led to significant decreases in depressive symptoms and rumination relative to a control group, while Tang et al. (2007) found that a brief mindfulness training led to lower anxiety, depression, anger, and fatigue and higher vigor and to a significant decrease in stress-related cortisol and an increase in immunoreactivity. These studies support the notion that mindfulness training decreases experiential avoidance, improves affect tolerance, and improves general emotional functioning, though they relied primarily on self-report methodology, which is problematic in several ways.

However, additional studies have begun to use more objective behavioral methods to study the relationship between the adoption of a mindful stance toward present-moment experience and emotional functioning. For example, Wenk-Sormaz (2005) demonstrated that a mindfulness induction in the laboratory promoted less automatized and habitual responding on an emotional Stroop task, suggesting increases in attentional control in the emotional domain. Campbell-Sills, Barlow, Brown, and Hofmann (2006) demonstrated that individuals diagnosed with mood and anxiety disorders who were instructed to watch a distressing film clip in an accepting, mindful way experienced faster recovery from the induced negative affect than those instructed to suppress their reactions to the film. Arch & Craske (2006) showed that individuals completing a focused breathing induction in which they were instructed to focus nonjudgmental attention on their breath, as compared with individuals engaging in unfocused attention or worrying, experienced the least emotional volatility while viewing emotion-relevant slides and the greatest willingness to view highly negative slides (Arch & Craske, 2006). Further, individuals high in anxiety sensitivity who received training in acceptance through the use of the Chinese finger trap metaphor (Hayes et al., 1999), which demonstrates how an accepting orientation can be used more successfully than a resisting orientation in response to a challenging situation, were demonstrated to be less behaviorally avoidant and fearful than participants engaging in diaphragmatic breathing or receiving no instructions when inhaling carbon dioxide enriched air (Eifert & Heffner, 2003). These studies provide behavioral evidence that mindfulness leads to increased emotional flexibility, decreased experiential avoidance, and improved affect tolerance.

Despite the promise of these newly developed psychotherapeutic techniques and the developing evidence supporting the notion that mindfulness practice increases attentional control and improves emotional functioning, some fundamental questions regarding the cognitive, emotional, and self-regulatory effects of mindfulness remain. While some studies have demonstrated effects of mindfulness practice on cognitive abilities, these studies are few in number and support only some of Bishop et al.'s (2004) hypotheses. No studies have specifically demonstrated effects of mindfulness on attention switching or inhibition of elaborative processing, though some studies may be suggestive of these phenomena. Additionally, many aspects of cognitive functioning have not been examined in relation to mindfulness skills, though they are known to be related to attentional processes. For example, both working memory (or activated memory) and long-term memory are largely dependent upon present moment direction of attention (Cowan, 1997). Thus, the influence of mindfulness practice on switching and inhibition of elaborative processing, as well as working and long-term memory, deserves investigation. Further, while the Chambers et al. (2008) study demonstrated superior working memory performance following participation in a mindfulness retreat, the processes underlying this finding were not examined. An increase in working memory performance could be due to an increase in the capacity of working memory or to the superior use of chunking strategies. Thus, the question of why working memory performance is improved also merits investigation. Further, no known studies have used behavioral methodologies to examine the influence of meditation status (meditator versus nonmeditator) on orientation to one's present-moment experiences. Finally, as mindfulness skills vary naturally in the population even in the absence of meditation practice (Baer et al., 2006), the influence of trait mindfulness on cognitive and emotional functioning should also be investigated. The current study will attempt to address these identified holes in the literature by examining the influence of mindfulness practice and trait mindfulness on vigilance, sustained attention, switching, working memory, long-term memory, inhibition of elaborative processing, and orientation to emotional experiences. In addition, if the previous finding that working memory performance is superior in meditators (as compared with nonmeditators) is replicated, the current study will investigate potential reasons for this finding.

An additional goal of the present study is to explore the impact of meditation experience and mindfulness on self-regulation. Self-regulation refers to the capacity to engage in behavior guided by goals or standards and to alter or override one's own response tendencies, including thoughts, emotions, and actions, when necessary to pursue goals or meet standards. The process of self-regulation is strongly influenced by executive functioning and is activated when a discrepancy is detected between one's current state and one's goals or expectancies. Self-regulatory capacity has been demonstrated to function as a reserve of strength, with the ability to self-regulate declining over prolonged or multiple efforts, a temporary effect known as ego depletion. In multiple studies, when participants are first asked to complete a self-control task, performance on a second, unrelated, task has been found to be worse than that of a control group who has not just engaged in a depleting task (Baumeister, 2002). For example, participants have been found to squeeze a handgrip for a shorter period of time after being asked to amplify or suppress emotions while watching a sad video clip compared with individuals who were not asked to regulate their emotions (Muraven, Tice, & Baumeister, 1998). Another study demonstrated that individuals who were asked to eat only from a bowl of radishes while seated in front of chocolates and cookies after having skipped a meal subsequently gave up faster on geometric figure tracing puzzles as compared with controls who either were able to eat the sweets or who were not exposed to food of any kind during the task (Baumeister, Bratslavsky, Muraven, & Tice, 1998). Multiple other studies have shown the same pattern, in which a first act of self-control diminishes the ability to engage in self-control on a second, unrelated, task, suggesting that acts of self-control consume some quantity of self-regulatory resources and temporarily impair the ability to self-regulate effectively, thus creating a state of ego depletion in which the self is temporarily operating at less than full self-regulatory power.

Research has ruled out factors such as the recognition that the task as impossible, the self-control task being more unpleasant than the control condition, the self-control act inducing negative affect, and the perception that one has done enough to satisfy experimental demands as alternate explanations for results found in ego depletion studies.

This state of depletion can be alleviated through sleep, rest, and positive emotionality (Baumeister, 2002). The ability to self-regulate can be improved over time through regular exercise in self-control. Multiple studies have demonstrated that participants who were assigned to engage in the regular practice of one of various forms of self-regulation, such as engaging in physical exercise, regulating posture, speech control, or the use of one's nondominant hand, were found to have improved self-regulatory stamina, and thus reduced susceptibility to ego depletion, on laboratory tasks compared with controls who had not engaged in such regular practice (Masicampo & Baumeister, 2007). While differences in self-regulatory strength have not been demonstrated as a result of such practice, the possibility that strength could be improved through regular self-control practice has been acknowledged theoretically (Baumeister, 2002).

The effects of meditation practice and mindfulness on self-regulation should be examined for a number of reasons. Attentional control has long been recognized as critical to the processes that underlie regulation of behavior, with dysregulation occurring when internal signals are ignored, suppressed, or cognitively exaggerated (Shapiro & Schwartz, 2000). The intentional cultivation of mindful attention may promote self-regulation by allowing for increased attentional sensitivity to psychological, somatic, and environmental cues (Kabat-Zinn, 1982; Linehan, 1993a) or by encouraging awareness of stimulus-response relationships previously associated with mindless, habitual, or overlearned behavior (Brown, Ryan, & Creswell, 2007; Leary, Adams, & Tate, 2006). Trait mindfulness has been found to correlate significantly with self-reports of ability to self-regulate, goal setting, goal clarity, and a stronger intention-behavior relationship (Baer et al., 2006; Chatzisarantis & Hagger, 2007; Kee & Wang, 2008; Lykins & Baer, in press), while a mindfulness induction and the intentional direction of attention, respectively, have been shown to lead to less automatized and habitual responding and to the ability to override unwanted responses (Baumeister, Heatherton, & Tice, 1994; Wenk-Sormaz, 2005), all suggestive of more effective self-regulation. Thus, a preliminary link between mindfulness and self-regulation has been established.

As self-control abilities have been shown to be related to many aspects of positive functioning (Tangney, Baumeister, & Boone, 2004), it seems important to determine how mindfulness-related concepts are related to the ability to self-regulate on behavioral tasks.

Additionally, recent theoretical work has suggested that trait mindfulness may be related to well-being because both are caused by the third variable of ability to successfully self-regulate and that mindfulness-based interventions may produce beneficial outcomes because they ask participants to practice self-control and thus increase the general capacity for self-regulation (Masicampo & Baumeister, 2007). However, no empirical work thus far has actually examined how meditation practice or trait mindfulness relate to one's demonstrated ability to self-regulate. Thus, an investigation of this nature is important practically and theoretically. As the deliberate direction of attention involves self-regulation, the tasks involved in the current study should be ego-depleting. If meditation practice cultivates the ability to direct attention mindfully while using fewer central executive resources, then meditators should show higher performance on attentional tasks and less evidence of ego depletion after completing these tasks than nonmeditators. It is also possible that those with higher levels of mindfulness skills in the absence of meditation experience will also experience less ego depletion from directing attention mindfully.

In summary, the general aims of the proposed research are to investigate the cognitive, emotional, and self-regulatory effects of mindfulness practice using non-self-report methodology. The knowledge and practical applications that can be gained from this investigation are important both conceptually and practically. First, this research can further demonstrate how and the extent to which meditation affects cognitive and emotional processes and will be the first investigation of this type to examine self-regulatory processes. It will additionally be the first investigation using behavioral methodology to investigate the impact of trait mindfulness on cognitive, emotional, and self-regulatory processes. These issues have far reaching implications regarding the impact and potential uses of meditation or mindfulness-based interventions and trait mindfulness, as well the validity of current conceptualizations of mindfulness.

Chapter Two

Methodology

Participants

Data were collected from three samples of participants: regular meditators (N = 33), age-matched nonmeditating controls (N = 33), and nonmeditating students (N = 32). For the first set of primary questions of this research, the comparison of meditators and nonmeditating controls on attentional processes, orientation to emotional experience, and self-regulation, a power analysis based on the most relevant data found in the literature at the time (Chambers et al., 2008; Lykins & Baer, in press; Valentine & Sweet, 1999) led to an estimated effect size of d = .71, meaning 33 individuals per group were required to adequately assess questions regarding meditation status (alpha = .05, power = .80). Recruitment successfully filled this desired sample size. For the second set of primary research questions, the examination of impact of trait mindfulness in the absence of meditation experience, a power analysis based on relevant literature (Baer et al., 2006; Lykins & Baer, in press) led to an estimated effect size of *r* = .34, meaning 60 total nonmeditating individuals were required to adequately assess questions regarding impact of trait mindfulness (alpha = .05, power = .80). Recruitment successfully filled this desired sample size by combining the nonmeditating control and nonmeditating student groups.

Participants were recruited through fliers (meditating group), listserv posts to University employees (meditating and nonmeditating control groups), recruitment e-mails to meditators identified from past studies (meditating group), and the PSY 100 subject pool (meditating, nonmeditating control, and nonmeditating student groups). To qualify for the meditating group, individuals were required to have been meditating regularly (at least twice per week for 20 minutes each time) for at least one year in a mindfulness-based tradition. To qualify for the nonmeditating control or student groups, participants must have had no experience with mindfulness meditation. For the meditating and nonmeditating control groups, participants contacted the researcher if interested in the study and details of the research were provided. For meditating participants who qualified, if he/she was still interested following receipt of detailed study information, a study appointment was scheduled. Participants from the PSY 100 subject pool were identified as potential participants for the meditating group only if they reported adequate meditation experience on an initial screening form and if this experience was confirmed at appointment. For potential participants for the nonmeditating control group, following participant contact and the provision of study details, a list of potential nonmeditating control participants was maintained and participants were contacted to participate in the order of initial contact once matched with a meditating participant within five years of age. For participants for the nonmeditating student group, participants signed themselves up for the experiment based on standard University procedures. Participants received either partial credit toward course completion of required experimental hours or $50 for their participation.

Demographic characteristics of the meditating, nonmeditating control, and nonmeditating student samples can be seen in Table 1. The meditating and nonmeditating control groups only were compared for analyses examining the impact of meditation experience, while the nonmeditating control and student groups only were used for examination of the impact of trait mindfulness in the absence of meditation experience. When comparing the meditating and nonmeditating control groups, the age-matched samples did not differ significantly on age, $t(64) = -0.02$, *ns*, gender, $\chi^2(1) = 0.99$, *ns*, minority status, $\chi^2(1) = 0.22$, *ns*, or years of completed education, $t(64) = 0.91$, *ns*. They also did not differ on the proportion of group ever diagnosed with a psychological disorder, $\chi^2(1) = 0.23$, *ns*, or currently diagnosed with a psychological disorder, $\chi^2(1) = 0.84$, *ns*. The meditating group was composed of 37% of individuals ever diagnosed with a psychological disorder (15% currently diagnosed), while 31% of the nonmeditating control group was ever diagnosed (21% currently diagnosed). For the meditating group, 22% of individuals reported ever being diagnosed with an anxiety disorder and 19% reported a history of a mood disorder diagnosis. For the nonmeditating control group, 21% of individuals reported ever being diagnosed with an anxiety disorder, 21% with a mood disorder, and 3% with Attention-Deficit/Hyperactivity Disorder.

The groups did, however, differ on the proportion of sample who currently practice yoga (51.5% of the meditating group, 6.1% of the nonmeditating group, $\chi^2(1) = 16.63$, $p <$ 001. This may not be a surprising finding, as yoga is commonly considered a type of meditative practice. For those 17 meditators who currently practiced yoga, they reported an average of 59.53 (107.43) months of regular yoga practice, with an average of 4.12 (3.72) sessions per week of a length of 46.76 (27.33) minutes per session. On a scale from 1 (not at all similar) to 5 (very similar), they ranked the similarity of their meditative and yoga practices as a 3.35 (1.27), on average.

Instruments

All study instruments have demonstrated adequate to good reliability and validity.

Measures of meditation experience and psychological functioning

Demographic questionnaire. The demographic questionnaire was designed for use in this study. It asked participants to report their age, gender, race/ethnicity, and years of education completed. Additionally, it asked participants to report whether they have ever been diagnosed with a psychological disorder and, if so, the diagnosis and whether still diagnosed. Regarding meditation experience, it asked participants to indicate whether they have had any meditation experience, and if so, on the duration, frequency, and type of meditation practice, as well as length of typical practice session. Finally, it asked participants to indicate whether they have had any experience practicing yoga, and if so, the duration, frequency, and length of typical yoga practice, as well as how similar the yoga and meditation practices are (for meditators only).

Five Facet Mindfulness Questionnaire (FFMQ; Baer et al., 2006). The FFMQ was used to assess five identified mindfulness facets, *observing*, *describing*, *acting with awareness*, *nonjudging*, and *nonreactivity*. This 39-item self-report measure was derived from a factor analysis of all available trait mindfulness questionnaires, identifying common elements between multiple independent conceptualizations of the mindfulness construct. The utility of examining multiple mindfulness facets has been supported (Baer et al., 2007; Baer et al., 2006; Carmody & Baer, 2008). Consistent with previous research, it was predicted that individuals with meditation experience would score higher than those without on the FFMQ.

Depression Anxiety Stress Scales (DASS; Lovibond & Lovibond, 1993). The 21-item, short-form version of the DASS was used to assess psychological symptoms, including negative affect and bodily symptoms, using Likert ratings of symptoms over the last week. The total score was used for all analyses. Consistent with past research findings (i.e., Lykins & Baer, in press), it was hypothesized that individuals with meditation experience or possessing greater skills in mindfulness (trait mindfulness) in the absence of meditation experience would have lower levels of psychological symptoms than individuals without meditation experience or lower in mindfulness skills, respectively.

Scales of Psychological Well-being (Scales of PWB; Ryff, 1989). This 18-item short-form version of the 54-item self-report measure assesses six elements of well-being: self-acceptance (positive attitude toward one's self, life, and past, including good and bad qualities), positive relations with others (warm, satisfying, trusting relationships), autonomy (independence, ability to resist social pressures and follow own standards), environmental mastery (competence in managing life's demands), purpose in life (goals and direction, sense of meaning in life), and personal growth (view of self as growing and developing, openness to new experiences). This instrument is based on a review of many theories of psychological health (Ryff, 1989), which is often described as broader than the absence of symptoms (Hayes et al., 1999; Keyes, 2007; Snyder & Lopez, 2002). The total score, which sums the six elements of well-being, was used in this study, as interpretation of individual subscales is not recommended for the 18-item version.

Rumination-Reflection Questionnaire (RRQ; Trapnell & Campbell, 1999). The RRQ is a 24-item measures that assesses the tendencies to ruminate and reflect. Rumination, or neurotic self-attentiveness, is recurrent thinking about the self that is motivated by perceived threat, loss, or injustice. Reflection, or intellectual self-attentiveness, is recurrent thinking about the self that is motivated by curiosity. These constructs are believed to be meaningfully distinct due to their differential motives for self-attentiveness.

Measures of cognitive functioning

Continuous Performance Task. A computerized continuous performance task (CPT), adapted from the vigilance task of the Gordon Diagnostic System (1986) by Lawrence et al. (2005), was used to assess vigilance, or the ability to detect brief and unpredictable signals over time (Parasuraman & Davies, 1976). During the CPT, stimuli were presented on a computer monitor positioned at eye level and included the numbers 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9. The numbers were presented one at a time in white text on a dark background. Stimuli remained on the screen for 200 ms with an 800-ms inter-stimulus interval. The task included one block of 360 sequentially displayed stimuli over 6 minutes. The target sequence was the number 1 followed immediately by the number 9. This sequence occurred 30 times at random intervals during the 360-stimulus block. Participants were asked to respond to the target sequence using a button pressed with the index finger of their dominant hand. The dependent variables included average response time to target sequences (correct responses only) and number of omission or commission errors. It was hypothesized that individuals with meditation experience or possessing greater skills in mindfulness in the absence of meditation experience would have shorter reaction times and would make fewer errors than individuals without meditation experience or lower in mindfulness skills, respectively.

Ruff 2 & 7 Selective Attention Test (Ruff & Allen, 1996). The 2 & 7 Test is a paper-and-pencil measure that was used to assess both sustained and selective visual attention. Sustained attention is the ability to maintain attentional focus or alertness over time, whereas selective attention is the ability to select relevant stimuli while ignoring salient, or similar, but irrelevant stimuli (Mirsky, Anthony, Duncan, Ahearn, & Kellam, 1991). This test was administered and scored in accordance with the instructions in the 2 & 7 Test professional manual (Ruff & Allen, 1996). In this task, participants were asked to mark target digits (2 and 7) by finding them among letters (automatic detection) or other digits (controlled search). The task consisted of 20 blocks (10 blocks of digits only and 10 blocks of both digits and letters). Each block contained three lines, in each of which 10 targets were interspersed among 40 non-target items. The time to complete each block was limited to 15 seconds. Three scores were computed and served as dependent variables. The Total Speed score was calculated by adding the total target digits correctly marked in all blocks. The Total Accuracy score, expressed as a percentage, was the Total Speed score divided by the number of errors of omission and commission plus the Total Speed score. The Processing score quantifies the difference between searching for digits among letters and searching for digits among other digits. This score was computed using the following formula: [Speed score in letter blocks — Errors in letter blocks]/[Speed score in digit blocks - Errors in digit blocks]. The comparison of automatic detection versus controlled processing assesses selective attention to external stimuli, or the ability to select relevant stimuli while ignoring irrelevant stimuli, with minimal demands on internal processing of information or immediate memory. The higher the Processing score, the more the participant benefited from searching for target digits among letters versus numbers (Ruff, Niemann, Allen, Farrow, & Wylie, 1992). These scores were corrected for age and education, in accordance with procedures described in the test's manual. It was hypothesized that individuals with meditation experience or possessing greater skills in mindfulness in the absence of meditation experience would have higher Total Speed, higher Total Accuracy, and lower Processing scores than individuals without meditation experience or lower in mindfulness skills, respectively.

Color Trails Test (CTT; D'Elia, Satz, Uchiyama, & White, 1994). The Color Trails Test is a paper-and-pencil task that was used to assess attention switching, or the ability to shift the attentional focus in a flexible and goal-consistent manner (Mirsky et al., 1991). The CTT is an adaptation of the Trails Making Test (TMT) from the Halstead–Reitan Battery and has two parts. Color Trails A is a control task that involves searching for and drawing a line between consecutive numbers presented individually in separate yellow circles scattered over a single page. Color Trails B is a switching task that involves searching for and connecting consecutive numbers presented individually in alternating colors, with each number presented in each of the two colors. The completion times and number of errors for Color Trails A and B and the difference between the completion times (in seconds) for Trails A and B were recorded for all participants, and the completion times were corrected for age and education. It was hypothesized that individuals with meditation experience or possessing greater skills in mindfulness in the absence of meditation experience would have shorter completion times, lower errors, and a smaller difference between completion times for Trails A and B than individuals without meditation experience or lower in mindfulness skills, respectively.

California Verbal Learning Test (CVLT; Delis, Kramer, Kaplan, & Ober, 1987). The CVLT is a well-known test of verbal learning and memory that was used to assess attention, learning, and short- and long-term memory. A list of 16 words (List A) was presented five times in succession, and subjects were instructed to recall as many words as possible after each presentation of the word list. After five test trials of List A, a new list of words (List B) was read to the subjects, who were instructed to recall as many words as possible from List B. Subjects were then asked to recall List A again (short delay) and, after a 20-minute interval, were asked to recall List A (long delay). The dependent variables for the current study included initial attention (number of words recalled following Trial 1), total learning (sum of words recalled following Trials 1 through 5), and short- and long-term memory (number of words recalled following short and long delays). Participant scores were corrected for age and gender according to procedures in the manual. It was hypothesized that individuals with meditation experience or possessing greater skills in mindfulness in the absence of meditation experience will have higher initial attention, total learning, and short- and long-term memory than individuals without meditation experience or lower in mindfulness skills, respectively.

Letter-Number Sequencing (LNS; Wechsler, 1997). The Letter-Number Sequencing subtest from the Wechsler Adult Intelligence Scale–III was used to assess working memory. This test was administered and scored in accordance with the instructions in the WAIS-III manual (Wechsler, 1997). The test involved oral presentation by the examiner of sequences of letters and numbers. Participants were asked to recall the items in each sequence, but not in the order they were presented. Instead, they first named the numbers in ascending order and then the letters in alphabetical order. Each sequence was slightly longer than the previously presented sequence. The age-corrected scaled score transformed using WAIS-III norms served as the dependent variable. It was hypothesized that individuals with meditation experience or possessing greater skills in mindfulness in the absence of meditation experience would have higher LNS scores than individuals without meditation experience or lower in mindfulness skills, respectively.

Computerized subitizing task. The computerized subitizing task was used to assess participant subitizing range. Subitizing is the rapid, parallel, and near-automatic process (Trick & Pylyshyn, 1994) that allows people to immediately “see” or “grasp” the total number of elements shown in a display, as long as the number of elements is very small (i.e., not more than four elements). When the number of elements in the display is larger than the maximum number that can be subitized by the individual (subitizing range), enumeration can no longer occur in parallel, and the slower, presumably serial and controlled process of counting must be used. Multiple theorists in cognitive psychology (Cowan, 2001; Engle, Kane, & Tuholski, 1999) have claimed that the subitizing range is an indicator of the size of an individual's focus of visual attention, with a smaller subitizing range being indicative of a more narrow focus of attention and, thus, a smaller capacity of short-term or working memory. As performance in tests of working memory in the verbal domain rely on both working memory capacity and chunking strategies while subitizing tasks rely on capacity only, performance on a subitizing task can help clarify whether meditators' superior performance on verbal working memory tasks is due to increased working memory capacity or the use of superior chunking strategies.

For the subitizing task, each trial began with a 1000 ms presentation of the word "READY," followed by a 20 ms blank interval and the presentation of a dot display. The dot displays ranged from 1 to 8 total dots, arranged randomly within a square presentation box. Each display (1 to 8 dots) was presented to each participant ten times. The dot display was terminated as soon as the participant hit the response key to indicate he/she knew the number of dots present. The "A" key was pressed to indicate that an odd number of dots was present, while the "L" key was pressed to indicate the presence of an even number of dots. Response times were recorded for correct responses, while the response was counted as an error if the participant response is not correct for the presented number of dots. The average response time to each dot presentation set (1 to 8) and the increases in response times between two adjacent sets (i.e., the increase in average response time between the presentation of 4 dots and 5 dots) were calculated and compared across groups. It was hypothesized that individuals with meditation experience or possessing greater skills in mindfulness in the absence of meditation experience would have a larger subitizing range than individuals without meditation experience or lower in mindfulness skills, respectively.

Stroop Color-Word Test (Stroop, 1935). The Stroop Color-Word Test was used to assess inhibition of elaborative processing, or the ability to inhibit the automatic process of reading printed words. A four-color version of the Stroop test was used in the current study. This task included two conditions. First, participants were asked to hit the appropriate color key, as fast as possible, to indicate the names of four colors (red, green, blue, yellow) printed in congruent-color ink (Congruent condition). Second, participants were asked to hit the appropriate color key to name the ink color of words written in a color different from the word's verbal content, such as the word *blue* written in red or the word *green* written in yellow (Incongruent condition). One practice block (10 stimuli) was completed by the participant at the beginning of each condition. The dependent variables for each condition were the average reaction time for correct responses from the 50 presented stimuli and the total number of errors. An interference score was computed by subtracting the average reaction time for the Congruent condition from the average reaction time of the Incongruent condition. It was hypothesized that individuals with meditation experience or possessing greater skills in mindfulness in the absence of meditation experience would have shorter reaction times, fewer errors, and a smaller interference score than individuals without meditation experience or lower in mindfulness skills, respectively.

Measures of emotional functioning

Emotional Stroop task (Stroop, 1935). The emotional Stroop task was used to assess inhibition of elaborative processing in the emotional domain. The emotional Stroop task is an adaptation of the original Stroop task, where the color words are replaced with emotional and neutral words. Multiple studies have demonstrated that individuals take longer to color-name emotional, threat, or disorder-relevant words than neutral words. While multiple explanations for Stroop-related phenomena exist (Harvey, Watkins, Mansell, & Shafran, 2004), recent work (Bishop et al., 2004) has argued for the utility of using the emotional Stroop task to assess mindfulness skills, as mindfulness training should cultivate the ability to inhibit semantic/secondary elaborative processing of the thoughts, feelings, and sensations that arise following confrontation with a stimulus, which should lead to shorter latency and fewer mistakes in color-naming emotional words in this paradigm. For the emotional Stroop task, participants were asked to hit the appropriate color key, as fast as possible, to indicate the name of the ink color of neutral words (Neutral condition). Second, participants were asked to hit the appropriate color key, as fast as possible, to indicate the name of the ink color of emotional words (Emotional condition). Negative emotional words, such as afraid, depressed, and panic, were used with neutral words that were matched for length and frequency of use. One practice block (10 stimuli) was completed by the participant at the beginning of each condition. The dependent variables for each condition were the average reaction time for correct responses from the 50 presented stimuli and the total number of errors. An emotional interference score was computed by subtracting the average reaction time for the Neutral condition from the average reaction time of the Emotional condition. Again, it was hypothesized that individuals with meditation experience or possessing greater skills in mindfulness in the absence of meditation experience would have shorter completion times, lower errors, and a smaller interference score than individuals without meditation experience or lower in mindfulness skills, respectively.

Implicit Association Test (IAT; Greenwald, McGhee, & Schwartz, 1998). The IAT examines automatic, evaluative biases in the processing of information. The underlying presumption is that when a task requires the same response (e.g., pressing a particular key) to be used for two stimuli that are associated, response times should be faster than when the same response is used for two unrelated stimuli. The IAT has been successfully used to examine attitudes, personality factors, self-esteem, and other self-related concepts in multiple studies (i.e., De Hower & De Bruycker, 2007; Gemar, Segal, Sagrati, & Kennedy, 2001; Grumm & von Collani, 2007). As individuals higher in mindfulness were proposed to be less fearful and avoidant of negative emotions (Kabat-Zinn, 1990; Kabat-Zinn et al., 1992; Linehan, 1993a, 1993b), the proposed IAT involved the word categories of approach versus avoid (i.e., touch versus dodge) and the picture categories of distressed versus neutral emotion (i.e., sorrow versus neutral).

Participants completed a total of five blocks during this task in the following order: a words only block (approach versus avoid), a pictures only block (distressed versus neutral), a compound block using both words and pictures, a second pictures only block (distressed versus neutral), and a second compound block using both words and pictures. Participants responded with either the “A” or “L” key to indicate to which of the appropriate categories a word or picture belonged. In the compound blocks, a word and picture category were combined with the same response key (approach with distressed and avoid with neutral or vice versa), and all participants were presented with both combinations. The categories that the “A” or “L” key were assigned, as well as the order of presentation of the compound blocks, was counterbalanced across participants. The dependent variables for the IAT included the number of errors made in the "approach" compound block (distress paired with approach), number of errors made in the "avoid" compound block (distress paired with avoid), and a difference score computed by subtracting the average reaction time for correct responses for the "avoid" compound block from the average reaction time for correct responses for the "approach" block. This difference score thus indicates how much longer it took participants to pair the distress and approach concepts than the distress and avoid concepts and serves as a means to measure avoidance and fear of negative emotions. It was hypothesized that individuals with meditation experience or possessing greater skills in mindfulness in the absence of meditation experience would pair the emotion/approach and the object/avoid words (the mindfulness-consistent condition) more quickly and thus have a smaller difference score than individuals without meditation experience or lower in mindfulness skills, respectively (though they may still pair the object/approach words more quickly at an absolute level).

Measure of self-regulatory functioning

<u>Ego depletion task</u>. In order to assess for ego depletion, participants completed a two-step handgrip procedure demonstrated to measure ego depletion in multiple studies (i.e., Martijn et al., 2007; Tice, Baumeister, Shmueli, & Muraven, 2007). Maintaining handgrip requires physical stamina and self-control to resist the impulse to quit as one's hand grows tired and physical discomfort increases. Squeezing a handgrip requires a great deal of effort, as one's grip will loosen if exertion is broken for even one moment. Prior research has demonstrated that maintaining a grip has little to do with general bodily strength and is almost entirely a measure of self-control, with grip maintenance time not loading onto a strength factor nor correlating with maximum grip strength (Hejak, 1989; Muraven et al., 1998; Rethlingshafer, 1942; Thornton, 1939). Thus, squeezing a handgrip is an ideal way to measure self-regulation (Muraven et al., 1998).

When participants first arrived, they completed a baseline measure of handgrip stamina. The apparatus was a commercially available hand exerciser consisting of two handles and a metal spring. Participants were told to squeeze the handles together and maintain that grip for as long as they could. A paperclip was inserted between the far ends of the handles so that when the grip was relaxed (under pressure from the spring), the paperclip fell out and thereby furnished a clear and objective signal to stop timing. The experimenter timed and recorded how long the participant successfully squeezed the handles. Following the rest of the experimental procedure, the handgrip stamina task was completed again. The individual change in handgrip stamina (in seconds) was calculated by subtracting each participant's baseline performance from their final performance and served as the dependent variable measuring ego depletion. Each of the current behavioral measures involves some aspect of executive control or self-regulation in addition to the ostensibly measured construct and, thus, should be ego depleting. The recognized paradigm of measuring self-control abilities after ego depletion (or comparing pre- and post-performance in the case of handgrip measurement) is a well-rccognized and validated way of assessing ego depletion. It was hypothesized that individuals with meditation experience or possessing greater skills in mindfulness in the absence of meditation experience would evidence less of a decrease in handgrip stamina than would individuals without meditation experience or lower in mindfulness skills, respectively.

Procedure

Participants who arrived for a scheduled assessment immediately provided informed consent to participate. Participants completed the assessment in individual sessions on the University of Kentucky campus (either in a research laboratory in Breckinridge Hall or in an assessment room at the Jesse G. Harris Psychological Services Center). The assessment was administered verbally, by hand, and by computer. During the assessment session, participants completed the questionnaires and tasks outlined previously. The initial handgrip stamina task, demographic questionnaire, FFMQ, and CVLT (up through long delay recall) were administered first for all participants, and the handgrip stamina end task was administered last for all participants. The CVLT (long delay recall), 2 & 7 Test, CPT, CTT, LNS, computerized subitizing task, Stroop tasks, and IAT presentation order was counterbalanced, with the CVLT (long delay recall) task being completed after an approximate 20 minute delay. The assessment session required approximately 75 minutes of participation.

In order to ensure participant confidentiality, the following procedures were followed. During the assessment, each participant was assigned an ID number. All data from each participant was identified by ID number only, with signed consent forms being stored separately from study data. Once payment was made to each participant at the end of the assessment session, all identifying information about that participant was destroyed, unless participants provided contact information and consent to contact them about future research opportunities. In this case, contact information was stored separately from study data. All data were stored by participant number only in a locked filing cabinet in the PI's office at the University of Kentucky, Department of Psychology.

Chapter Three

Results

Differences between the meditating and demographically matched nonmeditating groups were examined using a series of multivariate analyses of variance (MANOVA), which control for interrelationships among dependent variables and reduces the probability of Type I error. Dependent variables were grouped into logical categories and a MANOVA was conducted for each category. These categories included self-reported mindfulness (FFMQ), self-report measures of psychological functioning (DASS, PWB, and RRQ), behavioral measures of attention (CPT, Ruff 2 & 7 Selective Attention Test, CVLT List A, and CTT), behavioral measures of learning and memory (CVLT and LNS), behavioral measure of subitizing range (computerized subitizing task), behavioral measures of cognitive and emotional biases (Stroop Color-Word Test, Emotional Stroop task, and IAT), and behavioral measures of self-regulation (ego depletion task). These analyses included 33 individuals each from the meditating and nonmeditating control groups unless otherwise stated. In the case of a significant MANOVA, follow-up univariate ANOVAs were conducted to see which individual variables contributed to the overall difference, and effect sizes (Cohen's d) were computed. All analyses examining the impact of trait mindfulness in the absence of meditation experience (using data from the nonmeditation control and student groups) were conducted using correlational analyses and had a total sample size of N = 65. As 45 correlations were computed, a conservative alpha level of .01 was used.

Relationships of meditation experience and mindfulness. Pillai's Trace for the MANOVA examining self-reported mindfulness (FFMQ total and facet scores) was 0.46, $F(5, 60) = 10.02$, $p < .001$, indicating that participants in the meditating and nonmeditating control groups reported significantly different scores. Follow-up univariate ANOVAs revealed that, as predicted, meditators scored significantly higher than the nonmeditating controls on FFMQ total score, $F(1, 60) = 45.72$, $p < .001$, and on each facet score, including the observe, $F(1, 60) = 32.77$, $p < .001$, describe, $F(1, 60) = 17.60$, $p < .001$, act with awareness, $F(1, 60) = 8.79$, $p < .01$, nonjudge, $F(1, 60) = 9.20$, $p < .01$, and nonreact, $F(1, 60) = 11.99$, $p < .01$, facets. These results can be found in Table 2. Most effect sizes for the group comparisons were large (absolute values ranging from

.73 to 1.66). These findings replicated past findings showing higher levels of self-reported mindfulness among experienced meditators than among nonmeditators.

In order to further examine the relationship between meditation experience and self-reported levels of mindfulness, correlations were computed between months of meditation experience and FFMQ mindfulness scores in the meditating group only. Months of meditation experience did not correlate significantly with any of the FFMQ facet scores or total score: $r = .14$, *ns* (observe), $r = -.01$, *ns* (describe), $r = .02$, *ns* (act with awareness), $r = .28$, *ns* (nonjudge), $r = .19$, *ns* (nonreact), and $r = .24$, *ns* (total score). Thus, these analyses do not replicate previous findings showing significant correlations between levels of mindfulness and extent of meditation experience.

Relationships of meditation experience and psychological functioning. Results for analyses examining the relationships between meditation experience and self-reported psychological functioning can be found in Table 2. Pillai's Trace for the psychological functioning MANOVA (DASS, PWB, and RRQ) was 0.51, $F(4, 61) = 16.13$, $p < .001$, indicating that participants in the meditating and nonmeditating control groups reported significantly different scores for this group of variables. Follow-up univariate ANOVAs revealed that, as predicted, meditators scored significantly lower on rumination, $F(1, 61) = 9.08$, $p < .01$, and higher on reflection, $F(1, 61) = 39.12$, $p < .001$, than did the nonmeditating controls. The effect sizes for these findings were large (absolute values of .74 and 1.54) and replicated past findings.

However, contrary to predictions, the meditators did not score lower than the nonmeditating controls on self-reported psychological symptoms (DASS score), $F(1, 61) = 0.92$, *ns*, or higher on a measure of psychological well-being (Scales of PWB score), $F(1, 61) = 3.61$, *ns*. On the DASS, both groups fell above the mean total score previously reported for a large nonclinical community sample, with the meditating and nonmeditating control group samples falling at approximately the 65th and 73rd percentiles, respectively (Henry & Crawford, 2005). As no significant differences were found between the meditators and nonmeditating controls on psychological symptoms, which could be expected to exert an impact on behavioral measures of cognitive, emotional, or self-regulatory functioning, subsequent analyses examining the impact of meditation experience do not control for psychological symptoms.

Relationships of meditation experience and attention. Data from only 32 meditators were included in the attention MANOVA, as data was missing from one meditator who reported failing to understand CPT task instructions. Pillai's Trace for the attention MANOVA (CPT, Ruff 2 & 7 Selective Attention Test, CVLT List A, and CTT) was 0.14, $F(11, 53) = 0.79$, *ns*, indicating that participants in the meditating and nonmeditating control groups did not score significantly differently on these measures of attention. Thus, follow-up univariate ANOVAs for the individual behavioral measures of attention were not conducted. Means and standard deviations by group and effect sizes for the attention measures can be found in Table 3.

Relationships of meditation experience and learning and memory. Pillai's Trace for the learning and memory MANOVA (CVLT and LNS) was 0.22, $F(6, 59) = 2.75$, $p. < .05$, indicating that participants in the meditating and nonmeditating control groups scored significantly differently on this group of measures. Follow-up univariate ANOVAs revealed that, as predicted, meditators scored significantly higher on two measures of short-term memory (CVLT short delay free recall, $F(1, 59) = 6.25$, $p < .05$; short delay cued recall, $F(1, 59) = 6.32$, $p < .05$) and one measure of long-term memory (long delay free recall, $F(1, 59) = 6.02$, $p < .05$). Contrary to predictions, however, they did not score higher on a second index of long-term memory (long delay cued recall, $F(1, 59) = 3.79$, *ns*), on working memory (LNS standard score, $F(1, 59) = 2.28$, *ns*), or on total learning (CVLT, $F(1, 59) = 1.07$, *ns*). Results for analyses examining the relationships between meditation experience and learning and memory can be found in Table 4.

Relationships of meditation experience and subitizing range. Pillai's Trace for the subitizing MANOVA (computerized subitizing task) was 0.11, $F(8, 57) = 0.87$, *ns*, indicating that participants in the meditating and nonmeditating control groups did not score significantly differently on this measure of subitizing range. Thus, follow-up univariate ANOVAs for the individual subitizing variables were not conducted. Means and standard deviations by group and effect sizes for the measure of subitizing range can be found in Table 5. It is worth noting that both groups had the largest increase in response times between the adjacent 4 and 5 dot sets, consistent with the typical capacity for visual working memory (Trick & Pylyshyn, 1994).

Relationships of meditation experience and cognitive and emotional biases. Data from only 32 meditators were included in the cognitive and emotional biases MANOVA, as one meditator reported being yellow/green colorblind and thus did not complete the two Stroop tasks. Pillai's Trace for the cognitive and emotional biases MANOVA (Stroop Color-Word Test, emotional Stroop task, and IAT) was 0.28, $F(11, 53) = 1.85$, *ns*, indicating that participants in the meditating and nonmeditating control groups did not score significantly differently on a composite of measures of cognitive and emotional biases. Thus, follow-up univariate ANOVAs for the individual cognitive and emotional biases measures were not conducted. Means and standard deviations by group and effect sizes for these measures can be found in Table 6.

Relationship of meditation experience and self-regulatory functioning. Data from only 32 meditators were included in the self-regulatory functioning MANOVA, as one meditator reported suffering from arthritis in her hands and was excluded from analyses. Pillai's Trace for the self-regulatory functioning MANOVA (initial and final handgrip and difference score) was 0.15, $F(2, 62) = 5.41$, $p. < .01$, indicating that participants in the meditating and nonmeditating control groups scored significantly differently on this set of measures. Follow-up univariate ANOVAs revealed that, contrary to predictions, meditators did not have a significantly smaller difference score than did the nonmeditators, $F(1, 62) = 0.64$, *ns,* suggesting that they, as a group, did not experience less ego depletion than did the nonmeditators. These results were further confirmed in a 2 x 2 repeated measures analysis of variance, which demonstrated that there was no interaction between group and time in handgrip performance, $F(63) = 0.64$, *ns.* Neither group had even a moderate performance decrement from the initial to final evaluation of handgrip stamina, suggesting that neither group experienced significant ego depletion from the intervening tasks. The meditators did, however, evidence significantly longer handgrip performance at both the initial, $F(1, 62) = 5.44$, $p < .05$, and final, $F(1, 62) = 10.40$, $p < .01$, handgrip tasks. Results for analyses examining the relationships between meditation experience and self-regulatory functioning can be found in Table 7.

Despite the fact that handgrip endurance has been shown to measure self-regulation with little influence from physical strength, the practice of yoga may be reasonably hypothesized to lead to specific increases in handgrip strength and/or endurance. As the meditating group included a significantly higher proportion of individuals who practice yoga, their higher average performance may reasonably be hypothesized to be due to their yoga practice. As only three individuals who reported engaging in yoga practice were nonmeditators (two in the demographic control and 1 in the nonmeditating student group), a comparison of handgrip performance in the meditating individuals who either practice or do not practice yoga was conducted. The 17 meditating participants who reported yoga practice did not differ from the 16 who reported no yoga practice on handgrip performance at the initial (M = 90.45 (46.78) versus 78.09 (50.99), respectively, $t(30) = 0.72$, *ns*) or final evaluation (M = 83.65 (38.69) versus 87.13 (52.82), respectively, $t(30) = -0.21$, *ns*), suggesting that yoga practice does not lead to improvements in handgrip performance beyond that produced by meditation practice.

Relationships of mindfulness skills and psychological functioning. Results for analyses examining the relationships between self-reported mindfulness skills and psychological functioning in the absence of meditation experience can be found in Table 8. In order to examine these relationships, the correlations between mindfulness skills (FFMQ total score), psychological symptoms (DASS), psychological well-being (Scales of PWB), rumination (RRQ), and reflection (RRQ) were computed for the total sample of nonmeditators (nonmeditating controls and students). FFMQ total score was significantly related to psychological well-being, $r = .58$, $p < .001$, but was not significantly related to psychological symptoms, $r = -.30$, *ns*, rumination, $r = -0.19$, *ns*, or reflection, $r = 0.02$, *ns*.

Relationships of mindfulness skills and cognitive, emotional, and self-regulatory functioning. Results for analyses examining the relationships between mindfulness skills and cognitive and emotional functioning in the absence of meditation experience can also be found in Table 8. Contrary to predictions, in the nonmeditating sample, self-reported mindfulness skills (FFMQ total score and individual facet scores) did not significantly correlate with any of the measures of cognitive, emotional, or self-regulatory functioning.

TABLE 3.1

Demographic Characteristics of Participants

	Meditators	Nonmeditating Controls	Nonmeditating Students
N	33	33	32
Age in years			
Mean (SD)	35.24 (13.87)	35.30 (14.59)	18.94 (1.01)
Range	18-62	18-64	18-22
% male	48.5%	36.4%	31.3%
% Caucasian	93.9%	90.9%	96.9%
Years of education Mean (SD)	16.64 (3.11)	15.97 (2.82)	13.03 (0.74)
Proportion of group ever diagnosed with a mental disorder	37.0%	31.0%	17.6%
Proportion of group currently diagnosed with a mental disorder	14.8%	20.7%	5.9%
Months of meditation practice	74.26 (79.67)	n/a	n/a
Average meditation sessions per week	5.42 (3.92)	n/a	n/a
Average minutes per meditation session	30.30 (17.41)	n/a	n/a
Proportion of group currently practicing yoga	51.5%	6.1%	3.1%

Note: SD = standard deviation

TABLE 3.2

Mean Scores, Standard Deviations, Univariate F Ratios, and Cohen's d Values for Self-Report Measures of Mindfulness and Psychological Functioning by Group

	Meditators	Nonmeditating Controls	*F*	Effect size
	Mean (SD)	**Mean (SD)**		**(Cohen's d)**
Mindfulness variables				
Observe	33.85 (4.22)	27.67 (4.55)	32.77***	1.41
Describe	32.33 (5.26)	26.85 (5.36)	17.60***	1.03
Act with awareness	29.73 (5.51)	25.91 (4.93)	8.79**	0.73
Nonjudge	31.36 (6.34)	26.97 (5.39)	9.20**	0.75
Nonreact	25.58 (4.07)	22.06 (4.18)	11.99**	0.85
Total	152.85 (13.53)	129.45 (14.56)	45.72***	1.66
Psychological functioning variables				
Symptoms (DASS)	9.97 (8.66)	11.76 (6.26)	0.92	0.24
Well-being (PWB)	89.24 (9.79)	84.64 (9.92)	3.61	0.47
Rumination (RRQ)	33.42 (10.72)	40.73 (8.89)	9.08**	0.74
Reflection (RRQ)	49.36 (7.78)	37.79 (7.25)	39.12***	1.54

Note: SD = standard deviation, DASS = Depression Anxiety Stress Scales, PWB = Scales of Psychological Well-being, RRQ = Rumination-Reflection Questionnaire, *** = $p < .001$, ** = $p < .01$

TABLE 3.3

Mean Scores and Standard Deviations for Behavioral Measures of Attention by Group

	Meditators	**Nonmeditating Controls**	**Effect Size**
	Mean (SD)	**Mean (SD)**	**Cohen's d**
Vigilance			
CPT average RT	187.51 (71.27)	170.82 (58.47)	0.26
CPT # errors	0.84 (1.25)	1.55 (2.35)	0.38
Sustained attention			
2 & 7 Total Speed T-score	51.00 (11.98)	49.48 (9.27)	0.14
2 & 7 Total Accuracy T-score	49.69 (9.98)	48.39 (7.39)	0.15
Selective attention			
2 & 7 Processing Score	1.69 (3.99)	1.13 (0.29)	0.20
Initial attention			
CVLT List A T-score	-0.34 (1.21)	-0.42 (1.03)	0.07
Attention switching			
CTT Trail A RT T-score	54.91 (7.97)	51.70 (10.07)	0.35
CTT Trail A # errors	0.13 (0.34)	0.06 (0.35)	0.20
CTT Trail B RT T-score	58.16 (7.21)	56.15 (6.73)	0.29
CTT Trail B # color errors	0.13 (0.42)	0.18 (0.46)	0.11
CTT Trail B # number errors	0.06 (0.25)	0.03 (0.17)	0.14
Difference in Trails A and B RTs	3.25 (5.52)	4.45 (7.95)	0.18

Note: SD = standard deviation, RT = reaction time, CPT = Continuous Performance Task, 2 & 7 = Ruff 2 & 7 Selective Attention Test, CVLT = California Verbal Learning Test, CTT = Color Trails Test

TABLE 3.4

Mean Scores, Standard Deviations, Univariate F Ratios, and Cohen's d Values for Behavioral Measures of Learning and Memory by Group

	Meditators	**Nonmeditating Controls**	***F***	**Effect size**
	Mean (SD)	**Mean (SD)**		**(Cohen's d)**
Learning				
CVLT total learning	46.06 (15.37)	42.39 (13.32)	1.07	0.26
Working memory				
LNS scaled score	11.73 (2.13)	10.82 (2.73)	2.28	0.37
Short- and long-term memory				
CVLT short-delay free recall	-0.03 (1.51)	-1.00 (1.64)	6.25*	0.62
CVLT short-delay cued recall	-0.15 (1.33)	-1.00 (1.41)	6.32*	0.62
CVLT long-delay free recall	-0.24 (1.37)	-1.12 (1.54)	6.02*	0.60
CVLT long-delay cued recall	-0.55 (1.35)	-1.21 (1.43)	3.79	0.47

Note: SD = standard deviation, CVLT = California Verbal Learning Test, LNS = Letter-Number Sequencing, * = $p < .05$

TABLE 3.5

Mean Scores and Standard Deviations for Behavioral Measure of Subitizing Range by Group

	Meditators	**Nonmeditating Controls**	**Effect Size**
	Mean (SD)	**Mean (SD)**	**Cohen's d**
Average RT: 1 dot set	774.08 (194.39)	744.40 (137.79)	0.18
Average RT: 2 dot set	862.15 (171.90)	875.87 (178.31)	0.08
Average RT: 3 dot set	857.08 (184.52)	912.63 (272.12)	0.24
Average RT: 4 dot set	1078.09 (252.22)	1135.77 (320.53)	0.20
Average RT: 5 dot set	1481.79 (352.84)	1545.02 (307.86)	0.19
Average RT: 6 dot set	1726.78 (349.95)	1786.41 (370.37)	0.17
Average RT: 7 dot set	1994.69 (388.73)	2096.80 (309.40)	0.29
Average RT: 8 dot set	2286.80 (510.88)	2308.32 (509.66)	0.04
Increase in RT: 1 to 2 dot set	88.08 (114.57)	131.47 (117.80)	0.37
Increase in RT: 2 to 3 dot set	-5.07 (104.79)	36.76 (151.81)	0.32
Increase in RT: 3 to 4 dot set	221.01 (149.65)	223.15 (189.66)	0.01
Increase in RT: 4 to 5 dot set	403.70 (193.99)	409.25 (196.93)	0.03
Increase in RT: 5 to 6 dot set	244.99 (210.36)	241.39 (193.72)	0.02
Increase in RT: 6 to 7 dot set	267.92 (214.50)	310.39 (249.07)	0.18
Increase in RT: 7 to 8 dot set	292.11 (369.39)	211.52 (332.22)	0.23

Note: SD = standard deviation, RT = reaction time

TABLE 3.6

Mean Scores and Standard Deviations, Univariate F Ratios, and Cohen's d Values for Behavioral Measures of Cognitive and Emotional Biases by Group

	Meditators	Nonmeditating Controls	Effect Size
	Mean (SD)	**Mean (SD)**	**Cohen's d**
Inhibition of elaborative processing			
Color Stroop: Congruent RT	753.54 (159.08)	752.96 (127.47)	0.00
Color Stroop: Congruent errors	0.41 (0.71)	0.27 (0.57)	0.22
Color Stroop: Incongruent RT	875.82 (241.44)	917.02 (195.05)	0.19
Color Stroop: Incongruent errors	0.53 (1.19)	1.06 (1.37)	0.41
Color Stroop: Interference score	122.29 (179.04)	164.06 (116.61)	0.28
Emo Stroop: Neutral RT	767.54 (148.25)	782.91 (139.36)	0.11
Emo Stroop: Neutral errors	0.59 (0.95)	0.67 (0.92)	0.09
Emo Stroop: Emotional RT	813.13 (166.10)	801.89 (132.06)	0.07
Emo Stroop: Emotional errors	0.84 (0.99)	0.48 (0.76)	0.41
Emo Stroop: Interference score	45.59 (101.34)	18.98 (67.29)	0.31
Orientation to emotion			
IAT "approach" block errors	2.03 (1.96)	3.67 (4.60)	0.46
IAT "avoid" block errors	1.50 (1.16)	2.00 (1.75)	0.34
IAT difference score	426.10 (483.23)	386.44 (393.09)	0.09

Note: SD = standard deviation, RT = reaction time, Color Stroop = Stroop Color-Word Test, Emo Stroop = emotional Stroop task, IAT = Implicit Association Test

TABLE 3.7

Mean Scores, Standard Deviations, Univariate F Ratios, and Cohen's d Values for Behavioral Measures of Self-Regulation by Group

	Meditators	**Nonmeditating Controls**	***F***	**Effect size**
	Mean (SD)	**Mean (SD)**		**(Cohen's d)**
Initial handgrip (secs)	84.66 (48.40)	58.21 (42.98)	5.44*	0.58
Final handgrip (secs)	85.28 (45.11)	50.11 (42.81)	10.40**	0.80
Handgrip difference score (secs)	-0.63 (52.53)	8.09 (33.60)	0.64	0.20

Note: SD = standard deviation, secs = seconds, ** = $p < .01$, * = $p < .05$

TABLE 3.8

Correlations of Self-Reported Mindfulness Skills (FFMQ Total Scores) with Self-Report Measures of Psychological Functioning and Behavioral Measures of Cognitive, Emotional, and Self-Regulatory Functioning in Nonmeditators

	r-value
Psychological functioning variables	
Symptoms (DASS)	-0.30
Well-being (PWB)	0.58***
Rumination (RRQ)	-0.19
Reflection (RRQ)	0.02
Cognitive functioning variables	
Vigilance	
CPT average RT	-0.14
CPT # errors	0.00
Sustained attention	
2 & 7 Total Speed T-score	0.10
2 & 7 Total Accuracy T-score	0.02
Selective attention	
2 & 7 Processing Score	-0.08
Initial attention	
CVLT List A T-score	0.10
Attention switching	
CTT Trail A RT T-score	0.06
CTT Trail A # errors	0.07
CTT Trail B RT T-score	0.02
CTT Trail B # color errors	0.10
CTT Trail B # number errors	0.00
Difference in Trails A and B RTs	-0.06
Learning	
CVLT total learning	0.01
Working memory	
LNS scaled score	0.23
Short- and long-term memory	
CVLT short-delay free recall	-0.06
CVLT short-delay cued recall	0.02
CVLT long-delay free recall	-0.02
CVLT long-delay cued recall	0.08
Subitizing range	
Average RT: 1 dot set	-0.15
Average RT: 2 dot set	-0.09
Average RT: 3 dot set	-0.09
Average RT: 4 dot set	0.01

TABLE 3.8 (continued)

Average RT: 5 dot set	0.00
Average RT: 6 dot set	-0.04
Average RT: 7 dot set	-0.08
Average RT: 8 dot set	-0.07
Increase in RT: 1 to 2 dot set	0.05
Increase in RT: 2 to 3 dot set	-0.03
Increase in RT: 3 to 4 dot set	0.12
Increase in RT: 4 to 5 dot set	-0.01
Increase in RT: 5 to 6 dot set	-0.07
Increase in RT: 6 to 7 dot set	-0.04
Increase in RT: 7 to 8 dot set	-0.02
Inhibition of elaborative processing (Stroop)	
Color: Congruent RT	-0.07
Color: Congruent errors	-0.04
Color: Incongruent RT	0.03
Color: Incongruent errors	0.08
Color: Interference score	0.08
Emotional functioning variables	
Inhibition of elaborative processing – Emotional (Stroop)	
Emotional: Neutral RT	0.08
Emotional: Neutral errors	0.14
Emotional: Emotional RT	0.00
Emotional: Emotional errors	0.01
Emotional: Interference score	-0.20
Orientation to emotion	
IAT "approach" block errors	0.19
IAT "avoid" block errors	-0.01
IAT difference score	0.16
Self-regulatory functioning variables	
Ego depletion	
Handgrip performance: initial	0.15
Handgrip performance: final	0.00
Handgrip difference score	0.20

Note: SD = standard deviation, RT = reaction time, CPT = Continuous Performance Task, 2 & 7 = Ruff 2 & 7 Selective Attention Test, CTT = Color Trails Test, LNS = Letter-Number Sequencing, CVLT = California Verbal Learning Test, Color = Stroop Color-Word Test, Emotional = emotional Stroop task, IAT = Implicit Association Test, *** = $p < .001$

Chapter Four

Discussion

The purpose of the present study was to investigate differences between regular meditators and demographically similar nonmeditators on cognitive, emotional, and self-regulatory variables measured with non-self-report methodology and to examine correlations between self-reported trait mindfulness and behavioral measures in nonmeditators. On the whole, meditation experience was demonstrated to relate to very few of the cognitive, emotional, and self-regulatory constructs examined here. The only significant group differences found in analyses examining impact of meditation experience were in measures of short- and long-term memory and self-regulatory strength. Self-reported mindfulness skills in the nonmeditating samples were related to well-being but not to psychological symptoms or any of the cognitive, emotional, or self-regulatory tasks. These results stand in stark contrast to most of the current literature on meditation and mindfulness suggesting that mindfulness skills are enhanced through meditation practice or mindfulness-based interventions and that these skills are related to many cognitive, emotional, and physical benefits. A variety of explanations are possible for this notable divergence.

A first possible explanation is that, as previous theory and research suggest, meditation practice and trait mindfulness skills do indeed relate to observable and measurable changes or differences in cognitive, emotional, and self-regulatory functioning but that the behavioral measures used in the current study fail to validly measure the intended constructs. While this possibility cannot be thoroughly ruled out, the measures used in the current study are commonly used intellectual (Letter-Number Sequencing), neuropsychological (Ruff 2 & 7 Selective Attention Test, Color Trails Test, California Verbal Learning Test), cognitive (Continuous Performance Task, Computerized subitizing task, Stroop Color-Word Test, emotional Stroop task, Implicit Association Test), and self-regulatory (ego depletion task) measures or paradigms with considerable research attesting to their validity in measuring the respective constructs. Extreme care was taken to design and/or administer the behavioral measures consistent with the respective administration manual or with procedures commonly used in previous research. Thus, this explanation for the findings does not appear likely.

A contrasting possibility is that meditation practice and trait mindfulness are not related to differences or changes in emotional and cognitive functioning as previously theorized, suggesting that the previous conceptualizations of mindfulness and its expected effects need significant revision. While many studies have suggested clinically significant changes from meditation practice or mindfulness-based interventions, it is possible that these effects are due to demand effects, especially given the fact that the effects that practice "should" produce are commonly discussed during the administration of an intervention or in the course of adopting a meditation practice (i.e., through readings or discussion with meditation teachers). Alternately, previous studies examining meditators and controls may have found group differences due to a failure in matching, such as a difference by group in personality, age, or intelligence. For trait mindfulness studies, significant relationships between mindfulness and related concepts may actually be caused by an unmeasured third variable, such as self-regulatory strength (Masicampo & Baumeister, 2007). Thus, the previously proposed effects of mindfulness and meditation practice in the cognitive and emotional domains may need to be reexamined. However, no valid means for measuring psychological symptoms and well-being currently exist apart from self-report, and the results of a very large number of studies would have to be alternately explained to feel confident in the assertion that mindfulness does not exert beneficial effects. As the abundance of previous research suggests that meditation practice and trait mindfulness relate to enhanced psychological functioning, the results of one study should not be asserted as compelling evidence to the contrary.

Another possible explanation contrary to some of the currently accepted conceptualizations of mindfulness is that mindfulness is a state that must be induced and that the meditating group's performance was not elevated across most domains in the current study because we did not ask them to enter a mindful state while completing the tasks. However, the fact that individuals are able to report on how "mindful" they are in the absence of any meditation experience or even awareness of the concept of mindfulness combined with the strong evidence supporting the construct validity of these reports runs counter to this notion. Additionally, all participants were aware that the study was examining the effects of meditation experience and mindfulness. Thus, the assumption that individuals with meditation experience were attempting to complete the tasks mindfully is reasonable. Finally, the fact that a few performance-based differences were found between the groups also runs counter to this explanation. If mindfulness is a state that must be entered into and participants in this study did not enter it, then we would likely not have found results for handgrip endurance or memory given the very high degree of matching between the meditating and nonmeditating control groups. Thus, this explanation also seems relatively unlikely.

A variety of alternate explanations for the current results falling somewhere between these extreme positions are also plausible. For example, it is possible that the practice of mindfulness meditation and the cultivation of mindfulness skills are related to different attentional processes or to a narrower range of cognitive and emotional processes than has been previously theorized and was assessed here. Previous research (Jha et al., 2007; Tang et al., 2007) has demonstrated that mindfulness practice leads to increased alerting (improvements in achieving and maintaining an alert state), orienting (directing and limiting attention), and conflict monitoring (prioritizing among competing demands), and it is possible that these types of differences related to trait mindfulness or changes related to meditation practice are not captured in the current tasks. If this is the case, the currently accepted conceptualization of mindfulness would require some amount of revision, as the measures in the current study mapped onto the conceptual hypotheses asserted by Bishop et al. (2004) very closely. However, this explanation also seems relatively unlikely as changes in performance on tasks of the sort included in the current research have been found in previous studies (i.e., Chambers et al., 2008; Valentine & Sweet, 1999; Wenk-Sormaz, 2005). Additionally, changes in more narrow or specific attentional abilities would likely affect performance on the cognitive and emotional tasks included in the current research, as many aspects of downstream cognitive functioning are largely dependent upon present moment direction of attention (Cowan, 1997). It may also be possible that meditation practice or higher trait mindfulness is related to enhanced quality of attention, even if the amount of attentional control does not change. The fact that the meditators were found to have superior performance on measures of short- and long-term memory when compared with controls despite having equivalent performance in attention and learning may be supportive of this notion. The relationships of meditation and mindfulness with attentional quality should be examined more fully in future research.

An additional possible explanation for the current results may be that an unanticipated difference in motivation to perform at one's highest level of capability exists between meditators and nonmeditators. As no performance-based incentives were offered for quality of performance on the tasks, internal motivation to perform would be the only factor strongly influencing participants' approach to the tasks. Research suggests that individuals with higher levels of mindfulness have more stable and less contingent self-esteem, meaning that feelings of self-worth are not highly vulnerable to challenge and processes that promote excessive self-protection or self-promotion are unnecessary (Heppner & Kernis, 2007). Additionally, increased mindfulness is theorized to reduce the level of distress associated with perceived self-discrepancies through nonjudgmental acceptance of discrepancy-related thoughts and the perception of internal experiences as transitory mental events that do not necessitate particular behaviors (Bogels, Sijbers, & Voncken, 2006; Segal et al., 2002). These combined factors may have produced the surprising effect of minimizing striving toward optimal performance in the meditating group. Clinical observations by the experimenter did suggest that the meditating group may not have felt the same performance-based pressure as did the nonmeditating participants. Many nonmeditating controls and students were observed to make self-critical statements regarding their own performance and to become distressed when they viewed their own performance as insufficient. In contrast, self-critical comments and signs of distress about performance were rarely observed in the meditating sample. These feelings of distress in the nonmeditators may have served as a motivational factor to increase short-term effort in this group, which may have masked existing group differences. A related possibility is that the meditators responded differently to timed tasks than did the controls. As the meditators knew the study was examining the effects of meditation, which is often associated with emotional balance and less of a stressed orientation, the meditators may not have experienced time pressure in the same manner as did the controls. Given that most of the tasks in this study involved some element of timing, this possibility is not insignificant. Both of these potential explanations bear further investigation.

An additional possible explanation for the current study findings may be that the known groups paradigm utilized in this study was unable to detect differences or changes in functioning related to trait mindfulness or meditation practice because this particular group of meditating individuals was unrepresentative of typical samples of meditators studied in previous research. For example, they may have had higher levels of psychological distress. While the self-reported psychological symptoms (DASS scores) experienced by meditators and nonmeditators in the present study were not in the clinical range, they were not significantly different from each other and both groups fell above the nonclinical mean from a standardization study (Henry & Crawford, 2005), with the meditating group falling at the 65th percentile. Meditators in a previous study (Lykins & Baer, in press) were found to have psychological symptom scores (DASS long form) that were significantly lower than that of the nonmeditators and which fell at the 45th percentile. Unfortunately, other studies utilizing a similar known-groups design in which meditators were compared with nonmeditators (i.e., Jha et al., 2007; Massion, Teas, Hebert, Wertheimer, & Kabat-Zinn, 1995; Valentine & Sweet, 1999) did not examine psychological symptoms, so no other direct comparisons across studies can be made.

However, the many studies demonstrating significant decreases in psychological symptoms in those participating in a mindfulness-based intervention or meditation retreat that are not found in control participants, with many demonstrating that participants end the treatment in the "minimal" range for depression scores (i.e., Baer, 2003; Carmody & Baer, 2008; Chambers et al., 2008; Kabat-Zinn et al., 1992; Kenny & Williams, 2007; Ramel et al., 2004; Tang et al., 2007), also shed light on the current findings. If meditation practice improves functioning primarily through reduction of psychological symptoms and associated cognitive deficits (Chambers et al., 2008; Linehan, 1993a), then a comparison of nonmeditating controls with meditators who appear to have not obtained this emotional benefit from their practice would be unlikely to show group differences in the emotional or cognitive domain. Mindfulness-based intervention studies, which typically use clinical or at least distressed samples, may show strong effects because the interventions elicit positive and adaptive changes in emotional functioning which then promote better cognitive and generalized functioning. A study examining emotional, cognitive, and self-regulatory functioning with behavioral measures both before and after a mindfulness-based intervention may show similar statistically and clinically significant effects. However, the possibility that the meditating sample had failed to receive an emotional benefit from their practice does not explain why trait mindfulness failed to correlate with behavioral measures of cognitive or emotional functioning. While the possibility that the sampling in this particular study has masked real differences bears further investigation, this explanation fails to account for the full pattern of results.

A final, and related, possibility is that meditation practice and mindfulness are more strongly related to self-regulation and less directly related to cognitive and emotional functioning. Masicampo & Baumeister (2007) have suggested that meditation practice may lead to beneficial changes due to its inherent extended practice in self-regulation. In other words, they propose that, because meditation practice involves altering and controlling responses in some way or continuously regulating attention in a particular manner (i.e., nonjudgementally and repeatedly redirecting one's attention to a particular stimulus), the primary mechanism by which meditation practice operates is through enhanced abilities in self-control, which in turn may cause increases in mindfulness. Results from the current study may be interpreted as generally supportive of this notion, given the very large differences in self-regulatory strength (hand-grip task) and the essential lack of differences in cognitive and emotional functioning found between the meditating and nonmeditating control groups.

Interestingly, no evidence of ego depletion (change in handgrip performance from pre- to post-evaluation) was found in either group in the current study, despite the evidence of differences in self-regulatory strength (handgrip performance at pre- and post-evaluation). Thus, the current findings are different than those found in previous research focused on self-control exercise, which has tended to find changes in ego depletion as opposed to absolute handgrip performance (Gailliot, Plant, Butz, & Baumeister, 2007; Muraven, Baumeister, & Tice, 1999; Oaten & Cheng, 2006a, 2006b). It is possible that the methods utilized in the current study did not actually elicit ego depletion. The tasks that were completed by participants between the two handgrip evaluations were hypothesized to lead to ego depletion because they required regulation of attention which has been shown to lead to depletion in previous studies (i.e., DeWall, Baumesiter, Stillman, & Gailliot, 2007). However, a closer look at these studies that elicit depletion through attention regulation shows some important divergence from the current study. For example, thought suppression (Wegner, Shortt, Blake, & Page, 1990), actively ignoring words appearing on a television screen, learning a task and then having to immediately complete the task with different instructions, and inhibiting the tendency to read a color word and name the color of ink a word appears in (DeWall et al., 2007) are examples of the type of research showing that regulation of attention leads to ego depletion. The tasks in the current research, apart from the Stroop Color-Word Test, simply required participants to respond as they normally would and not to try to override their natural tendencies during the task or responses to the task. While regulation of attention was required, self-regulatory strength may not have been required to any significant degree, as self-regulation is primarily required for responses for which there is such a strong motivation to do the opposite (such as refraining from eating something tempting or enduring physical discomfort) that the exertion of strong self-control is required to override this tendency (Muraven et al., 1998).

Thus, while questions remain, the practice of meditation may directly build self-regulatory strength, which is known to be related to many aspects of adaptive functioning, including aspects of the emotional domain (Tangney et al., 2004), though the current study failed to demonstrate emotional effects. Additionally, the practice of meditation or skill in mindfulness may allow one to take mental breaks (rest) and/or engage in hypo-egoic self-regulation, in which deliberate, conscious control over one's behavior is relinquished and behavior is enacted more naturally, spontaneously, or automatically (Leary et al., 2006), which should allow for restoration from or minimization of ego depletion, respectively. In the total sample, initial handgrip performance was correlated with psychological well-being, $r = .23$, $p < .05$, and with reflection, $r = .27$, $p < .01$, though it was not significantly correlated with psychological symptoms or rumination, which is partially supportive of the notion that self-regulatory strength is associated with adaptive psychological functioning. However, no relationship was found between self-reported trait mindfulness and the hand-grip measures, which runs counter to the notion that self-regulatory strength actually causes dispositional mindfulness (Masicampo & Baumeister, 2007). Thus, while the current study suggests that more work is needed exploring the relationships between meditation, mindfulness, and self-regulation and potentially supports the notion that self-regulation is the primary mechanism by which mindfulness exerts beneficial effects, the current work cannot stand alone in discounting previous work suggesting primary roles for the enhancement of cognitive and emotional skills.

Unfortunately, the current research poses more questions than it answers. As the current research failed to replicate previous research using both self-report and behavioral measures, it is certainly possible that the prevailing conceptualization of mindfulness requires moderate to significant revision. However, it is also possible that some aspect of the current experimental design or sample may be responsible for the contradictory findings. One limitation of the current study is the fact that it utilized a known-groups, between-subjects design. While a known-groups design offers many advantages and group differences were anticipated, sampling issues can be a concern. A replication of this study with a different sample of meditators may go far in ruling out or supporting the potential explanations proposed for the current results. It may be important to recruit participants who are involved with some sort of meditation center to try to minimize variability in aspects of meditation practice. Additionally, the field would certainly benefit from future research that utilizes similar behavioral measures to determine whether they change over the course of a mindfulness-based intervention. Another aspect of the study that could be improved upon is refinement of some of the utilized instruments. While care was taken to choose well-designed and validated behavioral measures, some of the measures may require some minor improvements. For example, it is possible that "distressed" and "neutral" words may have been more effective than pictures in measuring avoidance of distressing emotions, as the pictures are of other people while the construct intended to be measured is personal emotional approach versus avoidance.

Taken as a whole, however, results suggest that the primary direction for future research should be the investigation of the relationships between meditation, mindfulness, and self-regulation. Additional paradigms exist for measuring self-regulatory strength and ego depletion (i.e., unsolvable anagrams, aggressiveness). Additional studies that utilize these paradigms and investigate how meditators or those high in trait mindfulness may respond differently than controls or those lower in trait mindfulness will likely be important. In addition, a self-report measure of self-control is available (Tangney et al., 2004). No research thus far has examined how meditators or those high in trait mindfulness report on their self-control abilities. Even a self-report study in which these groups report on mindfulness, self-control, other theorized mechanisms (emotional and cognitive), and typically recognized endpoints (psychological distress and well-being) would begin to answer many remaining questions, as these data could be used to determine whether mindfulness and its related concepts add any incremental validity to self-control, and vice versa, in predicting outcomes. An investigation into the role of values and goals in line with Self-Determination Theory (SDT; Deci & Ryan, 2000) may also offer interesting insights into why meditation practice or self-regulation abilities are related to improved outcomes, as these may likely influence goal preference or pursuit, which have been demonstrated to relate to well-being (Kasser & Ryan, 1996).

Although the current study provided little support for expected effects of meditation experience and self-reported mindfulness skills, this research points to many potentially fruitful directions for future research. The current study can serve as a building block that can ultimately contribute to a better understanding of what mindfulness is and is not and what effects meditation practice tends to elicit.

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