Effects of Mindfulness Training on Emotion Regulation and Attention

by

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Date: July 29, 2008
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Dissertation submitted in partial fulfillment of
the requirements for the degree of Doctor
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ABSTRACT

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Abstract

The effect of Mindfulness Based Stress Reduction (MBSR) training on experimental measures of emotion regulation and attention was assessed. Two laboratory based measures of emotion regulation and attention were employed. Amongst a number of hypotheses, the effect of MBSR on return to emotional baseline was assessed. Analyses indicated that MBSR training had no effect on physiological indices of emotion regulation. Analyses indicated that MBSR training had no effect on attention as it was assessed. Self-report measures indicated that MBSR training led contributed to decreased negative emotional experience following a stressor. Implications and future directions are discussed.

Dedication

The work and product which comprise this thesis are lovingly dedicated to my family and friends here, there and everywhere.

Contents

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I would like to express my sincere gratitude to the following people, each of whom has made profound and illuminating contributions to my learning:

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1. Introduction

1.1 Mindfulness based stress reduction

Mindfulness-Based Stress Reduction (MBSR) is a group based intervention originally developed as a complement to traditional medical treatments for individuals who were suffering from both a chronic health ailment and associated stress (Kabat-Zinn, 1982). Kabat-Zinn (1990) defines mindfulness as: "paying attention in a particular way: on purpose, in the present moment, and non-judgmentally" (p. 5). Mindfulness practice is proposed to enable practitioners increased focus on present moment experience and decreased preoccupation with past difficulties and future worries (Kabat-Zinn, 1990). These changes are believed to lead to decreases in inattention, emotion dysregulation, and other psychological difficulties (e.g., rumination) as well as increases in pleasant emotional experiences, and overall psychological well-being (Kabbat-Zinn, 1990; Lynch, Chapman, Rosenthal, Kuo, & Linehan, 2006; Shapiro, Carlson, & Astin, 2007).

MBSR consists of an eight-week course, in which participants meet with an instructor for approximately two-and-one-half hours per week for mindfulness meditation instruction, practices and group discussion. During class meetings, several mindfulness-related practices, such as body scan exercises, sitting meditation, hatha yoga, and walking meditation, are taught. Participants are also given a set of CDs with

guided meditation and other instructions for use at home as they begin their personal mindfulness practice. Participants are asked to practice skills taught during the weekly MBSR sessions for at least forty-five minutes per day, six days per week. Participants are given a work book which has weekly readings describing the experience of mindfulness training, core tenets of mindfulness training (e.g., patience, acceptance), its beneficial effects for a variety of life experiences, and answers to common questions that have arisen in previous MBSR courses. Following the conclusion of the MBSR course, participants are encouraged to continue practicing mindfulness and make formal mindfulness practice part of their daily life. For more details on the weekly structure of MBSR, see Appendix A.

In the years since MBSR was originally developed, the program has come to be offered as a training program that is beneficial for a variety of psychological and physical difficulties. Six randomized controlled trials (RCTs) (Astin, 1997; Shapiro et al., 1998; Shapiro et al., 2003; Shapiro et al., 2005; Weissbecker et al., 2002; Williams et al., 2001), one nonrandomized case-control matched trial (Ramel et al., 2004), and one RCT of a modified MBSR program (Speca et al., 2000) have been conducted. These studies have reported reductions in perceived stress, rumination, psychiatric and medical symptoms, and increases in sleep quality, empathy, self-compassion, acceptance, sense of coherence, spiritual experiences, and satisfaction with life.

Physiological evidence has begun to support the hypothesis that mindfulness affects well-being and associated experiences of stress and immune function. Davidson et al. (2003) studied participants who were randomly assigned to either an MBSR group or a non-intervention control group. Of these, 25 subjects participated in an MBSR group and were compared to 16 subjects who received no mindfulness related instruction during the study.

In the assessment of physiological response to mindfulness practice, participants were administered an influenza vaccine and submitted a blood sample three to five weeks after the MBSR course or the eight week wait-list period respectively. Participants then submitted a blood sample eight to nine weeks after the MBSR course or wait list as appropriate. Results revealed that individuals who completed the MBSR course experienced a significantly larger antibody response to the influenza vaccine compared to participants who had not completed the course. These results are compelling in light of the significant evidence which suggests a positive relationship between psychological well-being and immune system response to vaccination (Glaser, Kieclot-Glaser, Malarkey, & Sheridan 1998). Thus, while these results represent only a single study which needs replication before the relationship between mindfulness practice and immune response is clearly established, the findings of this study have an interesting implication for the physiological effects of mindfulness practice. These findings suggest

the possibility that mindfulness may be positively reinforced through strengthened immune response and improved overall health.

In the neurological assessment involved in this study, the same participants were assessed using functional Magnetic Resonance Imaging (fMRI) techniques. These techniques determined that participants who completed the MBSR course experienced a significant increase in left sided anterior temporal activation from pre intervention to post intervention assessment compared to wait list controls, who experienced no such change in neurological functioning. Furthermore, changes in anterior activation that indicated state and trait shifts in asymmetry were located, indicating that participants experienced an overall boost in baseline affect, and that state experience of positive affect was more pronounced following MBSR participation than it was prior to MBSR participation. Left anterior temporal activation has previously been associated with decreases in experiences of anxiety and negative affect as well as increases in positive affect (Davidson & Irwin, 1999). These findings lend further credence to the hypothesis that mindfulness may be positively reinforced through increases in positive affect and associated behavioral benefits (see Fredericksen, 2000, below) Furthermore, mindfulness may be negatively reinforced through reductions in negative affect and anxiety. These findings add interesting neurological evidence to this hypothesis, which was previously based solely on subjective measures of self-report. While the sample size of this study is relatively small, and replication of this research is needed to establish the veracity of

these findings, the results of this study are an important indicator of beneficial physiological experiences associated with completion of an eight-week meditation program. Finally, these results offer credence for the hypothesis that mindfulness is a behavior which, like all other behaviors, is increased through practice. As reinforcing consequences of mindfulness accrue, the individual may be more likely to repeat the behavior (mindfulness) which has led to these reinforcing consequences.

1.2 Mechanisms of mindfulness

While studies suggesting the effectiveness of mindfulness-based interventions (see Bishop, 2002; & Baer, 2003 for reviews) and positive psychological correlates of mindfulness (see Bar, Smith, Hopkins, Krietemeyer, & Toney, 2006 for a review) continue to mount, few studies have examined how mindfulness enacts its effects on individuals. The question of how mindfulness works is the concern of researchers who have begun to explore the mechanisms of mindfulness (Lynch et al., 2006; Shapiro et al., 2006). The present study aims to offer a more nuanced description of how mindfulness affects the individual by focusing on the impact of mindfulness training on the basic behaviors of attention and emotion that have been theorized to be mechanisms of mindfulness.

1.2.1 Mindfulness & attentional control

Lynch et al. (2006) suggest that increased ability to control the present moment focus of attention may lead the individual to experience increases in effective behavior and decreases in overall psychological distress. Specifically, these researchers suggest mindfulness may create its effects on the practitioner through its emphasis on learning to control the *focus* of attention, as opposed to the *object* or sensation to which one is attending. For instance, if one is distracted while taking a test, instead of repeatedly thinking about this source of frustration, the individual could instead shift the focus of attention away from the frustration, and back to the task at hand. Attentional control has been shown to be advantageous with regard to effective behavior (Yantis & Johnson, 1990). Thus, the commonly emphasized use of attentional control and single mindedness of focus is theorized to contribute to the effective behavior of the mindfulness practitioner (Linehan, 1993).

An emphasis on control of the focus of attention also highlights the *accepting* quality of mindful attention. In the previous example, the mindful response does not include any attempts to control or otherwise reduce the frustration. This is an important difference from strategies such as suppression or avoidance which are often common responses to difficult experiences. A growing body of empirical evidence suggests that such control strategies are associated with emotional difficulties (Bijttebier & Vertommen, 1999; Cheavens et al., 2005; Lynch, Robins, Morse, & Krause, 2001).

Mindfulness teachers have spoken of the mind "hijacked" by the desire to control the object of attention (Brantley, 2007).

A common metaphor which is used to distinguish mindful attention from more control based types of attention describes a monkey who finds a banana in a forest. The monkey reaches through a few sticks, grabs the banana, and realizes that her hand is trapped. In fact, the sticks were bars of a cage which were thin enough to let the monkey's empty hand through, but too narrow to allow the monkey to escape while holding onto the banana. If the monkey tries to get the banana out for hours on end, she will end up caught by the trapper. Mindless attention can often be much like this monkey. The emphasis on control and 'getting what one wants' (e.g., reduction of distraction, frustration, the perfect job) can dim the opportunities which are available if some imperfections and frustrations are simply accepted. While the monkey may not be able to control her environment enough to get the banana, flexibility of attention and a willingness to turn the focus of attention to other present moment contingencies would reveal to the monkey an entire forest where she might be able to seek other, less dangerous, bananas.

Theorists suggest that attentional control may be beneficial in both benign and distressing situations. In benign situations, attentional control can lead an individual to discover more about present-moment experience. This increasing depth of awareness may contribute to increased pleasant emotional experiences, improved knowledge about

present moment contingencies, and therefore improved problem solving (Kabat-Zinn, 1990). In distressing situations, mindful attention may create a sense of balance for an individual who is emotionally provoked. Instead of falling victim to a 'hijacked' experience of emotion dysregulation, the individual can use mindful attention to effectively return to present moment goals and contingencies, thereby keeping her emotions from becoming increasingly dysregulated, and improving her ability to act with wisdom in the moment (Linehan, 1993). Despite suggestions from many theorists, laboratory tests of the effect of mindful attention in benign and distressing situations have not been previously studied.

1.2.2 Mindfulness & emotion regulation

If mindful attention contributes to emotion regulation, it is possible that these improvements in emotion regulation result from overall increases in positive emotional experiences, and decreases in negative emotional experiences. The beneficial effects of positive emotion and mood have been described by Frederickson (1998, 2001, 2003) in her *broaden-and-build* theory of positive emotions. The theory suggests that specific positive emotions (e.g., joy, contentment) share the ability to broaden an individual's *thought-action repertoires*, and build personal physical, intellectual, social, and psychological resources. Frederickson (2000) has linked the broaden-and-build theory to mindfulness practice. She proposes that mindfulness practice is associated with

increased experiences of positive emotions such as contentment. She hypothesizes that contentment experienced as a result of mindfulness practice may lead to relief from anxiety and other common psychological stressors. While these suggestions make theoretical sense, the effect of a single brief mindfulness practice on emotional experience has rarely been studied (one exception is reviewed below).

One study has addressed the effects of a brief mindfulness exercise on experiences of emotion regulation. Arch & Craske (2006) report on the effects of a 15-minute mindful breathing exercise compared to a 15-minute unfocused attention exercise and a 15-minute instructed worry exercise. Subjects were randomly assigned to one of three groups, and all participants viewed positively, negatively, and neutrally valenced slides from the International Affective Picture System (IAPS, Lang, Bradley, & Cuthbert, 1999) before and after the laboratory induction.

Results revealed that, following the induction, the focused breathing group maintained moderately positive responses to neutrally valenced slides throughout the exercise, while the unfocused attention and worry groups responded negatively to neutrally valenced slides. The focused breathing group also reported lower overall negative affect in response to the unpleasant slides compared to the unfocused and worried groups. Furthermore, compared to the unfocused and worried groups, the mindful breathing group reported higher overall positive affect in response to the positive slides following the induction. Finally, compared to the other two groups, the

focused breathing group reported higher willingness to view more negatively valenced pictures following the induction. This final result suggests a greater willingness to maintain contact with difficult stimuli, which may be adaptive in difficult situations.

These results lend further support to the suggestion that mindfulness contributes to emotion regulation through reductions in negative affect. These reductions in negative affect may be associated with the enhanced acceptance of difficult stimuli that participants in the mindful breathing induction reported. Such acceptance is not antithetical to purposeful distraction or attentional deployments which may have helped to *turn the mind* of the participant toward less upsetting aspects of a given negative stimulus presentation.

While this study is limited by the undergraduate sample which is homogenous in age range, there are a number of interesting implications of these results. First, while long-term mindfulness practice may be beneficial, these results demonstrate that a single brief period of mindfulness practice may also be beneficial to psychological well-being. The results suggest the possibility that mindfulness practice leads to a *positivity bias*, a process by which individuals experience even neutrally valenced stimuli through "rose colored glasses" (Issacowitz, 2005, p. 407). The positivity bias has been conceptualized as a cognitive appraisal process whereby individuals both attend more to positive stimuli, and are more likely to appraise neutral stimuli in positive emotional terms. Several theories describe conditions under which individuals may experience a positivity bias.

First, Carstensen and colleagues (1999) describe a Socio-Emotional Selectivity Theory (SEST), which suggests that when individual's motivation becomes less future oriented, and more present moment oriented, the individual has a more nuanced and positively valenced experience of all stimuli. SEST suggests that this positivity bias often occurs in older individuals who, aware of a shortened future for their lifetime, increase their attention to present moment stimuli and report increased positive perceptions of those stimuli, including stimuli which were previously appraised as neutral in valence.

SEST posits that the positivity bias improves emotion regulation. The bias is thought to improve emotion regulation through a focus on positive aspects of an outcome in a given situation, or emotional distancing from emotionally painful aspects of a given situation.

This conceptualization linking positivity bias and selection of positive aspects of the current experience is compatible with the process model of emotion regulation described by Gross (2006). According to the Gross model of emotion, an Emotional experience consists of a sequential order of Situation> Attention> Appraisal> Response. In this model, the *situation* and *response* are external overt behavioral events, while *attention* and *appraisal* occur within the individual and drive the response to the situation. If the mindfulness induction described by Arch and Craske (2006) led to a positivity bias, such a bias could affect a broad emotion regulation strategy which may

modulate the emotional experience of an individual. This emotion regulation strategy is: attentional deployment.

While an individual may not be able to alter the situation they are in (viewing slides of a positive, negative, or neutral valence during an experiment), the individual can control the deployment of their attention in that situation (Rothbart, Ziaie, & O'Boyle, 1992). *Distraction* is a form of attentional deployment which is characterized by paying attention to different aspects of a situation, or turning attention away from the situation altogether. Mindful attention may lead an individual to turn their attention away from the distressing aspects of a certain situation if that distracting is both *effective* and *purposeful* (Linehan, 1993; Kabat-Zinn, 1990). For instance, turning the mind is a skill recommended in DBT as effective for regulating emotions when there is no opportunity to extricate oneself from the situation. Importantly, a mindful turning of attention away from an aversive stimulus should be distinguished from mind wandering, or avoidance strategies which seek to suppress aspects of a given stimulus (Smallwood & Schooler, 2006; Hayes, Stroshal, & Wilson, 1999). These problematic forms of distraction are characterized by either a purposeless experience of attention, or a kind of attention merely focused on avoidance of a given stimulus (e.g., thought suppression) rather than an attentional shift to different aspects of a given situation.

Concentration is a form of attentional deployment characterized by an intentional focus on the emotional aspects of a given situation. When in a situation

where a desirable stimulus is available for attentional deployment, a present-moment oriented, mindful perspective may allow for a rich and powerful experience of that positive emotional stimulus. Indeed, concentration has long been considered an essential component of mindfulness, often cited as beneficial for the enhancement of positive emotional experiences (Kabat-Zinn, 1990).

While much of the research on SEST has focused on the experience of a positivity bias in older adults, the theory suggests that it is a present moment focus, *not* age, which leads to the positivity bias. Since the positivity bias is thought to be a dynamic process which increases with present moment focus it may be that mindfulness, through its emphasis on purposeful, present moment attention leads to an increase in positivity bias and associated emotion regulation. Overall, the results support the previously expressed hypothesis that mindfulness may benefit individuals by enhancing their emotion regulation capacities (Linehan, 1993; Lynch, et al., 2006).

The enhanced attentional (Lynch et al., 2006; Shapiro et al., 2006) and positive affective (Fredericksen, 2003) experiences of the mindfulness practitioner may improve emotion regulation capabilities. While extreme dysregulation of emotions may be a defining aspect of some psychological diagnoses (e.g., borderline personality disorder), emotional distress or suffering is ubiquitous among humans regardless of the status of their mental health (Gross, 2007). Emotion dysregulation may be characterized by the intense experience of emotions, extreme emotional lability, (Linehan, 1993) a narrowing

of attentional focus on the difficult emotion or source of the emotion (Fredericksen, 1999), and associated central nervous system changes (e.g., increased heart rate, respiration, skin conductance level) (Frijda, 1986). Finally, healthy individuals also commonly experience a return to emotional "baseline" or normal mood following emotion dysregulation. Fast return to emotion baseline has been linked to psychological health (Ellenbogen, 2004). A variety of mindfulness-based interventions and training programs have demonstrated effectiveness in alleviating psychological difficulties associated with difficult emotional experiences (Kabat-Zinn, 1990; Linehan, 1993; Hayes et al., 1999; Segal et al., 2002). Despite the growing evidence linking mindfulness and improved emotion regulation capabilities, no studies have examined the effects of mindfulness training on laboratory tasks that assess these psychological experiences.

1.3 Mindful attention and attitude

Shapiro et al. (2006) also emphasize an attitudinal component to the mechanisms of mindfulness. Their emphasis stems from Kabat-Zinn's (1990) description of seven essential attitudes of mindfulness practice non-judging, patience, beginner's mind, trust, non-striving, acceptance and letting go. Since these attitudes are considered essential to the attitudinal component of mindfulness, these essential attitudes may themselves be appropriately thought of as mechanisms, the type of process the current study sought to examine.

Non-judging (also emphasized in DBT) is characterized by being an "unbiased, attentive witness to your experience as it happens in the present moment" (Brantley, 2005, p. 73). Patience is the "ability to bear difficulty with calmness and self control", (Brantley, 2005, p. 74). Beginner's mind is a term derived from the Zen term Shoshin (Suzuki, 1971). Beginner's mind is often described through a quote by Shunryo Suzuki-Roshi: "In the beginner's mind there are many possibilities, but in the expert's there are few," (p. 7). This quote speaks to the emphasis on an open and fresh attitude toward experience, which is valued in mindfulness training. Trust is particularly oriented to faith in one's intimate and innate knowledge about her own experience. This is to say that all individuals have an innate capability to develop the awareness which is mindfulness. The concept of non-striving bears resemblance to the *being mind* state which is contrasted with the *doing mind* state in MBCT (Segal et al, 2002). These authors emphasize that if goal oriented behavior is eliminated, there is no need to evaluate or categorize experience as "good" or "bad", right or wrong. *Acceptance* in MBSR is the purposeful allowing and whole hearted awareness of any stimuli present in the current moment. Letting go is sometimes described in MBSR classes as an allowing component of mindful attention which does not cling to a desired object or experience.

1.4 Summary

Despite increasing interest in mechanisms of change that drive treatment outcomes in mindfulness based interventions, there remain a number of empirical holes in the research to date as well as difficulties associated with the study of mindfulness in the laboratory (Brown & Ryan, 2004). First, although attentional control may be a core component of mindfulness, measurement of this component is difficult, particularly since there are few, if any *overt* behaviors that could be reliably and validly verified as mindful attention. Second, to date no laboratory studies have addressed the effect of sustained mindfulness training on the ability to pay attention to a chosen point of focus. Third, despite the above reviewed exceptions, few studies have addressed the effect of a single mindfulness practice on emotional experience. Fourth, no studies have addressed the effects of sustained mindfulness practice on attention during a stressful situation, a theorized outcome of some mindfulness-based interventions (Kabat-Zinn, 1990; Linehan, 1993). Fifth, no studies have addressed the effect of sustained mindfulness practice on recovery from emotional dysregulation, a theorized consequence of some mindfulness-based interventions (Kabat-Zinn, 1990; Linehan, 1993).

The goal of the proposed research project is to use multiple methods of assessment (i.e., behavioral, psychophysiological, self-report) in order to generate a more complete picture of the potential attentional, emotional and psychophysiological effects associated with the completion of a sustained mindfulness-based stress reduction

training program. Laboratory and psychophysiological methods are emphasized in order to help improve on the existing literature and hopefully increase the precision with which mindfulness can be understood.

The present study will extend the existing literature by assessing:

- Two measures of attention that require overt behavioral responses in order to study the effect of mindfulness training on attention.
- The attentional and emotional effects of both a single, brief mindfulness practice and a sustained course of mindfulness training on the same individuals.
- A laboratory task to assess the effects of mindfulness training on attention while under emotional duress.
- A laboratory task to assess the effects of mindfulness training on return to emotional baseline following an emotionally distressing event.

1.5 Specific aims and hypotheses

The overarching aim of this study is to examine whether Mindfulness Based Stress Reduction (MBSR) training increases self-report of positive emotions, reduces self-report of negative emotions, improves attention, and enhances recovery from arousal. following an emotional stressor. There will be two assessment points for each group that will serve as the primary points for data analysis: baseline assessment (pre-MBSR/ WL),

referred to hereon as time 1, and post-assessment (8 weeks following baseline), referred to hereon as time 2.

It is important to describe the differences between mediators of treatment response (sometimes called mechanisms of change) and the outcomes of these mediators, especially as they apply to this study. Mediators are the behaviors thought to underlie how and when the intervention outcomes take place (Kraemer et al., 2002). For example, one purpose of MBSR might be to reduce the stress of those who participate in the class. Mediators of treatment effects are thought to be those behaviors which lead to the broad, desired outcome experience (e.g., stress reduction). In this study, the mediators which are to be assessed are attention and emotion regulation. Since the beneficial outcomes of MBSR have enjoyed increasing empirical evidence, the purpose of this study is to address more *basic* processes which may underlie these outcomes. Thus, for the purposes of the current study, the mediators which are to be assessed (and here treated as outcome variables) are attention and emotion regulation. Therefore, the design of the current study *assumes* beneficial outcome effects (i.e., stress reduction) will result from the class. The current study *does not assess* these outcome variables (analysis of more traditional outcome variables are being prepared in a separate manuscript). See appendix B for a visual description of the links between interventions, mediators, and overt benefits of interventions.

Hypothesis 1a: MBSR > WL in self-report of positive emotions following attention to breath task at time 2 assessment over and above incremental improvements in one time instructed breathing exercise at Time 1..

Hypothesis 1b: MBSR < WL in self-report of negative emotions following attention to breath task at time 2 assessment over and above incremental improvements in one time instructed breathing exercise at Time 1.

Hypothesis 1c: MBSR > WL in accurately attending to breath during task assessing attention to breath at time 2 assessment over and above accuracy score on an instructed breathing exercise which occurs at Time 1.

Hypothesis 2a: MBSR > WL in performance on an attention task which includes an emotional stressor at time 2 assessment over and above accuracy score on an attention task which includes an emotional stressor which occurs at Time 1.

Hypothesis 2b: MBSR > WL in returning to baseline arousal following an attentional task which includes emotional stressor as indexed by lower skin conductance level at time 2 assessment.

Hypothesis 2c: MBSR > WL in returning to baseline arousal following an attentional task which includes emotional stressor as indexed by slower speed of respiration at time 2 assessment.

Hypothesis 2d: MBSR > WL in returning to baseline arousal following an attentional task which includes emotional stressor as indexed by slower heart rate at time 2 assessment..

Hypothesis 2e: MBSR > WL in returning to baseline arousal following an attentional task which includes emotional stressor as indexed by self-report of positive emotion following an emotional stressor at time 2 assessment.

Hypothesis 2f: MBSR < WL in self-report of negative emotions following an attentional task which includes emotional stressor as indexed by self-report of positive emotion following an emotional stressor at time 2 assessment.

2. Methods

2.1 Random assignment to condition

Following the acceptance of participants into the study, participants were randomly assigned to either MBSR or WL. Randomization was performed by removing equally sized pieces of paper marked with numbers out of a hat in which they had been thoroughly mixed. The numbers corresponded to participant number and group membership was then assigned. Following randomization, groups were checked for sex differences to determine that there are no significant differences between the MBSR and WL groups. This check was performed for several reasons: informal information from the DCIM suggests that traditionally there is a low level of men compared to women enrolling in MBSR programs. Additionally, group processes such as interpersonal communicating about difficult experiences may be affected by unequal distribution of sexes in the groups. Finally, research suggests that men and women experience differences in the way they process both attention and emotion. Regarding attention, women are known to perform better than men on tasks related to verbal memory, while men exhibit better performance on spatial tasks (Silverman et al., 1996; Caplan et al., 1997). In terms of emotional processing, women are known to perform better on tasks of emotional recognition, are generally more expressive, and more prone to changes in mood as well as difficult emotional experiences such as clinical depression than are men

(Natale et al., 1983; Asthana and Mandal, 1998 Hartung and Widiger, 1998; Van Goozen et al., 1996). Women and men are particularly prone to differences in the experience of aggression, with men reporting far more experience of aggressive emotional experiences than women (Björkqvist et al., 1994; Wrangham and Peterson, 1996, Gur et al., 2002). Since the current study addresses behaviors of attention and emotional processing, the equal distribution of men and women was particularly important.

The randomization check revealed no differences were found in sex distribution between the two groups. Participants learned of the outcome of random assignment immediately following their baseline assessment.

2.2 Participants & demographics

Participants were 56 community volunteers who responded to mailing list notices for a free, research-based MBSR course. Emails were sent to local health care and yoga center mailing lists in addition to mailing lists from the Duke Center for Integrative Medicine (DCIM). Participants completed a phone screening with the study coordinator before being accepted into the study. During the phone screening, participants were given an approximately 10 minute overview of the study, including description of the MBSR program and research assessment expectations. According to inclusionary/ exclusionary criteria, all participants were at least 18 years of age; must not have taken an MBSR course previously; and must not have participated in any mindfulness or yoga

practice for more than an average amount of 20 minutes per week for the previous six months. Participants reporting a "serious mental illness" (e.g., depression, post-traumatic stress disorder) must also have reported that they were under the care of a licensed physician or mental heath care provider for this condition, and must not have been hospitalized for psychiatric reasons in the previous six months. Finally, due to random assignment to MBSR or wait list conditions, participants must have committed to availability for an MBSR course to begin approximately two weeks after the initial screening, or one which would begin approximately two-and-one-half months after the screening.

Of the 56 participants in this study, the mean age was 46.41 years (*SD* = 12.99, range = 21 to 87). The gender composition of the sample was 83.92% female (N= 47), and 16.07% male (N= 9). The ethnic composition of the sample was 92.9% Caucasian (N= 51), 3.4% Hispanic (N=2), and 3.4% Asian (N=2). The modal relationship status of participants was married 44.6% (N= 25); 25% (N=14) reported being divorced or separated; 12.5% (N=7) reported being in a relationship but not living together; 14.3% (N=8) reported never having been married; and 1.8% (N=1) reported being widowed. The study population was highly educated: 55.4% (N=31) reported having completed an advanced degree; 35.0% (N= 14) reported having completed college; 8.8% (N= 5) reported having completed an associate or two year college degree; 1.8% (N= 1) reported having completed some high school without having received a degree. In terms of

income, 19.3% (N=11) reported a household income of over $100,000; 19.3% (N=11) reported a household income of $65,000-$100,000; 40.4% (N=23) reported a combined household income of $40,000-65,000; 17.5% (N=10) reported a household income of $20,000-40,000; and 1.8% (N= 1) reported a family income of less than $10,000. The past meditation experience of participants was also high. Though all participants met the above criteria which was designed to exclude individuals with a current high level of mindfulness practice, 67.9% (N=38) reported some past meditation experience. In reporting this experience, participants were explicitly encouraged to consider any meditation practice, including formal meditation, yoga, contemplative prayer, or the reciting of the rosary or mantras. Only 32.1% (N=18) reported no previous meditation experience.

2.3 Measures

2.3.1 Self report

At time 1, participants also completed a form assessing *demographic* information, including religious affiliation, practices, and opinions, as well as questions on previous experience with meditation, yoga, or similar practices.

Participants randomly assigned to MBSR training completed a *daily practice form* to assess their amount of formal mindfulness practice during MBSR.

2.3.2 Behavioral

Mindful Monitor Task (MM) was created by Moria Smoski, Ph.D., of the Duke University Medical Center. The task is designed to assess an individual's experience during a common mindfulness practice (conscious attention to the sensations of breath). The task assesses the accuracy with which an individual can attend to breath during a 10 minute period. A respiration band is attached to the participant's chest, and the individual is asked to press the space bar on the computer at each exhalation. The number of breaths during which the space bar is not pressed and presses which do not correspond with the exhalation are counted as 'misses', and lower a participant's score on this task. Total scores will be computed by dividing the total number of accurate space bar presses from the total number of breaths over the 10 minute examination period, yielding an overall percentage score. For example, 78 accurate presses out of a total number of 100 during the testing period would yield a score of 78%. As a component of the MM behavioral measure, participants completed a *brief emotion rating measure* listing the extent to which they were feeling: excited, angry, frustrated, satisfied, happy, and depressed immediately before and after the completion of each task. The brief emotion rating measure asks the participant to report her experience of each emotion assessed on a scale of 1-100, with 1 being the least this emotion could be experienced, and 100 being the most this emotion could be experienced. For the purposes of this study, two composite measures of positive (happiness, satisfaction) and

negative (angry, frustrated, depressed) emotional experiences were assessed. The MM has never before been used in a published empirical investigation, thus, no psychometric tests or group norms for the experiment are available for the MM.

PASAT-C (Paced Auditory Serial Addition Task- Computerized: PASAT-C; Lejuez et al., 2003).

The original PASAT (Gronwall, 1977) was designed to measure information processing speed and attention. The modified PASAT-C uses visual presentation of stimuli. In this task, numbers are sequentially flashed on a computer screen. Participants sum the most recent number with the previous number and use the computer's mouse to click on the correct answer using a keyboard provided on the computer screen. After providing each sum, the participant must then ignore the sum and add the following number to the most recent number. The PASAT-C is comprised of three levels lasting 1, 2, and 3 minutes, respectively. The latency between number presentations is 3 s for Level 1, 2 s for Level 2, and 1 s for Level 3. Level 3 was designed to be extremely difficult, as the latency is too short for most participants to consistently calculate and make a response. In this study, the PASAT-C included the addition of negative feedback for incorrect or omitted responses (the loud sound of an explosion, set identically at a high, but not harmful level for each participant). Participants received instructions from the experimenter on how to complete the laboratory task, and were given up to 5 minutes to practice the laboratory task on a 'trial' setting without loud sounds, and with the pace of

numbers appearing 3 s apart.

At the conclusion of the PASAT-C, a feedback screen immediately appeared which gave the participant her accurate total score, and an inaccurate, disparaging indicator of her performance compared to the performance of others. That is to say, upon the completion of the seven minute long program, and regardless of the individual's performance, the program always reported to the participant that their performance was in the bottom 7-12% of all individuals who have ever previously performed the task. At the bottom of this feedback screen, text says: "BETTER LUCK NEXT TIME!"

As a component of the PASAT-C behavioral measure, participants completed a *brief emotion rating measure* identical to that used after the MM. However, as opposed to the MM which assessed emotional experiences immediately before and after the task, participants were required to complete the emotion rating measure immediately before and then repeatedly at 6 one minute increments immediately following the conclusion of the task.

The PASAT-C has been shown to reliably produce self-reported psychological stress (Lejuez, Kahler, and Brown, 2003), and negative affect (including anxiety, sadness, and hostility) (Holdwick & Wingenfeld, 1999). Additionally, the PASAT-C has been shown to reliably produce physiological indices of emotion dysregulation such as

increased SCL and heart rate (Lejuez, Kahler, and Brown, 2003). Scores on the PASAT-C are provided for correct, incorrect, and not attempted trials.

2.3.3 Psychophysiological

While completing computer-based measures, participants will be monitored for skin conductance level (SCL), respiration rate (RR), and heart rate (HR). These three physiological behaviors have been selected for measurement during the laboratory tasks because previous studies suggest they are indices of emotional experience (Stern, Ray, & Quigley, 2001). These psychophysiological behaviors have been linked to the sympathetic nervous system, which typically becomes more active when the organism is under stress. For example, activation of these three central nervous system activities above an individual's normal baseline has been linked to emotional dysregulation as well as reduced attentional and problem solving capabilities (Cacioppo, Berntson, Larsen, Poehlmann, & Ito, 2000). While these indices are not considered sensitive to, or predictive of any particular emotion, they have been used widely as an indicator of overall arousal.

Skin conductance level (SCL) has been recommended as a psychophysiological measure of response to a stimulus. In particular, SCL is sensitive to moment-to-moment changes in electrodermal activity following an emotionally provocative stimulus. While there is typically some delay between stimulus presentation and a SCL response, the

latency is brief, typically coming 1-3 seconds after the stimulus presentation (Stern, Ray, & Quigley, 2001).

However, recovery to baseline SCL level following an initial SCL response varies by testing situation (e.g., threatening vs. non-threatening laboratory task) and can often last minutes after the session of any stimulus presentation (Christie, 1976). Numerous previous studies have linked the increase of electrodermal activity with emotion dysregulation (Naveteur & Freixa i Baque, 1988; Tassinary, et al., 1984; Geer, 1966; Montagu & Coles, 1966). In accordance with methods used in previous studies (Cacioppo, Berntson, Larsen, Poehlmann, & Ito, 2000), prior to the beginning of SCL recording, the fingers to be tested will be swabbed with alcohol to remove any oil or dirt build up and assure clean contact with the skin during recording. SCL will be assessed using one electrode placed on each of the middle and index fingers of the participant's non-dominant hand. The electrode will be affixed to the middle phalanges of the second and third digits of the participant's non-dominant hand. The sensor will be attached with a Velcro band. The recording will be conducted through BIOPAC systems computerized hardware.

SCL measurement yields peak scores of change in electrodermal activity from baseline. Changes in SCL sores were computed by the subtracting the mean SCL of a 60 second period following 4 minutes of uninstructed baseline assessment from SCL at six one minute intervals beginning immediately after the end of the PASAT-C. SCL data

were excluded from the study if there was a lack of signal from the sensors (a common indicator of sensor misplacement, movement, or failure), or if there was obvious physical movement related artifact reflected in the SCL recording. All selections of one minute interval of SCL included at least 30 seconds of data following removal of any movement related artifacts. In all, 80% of SCL scores recorded included 100% of data recorded in each reported 60 second interval.

Respiration Rate (RR) has also been linked to emotional experience. Studies suggest that when emotionally dysregulated, an individual has a tendency to breathe at a faster rate than she would have when she was in a more emotionally regulated state (Stern, Ray, & Quigley, 2001). The link between respiration and emotion has a lengthy history in the field of psychology (see Boiten et al., 1994 for a review). There is no clear consensus on the relationship between negative emotional states and RR. For instance, emotional inductions associated with erotic stimuli are also associated with increased RR (Zuckerman, 1971). However, results from a number of studies indicate increases in rate of respiration in conjunction with increases in negative emotion (Rehwoldt, 1911; Ax, 1953; Fenz & Jones, 1972). Such findings have been most consistent linking increased RR with the experience of anger. As noted above, the PASAT-C is designed to induce frustration, a feeling state commonly associated with anger. For these reasons, RR was selected as the second indicator of psychophysiological emotion dysregulation in the current study.

Respiration will be measured with an elastic band that will be worn around the participant's upper chest. The band expands and contracts during respiration. As such, measures of rate of the participant's respiratory pattern will be obtained. RR scores will be computed by subtracting the number of breaths in a 60 second period following four minutes of uninstructed baseline assessment from mean breaths per minute for each of five 60 second intervals following the conclusion of an emotional stressor. The sum of this equation will yield a score for respiration indicative of the extent to which an individual's normal respiration has increased in pace following the conclusion of the emotional stressor.

As with SCL and RR, studies indicate that increased heart rate (HR) is reliably linked to difficult emotional states (Stern, Ray, & Quigley, 2002). Specifically, studies suggest that HR is an aspect of the sympathetic nervous system, a broad system of interconnecting neurons located primarily along the spinal cord. The SNS is responsible for the release of such neurotransmitters as norepinephrine, epinephrine, and adrenaline, chemicals known to increase in times of stress as they prepare the body's organs for action. Due to the role SNS plays in reactions to stress, the SNS is commonly known as being responsible for the body's 'fight or flight' mechanism, as it primes the body to respond aggressively or fearfully to an emotionally dysregulating stimulus. SNS and HR are known to increase in response to stressful emotional experiences such as fear or anger (Ekman, Levenson, & Friesen, 1983). Importantly, recent studies have

suggested that the parasympathetic nervous system (PNS) may play a role in HR reactivity (Beauchaine, 2001; Beauchaine et al., 2001). The PNS is broadly linked to homeostatic functions designed to balance somatic experiences of SNS activation by calming the body between stressors. In contrast to the 'fight or flight' of SNS, PNS has been characterized as the 'rest and repose' response, returning the body to physiological baseline. However, no studies call into question the links between difficult emotional experiences and HR.

HR was selected as the cardiac measure in the current study due to its strong association with anger and frustration. One of the laboratory tasks of interest in this study (PASAT-C) is specifically designed to induce frustration, an emotional experience associated with the blockage of some goal, which frequently precedes the more aggressive emotional experience of anger (Dollard, 1939; Berkowitz, 1989). Additionally, the self-report measure of negative emotions in this study (see above) is a composite of three negative emotions with specific links to HR activation: sadness, anger, and frustration.

HR is computed as mean heart beats per minute. In this study, HR will be assessed through electrodes that will be affixed to the skin with stickers. One electrode will be placed just below the participant's top right clavicle, and one will be placed just below the participant's bottom left rib; this method of 'crossing' the participant's chest

with the electrodes has been recommended as ideal for the accurate collection of HR data.

Changes in HR sores were computed by the subtracting the mean HR of a 60 second period following 4 minutes of uninstructed baseline assessment from HR at six one minute intervals beginning immediately after the end of the emotional stressor.

The mean HR revealed through these instruments will yield a score for HR indicative of the extent to which an individual's normal heart rate becomes dysregulated during an emotional stressor.

Due the previously established (see above) robust impact of the PASAT-C on mood, and in order to control the influence of the PASAT-C on other aspects of the assessment process, participants always completed the Mindful Monitor task before completing the PASAT-C.

2.4 Data analytic strategy

The first step of the data analytic strategy was to examine the distribution of the PASAT-C and MM to evaluate the influence of potential extreme outliers. Extreme outliers represented by falling three or more standard deviations from the mean score on a given variable were removed (Sincich, 1986). Due to the high number of equations described in the results section, outliers for each specific equation will not be reported. The highest number of outliers removed from any one equation was eight.

Analyses on all hypotheses were conducted using hierarchical multiple regressions to assess for the impact of group membership on time two dependent variables over and above the contribution of the same variable at time 1. For these analyses, dependent variables of time 2 scores were regressed onto time 1 scores in the first step and group at the second step. Hypotheses 1a-1d regarded only the impact of a variable of interest (e.g., MBSR group membership) on a given DV (accuracy performance on the PASAT-C) over and above previous performance on the same measure. Thus, hypotheses 1a-1d were assessed with *only* hierarchical multiple regressions as are noted in the results of that particular hypothesis.

For each hypothesis which assessed a dependent variable related to return to emotion baseline at both Time 1 and to Time 2 (Hypotheses 1e-1i), there were six time points of assessment following the conclusion of a stressor, one assessment of the DV of interest each minute from immediately following the conclusion of the stressor and for 6 minutes following the conclusion of the stressor. For each DV assessed on Hypotheses 1e-1i, two equations were conducted. First, as with Hypotheses 1a-1d, a hierarchical multiple regression was conducted to assess the effect of group on a DV of interest at time 2 over and above the effect time 1 performance on that DV.

Second, repeated measures ANOVA's were conducted to assess any changes in the DV (e.g., self-report of negative emotional experience). For each repeated measures ANOVA, the score of the dependent variable was assessed within and between groups

to assess whether or not there was any effect on that variable within groups and second, to assess whether or not that change differed between the two groups.

Tables following the references describe the means and standard deviations of all dependent variables. Significance criterion of $p < .05$ was used to assess all hypotheses. While the somewhat high number of hypotheses might lead to corrections of significance criterion (lower p value to declare significance) in some studies, the low N and novel (experimental) methods of this study make a p value of .05 appropriate for all hypotheses.

2.5 Pre-treatment group comparisons

In order to assure no between group differences on demographic characteristics such as age, sex, or income, independent sample mean comparisons were executed on potential covariates. These comparisons revealed no significant pre-treatment differences between MBSR and WL groups at time 1.

3 Results

3.1 Treatment effects for mindful monitor laboratory task

Test of Hypothesis 1a: MBSR > WL in self-report of increases in positive emotions over baseline following attention to breath task at Time 2 over and above any increases in self-report of positive emotions over baseline in response to Time 1 mindfulness of breath exercise.

The first step in this analysis involved the regression of time 2 scores on the time 1 scores. This first step of this analysis was significant, F (1, 44) = (12.08), p<.001, β= .464, confirming that time 1 report of positive emotional experiences above baseline following the MM exercise contributed to variance in the experience of these same positive emotional experiences at time 2. The second step of this analysis was to enter our predictor variable of interest, namely, group membership. The result of this regression analysis was non-significant, F (2, 43) = .682, p= .41, β= -.114. These results fail to confirm the hypothesis that MBSR group participation leads to positive emotional experiences following a mindful breathing exercise over and above any experiences of positive emotions experienced after the same exercise at time 1. See tables 3 and 4 and figure 1 for details on hypothesis 1a findings.

Test of Hypothesis 1b: MBSR < WL in self-report of decreases in negative emotions compared to baseline following a mindful breathing exercise at Time 2 over and above

any reductions in self-report of negative emotions over baseline in response to Time 1 mindfulness of breath exercise.

The first step in this process involved the regression of time 2 scores on the time 1 scores. This step was significant, F (1, 45) = (4.04), p=.05, β= .29, confirming that time 1 report of negative emotional experiences below baseline following the MM exercise contributed to variance in the experience of these same negative emotional experiences at time 2. The second step of this analysis was to enter our predictor variable of interest, namely, group membership. The result of this regression analysis was non significant, F (2, 44) = .031, p= .86, β= -.03. These results fail to confirm the hypothesis that MBSR group participation leads to reduced experiences of negative emotional experiences following a mindful breathing exercise over and above any experiences of negative emotions experienced after the same exercise at time 1. See tables 5 and 6 and figure 2 for details on hypothesis 1b findings

Test of Hypothesis 1c: MBSR > WL in accurately attending to breath during laboratory task at time 2 assessment.

The first step in this process involved the regression of time 2 scores on the time 1 scores. This step was non-significant, F (1, 33) = .35, p= .56, β= -.10, revealing that time 1 performance on the MM did not contribute to variance in performance on the MM at time 2. The second step of this analysis was to enter our predictor variable of interest, namely, group membership. The result of this regression analysis was non significant, F

(2, 32) = .52, p= .60, β= -.15. This finding fails to confirm the hypothesis that MBSR participation increases the ability to pay attention to breath over and above time 1 performance during a mindful breathing task. See tables 7 and 8 and figure 3 for details on hypothesis 1c findings.

3.2 Treatment effects for PASAT-C laboratory task

Hypothesis 2a: MBSR > WL in performance on an attention task which includes an emotional stressor at time 2 assessment.

The first step in this process involved the regression of time 2 scores on the time 1 scores. This step was significant, F (1, 45) = (127.04), p<.001, β= .858, confirming that time 1 performance on the PASAT-C contributed to variance in performance on the PASAT-C at time 2. The second step of this analysis was to enter our predictor variable of interest, namely, group membership. The result of this regression analysis was non-significant, F (2, 44) = .022, p= .884, β= .858. This finding fails to confirm the hypothesis that MBSR participation increases the ability to pay attention during an emotionally stressful task at time 2 breath over and above time 1 performance. See tables 9 and 10 and figure 4 for details on hypothesis 1d findings.

Hypothesis 2b: MBSR > WL in returning to baseline arousal following an attention task which includes emotional stressor as indexed by lower SCL at time 2.

Repeated measures ANOVA of Hypothesis 2b

To test this hypothesis, repeated measures ANOVA were performed on SCL scores at time 1 and at time 2. Time 1 analyses revealed a significant effect for decreases in SCL within groups F (5, 32)= 3.10, p= .01. However, as predicted, no between group differences were found for the effect of group on return to SCL baseline F= .34, p=.89. Tests of the effect of group on SCL return to baseline at time 2 were then assessed. To test this hypothesis, repeated measures ANOVA were performed on SCL scores at time 2. As with time 1 data, time 2 analyses revealed a trend level effect for decreases in SCL within groups F *(6,31)*= 1.76, p=.13. However, contrary to hypotheses, no between group differences were found for the effect of group on SCL. These results fail to confirm the hypothesis that participants in the MBSR group will evidence faster return to SCL baseline following a stressful task at time 2 compared to a WL control group.

Multiple regression assessment of hypothesis 2b

The first step in this process involved the regression of time 2 scores on the Time 1 scores. This step was non-significant, F (1, 45) = (.064), p= .803, β= -.044, revealing that time 1 SCL following the PASAT-C did not contribute significant variance SCL following the PASAT-C at time 2. The second step of this analysis was to enter our predictor variable of interest, namely, group membership. The result of this regression analysis was non-significant, F (2, 44) = 1.937, p= .167, β= -.243. This finding fails to confirm the hypothesis that MBSR group membership contributes to faster return to baseline following a task which includes an emotional stressor as indexed by lower SCL

over and above the predictive value of changes in SCL. See tables 11-14 and figures 5 and 6 for details of hypothesis 1e findings.

Hypothesis 2c: MBSR > WL in returning to baseline arousal following an attentional task which includes emotional stressor as indexed by RR at time 2.

Repeated measures ANOVA test of hypothesis 2c

To test this hypothesis, repeated measures ANOVA were performed on RR scores at time 1 and at time 2. Time 1 analyses revealed a no effect for decreases in RR within groups F (5, 30) = .72, p= .61. Additionally, as predicted, no between group differences were found for the effect of group on return to RR baseline F= (6, 31) .92, p=.47. Tests of the effect of group on RR return to baseline at time 2 were then assessed. To test this hypothesis, repeated measures ANOVA were performed on self-reported RR scores at Time 2. As opposed to time 1 data, time 2 analyses revealed a significant effect for decreases in RR within groups F (5,18)= 3.09, p=.01. However, contrary to hypotheses, no between group differences were found for the effect of group on return to RR baseline F (6, 19)= .11, p=.37. These results fail to confirm the hypothesis that participants in the MBSR group will evidence faster return to RR baseline following a stressful task at Time 2 compared to a WL control group.

Multiple Regression Test of Hypothesis 2c

The first step in this process involved the regression of Time 2 scores on the Time 1 scores. This step was non-significant, F (1, 45) = (.15), p= .325, β= -.189, revealing that

time 1 RR following the PASAT-C did not contribute significant variance to RR following the PASAT-C at Time 2. The second step of this analysis was to enter our predictor variable of interest, namely, group membership. The result of this regression analysis was non-significant, F (2, 44) = .686, p= .415, β= .159. This finding fails to confirm the hypothesis that MBSR group membership will contribute to faster return to baseline following a task which includes an emotional stressor over and above the contribution of any changes in RR at time 1. See tables 15 through 18 and figures 7 and 8 for details on hypothesis 1f findings.

Hypothesis 2d: MBSR > WL in returning to baseline arousal following an attentional task which includes emotional stressor as indexed by slower HR at time 2.

Repeated Measures ANOVA Test of Hypothesis 2d

To test this hypothesis, repeated measures ANOVA were performed on HR scores at time 1 and at time 2. Time 1 analyses revealed a significant effect for decreases in HR within groups F (5,20)= .37, p= .87. However, as predicted, no between group differences were found for the effect of group on return to HR baseline F (6,21)= .67, p=.65. Tests of the effect of group on HR return to baseline at Time 2 were then assessed. To test this hypothesis, repeated measures ANOVA were performed on HR scores at Time 2. As with Time 1 data, Time 2 analyses revealed a trend level effect for decreases in HR within groups F (5,25)= 2.17, p=.06. However, contrary to hypotheses, no between group differences were found for the effect of group on return to HR baseline F (6,24)=

.57, p=.72. These results fail to confirm the hypothesis that participants in the MBSR group will evidence faster return to HR baseline following a stressful task at Time 2 compared to a WL control group.

Multiple regression test of hypothesis 2d

The first step in this process involved the regression of Time 2 scores on the Time 1 scores. This step was significant, F (1, 30) = (5.099), p= .031, β= .381, confirming that time 1 HR following the PASAT-C contributed significant variance to HR following the PASAT-C at Time 2.. The second step of this analysis was to enter our predictor variable of interest, namely, group membership. The result of this regression analysis was non-significant, F (2, 29) = 2.465, p= .981, β= -.004. This finding fails to confirm the hypothesis that MBSR group membership will contribute to faster return to baseline HR following a task which includes an emotional stressor over and above any contributions made by changes in time 1 HR. See tables 19 through 22 and figures 9-10 for details on hypothesis 1g findings.

Hypothesis 2e: MBSR > WL in returning to baseline arousal following an attentional task which includes emotional stressor as indexed by self-report of positive emotion following an emotional stressor at time 2 assessment.

Repeated measures ANOVA test of hypothesis 2e

To test this hypothesis, repeated measures ANOVA were performed on self-reported positive emotion scores at Time 1 and at Time 2. Time 1 analyses revealed a

significant effect for decreases in positive emotion within groups F (5, 37)= 24.28, p<.001. However, as predicted, no between group differences were found for the effect of group on return to positive emotion baseline F (6, 36)= .231, p=.95. Tests of the effect of group on positive emotion return to baseline at Time 2 were then assessed. To test this hypothesis, repeated measures ANOVA were performed on self-reported positive emotion scores at Time 2. As with Time 1 data, Time 2 analyses revealed a significant effect for decreases in positive emotion within groups F (5, 37)= 37.39, p<.001. However, contrary to hypotheses, no between group differences were found for the effect of group on return to positive emotion baseline F (6, 36)= 2.42, p=.03. These results fail to confirm the hypothesis that participants in the MBSR group will evidence faster return to positive emotion baseline following a stressful task at time 2 compared to a WL control group.

Multiple Regression Test of Hypothesis 2e

The first step in this process involved the regression of Time 2 scores on the Time 1 scores. This step was non-significant, F (1, 30) = (.13), p= .91, β= .02, revealing that time 1 self-report of positive emotions did not contribute significant variance to time 2 self-report of positive emotions. The second step of this analysis was to enter our predictor variable of interest, namely, group membership. The result of this regression analysis was non-significant, F (2, 29) = .09, p= .77, β= .77. This finding fails to confirm the hypothesis that MBSR group membership will contribute to faster return to baseline

following a task which includes an emotional stressor as indexed by self-report of positive emotions over and above any predictive value of time 1 self-report of positive emotions. See tables 23 through 26 and figures 11-12 for details on hypothesis 1h findings.

Hypothesis 2f: MBSR < WL in self-report of negative emotions following an attentional task which includes an emotional stressor at time 2 over and above any increases in negative emotion above baseline as indexed by self-report of negative emotion following an emotional stressor at time 1.

Repeated Measures ANOVA Assessment of Hypothesis 2f

To test this hypothesis, repeated measures ANOVA were performed on self-reported negative emotion scores at time 1 and at time 2. Time 1 analyses revealed a significant effect for decreases in negative emotion within groups F (5, 37)= 24.28, p<.001. However, as predicted, no between group differences were found for the effect of group on return to negative emotion baseline F (6, 36)= .231, p=.95. Tests of the effect of group on negative emotion return to baseline at Time 2 were then assessed. To test this hypothesis, repeated measures ANOVA were performed on self-reported negative emotion scores at time 2. As with time 1 data, time 2 analyses revealed a significant effect for decreases in negative emotion within groups F (5, 37)= 37.39, p<.001. Consistent with hypotheses, between group differences were found for the effect of group on return to negative emotion baseline F (6, 36)= 2.42, p=.03. These results confirm the hypothesis

that participants in the MBSR group will evidence faster return to negative emotion baseline following a stressful task at time 2 compared to a WL control group.

Multiple Regression Test of Hypothesis 2f

The first step in this process involved the regression of Time 2 scores on the Time 1 scores. This step was significant, F (5, 40) = (4.09), p= .05, β= .307. The second step of this analysis was to enter our predictor variable of interest, namely, group membership. The result of this regression analysis was significant, F (6, 39) = 4.69, p= .033, β= .327. This finding confirms the hypothesis that MBSR group membership contributes to faster return to baseline immediately following a task which includes an emotional stressor as indexed by self-report of negative emotions over and above any contribution of time 1 negative emotion scores.

Based on the finding that group membership accounts for time 2 scores of self-report of negative emotion over and above the variance of time 1 scores, the hypothesis that MBSR group membership will contribute to faster return to baseline one minute after the conclusion of a task which includes an emotional stressor as indexed by lower self-report of negative emotion one minute following the emotional stressor was assessed. To test this hypothesis, multiple regressions of time 2 scores on the Time 1 scores at the first step and on group at the second step were performed. The first step in this process involved the regression of time 2 scores on the time 1 scores. This step was significant, F (5, 38) = 7.76, p= .018, β= .38. The second step of this analysis was to enter

our predictor variable of interest, namely, group membership. The result of this regression analysis reached trend level significance, F (6, 37) = 5.85, p= .07, β= .255. This finding suggests a trend which may confirm the hypothesis that MBSR group membership will contribute to faster return to baseline one minute following a task which includes an emotional stressor as indexed by self-report of negative emotions over and above any contribution of time 1 negative emotion scores.

Based on the trend finding that group membership accounts for Time 2 scores of self-report of negative emotion over and above the variance of Time 1 scores, the hypothesis that MBSR group membership will contribute to faster return to baseline two minutes after the conclusion of a task which includes an emotional stressor as indexed by lower self-report of negative emotion one minute following the emotional stressor was assessed. To test this hypothesis, multiple regressions of Time 2 scores on the Time 1 scores at the first step and on group at the second step were performed. The first step in this process involved the regression of Time 2 scores on the Time 1 scores. This step reached trend level significance, F (5, 38) = 3.37, p= .07, β= .27, confirming that time 1 report of negative emotional experiences above baseline at 2 minutes following the PASAT-C contributed significant variance to the time 2 report of these emotions at this 1 minute assessment point following the PASAT-C. The second step of this analysis was to enter our predictor variable of interest, namely, group membership. The result of this regression analysis was non-significant F (6, 37) = 2.39, p= .25, β= .176. This finding fails

to confirm the hypothesis that MBSR group membership will contribute to faster return to baseline following a task which includes an emotional stressor as indexed by self-report of negative emotions more than two minutes after the conclusion of the stressor over and above any contribution of time 1 negative emotion scores over and above any contribution of time 1 negative emotion scores. See tables 27-32 and tables 13-14 for details on hypothesis 1i findings.

Post hoc analysis on effect of formal mindfulness practice

Attempts to collect formal mindfulness practice data revealed mixed results. Reporting of practice varied from participant to participant. Some participants verbally reported to the investigator that they recorded "informal" practice (e.g., mindfully feeling the breeze on one's face while walking) even though they were asked not to by the investigator. Other participants reported they occasionally filled out the practice log daily, and at other times only once at the end of each week, and some participants reported completing logs up to seven weeks after the week for a particular set of dates, calling into question the role memory played in the recollection and reporting of actual practice. Some participants reported regular practice but failure to remember to complete and return the practice log. Other participants occasionally turned in practice logs reporting no practice whatsoever, revealing that faithful reporting of practice (or no practice) could not be compared to a total failure to report practice. In all, 92% of participants failed to turn in at least one practice log, 30% turned in a practice log for less

than half of the weeks of the eight week long course, and overall 65% of practice logs were returned. Average reported practice of those logs returned was 36 minutes per day over the eight week MBSR course.

Despite these confounds, and in an effort to discover any predictive effect of self-reported formal mindfulness practice on any changes in attentional or emotional regulatory responses to the laboratory tasks, formal mindfulness practice logs were analyzed for their predictive value on any dependent variables. The first step in the process of examining the effect of formal mindfulness practice on all dependent variables in this study involved the regression of time 2 scores on the time 1 scores of each respective dependent variable. The second step of this analysis was to enter our predictor variable of interest, namely, group membership. The result of this regression analysis was non-significant in the case of each dependent variable. These findings fail to confirm the hypothesis that formal practice during MBSR participation enhances attention or speeds return to physiological or self-reported emotional baseline following an emotionally stressful task.

4 Discussion & limitations

4.1 Summary of general findings

The preceding study was designed to test the effects of mindfulness training on attention and emotion regulation. This discussion will begin with a discussion of the findings on each specific hypothesis, followed by a general discussion.

4.1.1 Summary of findings testing the effect of mindfulness practice on attention

The study failed to confirm the hypothesis that individuals in the MBSR group will more accurately attend to breath through moment to moment self-report of respiration after the MBSR program over and above accurate reporting of respiratory behavior at time 1. This hypothesis suffered from a methodological flaw in the form of a ceiling effect. A ceiling effect occurs when scores on a given measure are so high that no meaningful difference between groups can be determined. The ceiling effect related to this hypothesis concerns the lack of variance in accuracy of moment to moment attending to breath due to an extremely high score (97%) These results virtually precluded any possibility that increases in accuracy could be found at time 2.

An alternative possibility is that individuals are already quite capable of attending to their breath without participating in an eight-week long formal mindfulness training program. If a major focus of some mindfulness practices is attending to one's breath, perhaps finding time in one's schedule to dedicate to such

practice, and the reminder of brief instructions at the beginning of the practice are all one needs to bring attention to breath.

One other aspect of the MM which may have affected participant ability to attend to breath is the manner in which participants reported their attention to breath, that is, pressing a space bar in correspondence with an inhalation or exhalation. This kind of noting of the breath may have aided in participant ability to attend to breath. A common recommendation for individuals struggling with attending to breath is that they count breaths, sometimes up to a given number such as 10, and then count back again. This noting of the breath is recommended as only an aid to attending to breath (not a new focus of attention in and of itself). The pressing of the space bar may have acted as a kind of notation or reminder to the self to stay on the task of attending to breath. Indeed, one participant in the study noted several months after the time 1 assessment that when she practiced formal mindfulness as part of the MBSR program she would often lightly tap a finger on her leg because she found such a simple reminder of great benefit to her ability to pay attention after doing so during the MM task. She chose to do this even though use of tapping the finger was only asked with the task as a way of noting attention for the purposes of the experiment, the tapping was never explicitly recommended as a way of increasing her ability to remain in attentional contact with her breath. attending to one's breath. Future studies are recommended to

address the benefit such forms of noting may have on one's ability to continue attentional contact with the breath during a mindful breathing exercise.

A final aspect of these findings relates to overall sample characteristics. All participants were told that the MBSR program expected a practice amount of 45 minutes per day six days per week, and all participants said they were committed to that amount of practice. Analyses examining the predictive effect of mindfulness practice within the MBSR group on attention to breath at time 2 failed to find any links between practice and performance. However, a strong commitment to mindfulness practice by all participants may have been a factor which led to high scores of attention to breath at time 1.

The study failed to confirm the hypothesis that participants in the MBSR group would perform with improved attention to an attention task which included an emotional stressor over and above time 1 scores compared to the WL group. While these findings contrast with suggestions in the research literature that mindfulness contributes to improved attention (Kabbat-Zinn, 1990) aspects of the methodology used to assess attention may have contributed to the null findings of this hypothesis. Specifically, the PASAT-C has never before been used as a measure of attention (only of frustration induction, see above), though its basis, the original PASAT *is* a test of attention. Additionally, few studies have experimentally assessed the relationship between mindfulness practice and attention. For example, Jha (2007) describes a test of working

memory (similar to the aspects of attention assessed by the PASAT-C) which revealed differential responses for meditators vs. non-meditators. However, there are several caveats to this finding which are particularly important for the current study.

First, Jha's study did not include an emotional dysregulatory challenge as part of the attentional task. The distraction of difficult (loud, caustic) noises representing feedback on poor performance may have led to difficulties in dedicating full cognitive abilities to attentional performance. Additionally, Jha's study reported on the responses of long-term meditators, some of whom were Buddhist monks dedicating their lives to meditation and related practices. Since the group in the previous study represents individuals with an extremely high level of practice (10,000+ hours), it is virtually impossible to compare exceptional attentional capabilities evidenced by this group to the participants in the current study who have completed far less formal practice. Thus, while mindfulness training may contribute to improved attentional abilities, the present study failed to confirm this hypothesis, and empirical findings which do confirm the hypothesis are only found in groups which have extremely high levels of mindfulness practice and in attention tasks which do not include an emotional stressor.

4.1.2 Summary of findings testing the effect of MBSR participation practice on psychophysiological indices of emotion

Together, tests on hypotheses failed to prove that mindfulness training improves physiologically based experiences of emotion regulation. As discussed previously, each

of the physiological measures of interest (SCL, HR, RR) has previously been associated with negative affect. However, research has also implicated each of these physiological behaviors with experiences other than negative affect. SCL, HR, and RR have all been linked with exercise, erotic stimulation, and joyful behavior (e.g., laughter) (see above for more details). In contrast to the physiological indicators measured in this study, positive findings of links between physiological experiences and mindfulness practice have previously been based on subtle, non-muscular physiological activity (e.g., neurological and immune response assessments) which is not testable from outside the body. It may be that some physiological experiences are more prone to responding to mindfulness practice than others. Perhaps the more subtle and covert a behavior is, the more sensitive it is to mindfulness practice. It is recommended that future studies explore the sensitivity of different forms of physiological activity to mindfulness practice.

4.1.3 Summary of findings testing the effect of MBSR participation on self-reported indices of emotion

The findings for return to positive emotion baseline emotional experience following the stressful task were not different between the two groups, indicating that MBSR may not benefit individuals in a faster return to baseline positive emotional experiences. This finding is inconsistent with previous theoretical and empirical descriptions which link mindfulness practice and positive emotions. However, it is

important to note that MBSR is a *stress reduction* program, not a positive emotion enhancement program. While increasing positive emotion is one aspect of emotion regulation (see introduction) reducing negative affect may be a more central focus of MBSR, suggesting that MBSR may have more emphasis on *reducing* negative affect following a stressor than *increasing* positive affect.

The findings that participants in the MBSR program self-reported a faster return to baseline negative affect (for the initial two minutes following the task until the individuals reached the same level of self-reported negative affect) was consistent with study hypotheses. These findings suggest that, as Jeff Brantley (personal correspondence, 2008) has noted even if you "cannot help getting caught in the thunderstorm and getting wet, practicing mindfulness will help you dry off more quickly."

While this study was conducted with a non-clinical sample, and can thus only be cautiously generalized to clinical populations, these findings are consistent with previous suggestions concerning the contribution mindfulness may have on attenuating dysregulation associated with intense negative emotions in clinical populations. Researchers have suggested that prolonged activation of negative emotional experiences may be a key component of emotion dysregulation disorders (e.g., BPD) (Linehan 1993, Linehan, Bohus, & Lynch, 2007). Despite this core theoretical assertion in DBT, little research has investigated return to emotion baseline in individuals. One previous study

has linked difficulties in returning to emotion baseline to a disorder of emotion dysregulation. Siglmayer et al. (2005) reported that individuals with BPD self-report higher and longer lasting experiences of negative emotions compared to healthy control participants. Thus, while prolonged activation of emotion dysregulation may be a key component of some disorders, it is an understudied area in the research literature. Additionally, no studies have addressed any contribution mindfulness may have to speeding return to emotion baseline, another suggestion made by Linehan (1993).

To the author's knowledge, the findings of the current study represent the first empirical evidence that suggests mindfulness practice aids in return to baseline affective experience following a stressor. While it is important to reiterate the substantial caveat that the current study assessed emotional experiences in a non-clinical sample, the findings can be considered tentative evidence that mindfulness training assists in faster return to emotion baseline for some individuals. It would be valuable for future studies to address this question in clinical populations of individuals with disorders of emotion dysregulation, such as those with BPD.

The study failed to find that individuals participating in the MBSR program would self-report increases in positive emotion over and above any changes in positive emotion reported following an instructed breathing exercise at Time 1.

One possible explanation of these findings is that the relatively long 20-60 minutes) formal mindfulness practices in MBSR lead individuals to experience increases

in positive emotion only after periods of practice which exceed the 10 minutes of this laboratory exercise. However, this suggestion is antithetical to recommendations in the literature that even short mindfulness practices (approximately five minutes) may be effective in increasing positive emotions (Brantley, 2008). Another possible explanation is that formal mindfulness training, such as that found in MBSR does not in fact increase positive emotions over and above any increases experienced in relatively brief (10 minutes) practices which include very little instruction. Future studies should address the issue of 'dose effect' and the extent to which programmatic formal mindfulness training increases an individual's experience of positive emotion over and above brief practices which involve very little instruction.

In findings that mirror the above, the study failed to find that individuals participating in the MBSR program would self-report decreases in negative emotion over and above any incremental decreases in negative emotion reported following an instructed breathing exercise at Time 1. As with hypothesis 1a., one explanation of these results is that MBSR participation does not lead to decreases in negative emotion over and above any changes an individual might experience as a result of a brief instructed practice.

However, another explanation of these results is that there is relatively little change due to a 'floor effect' or an overall low report of baseline negative affect at Time 1. Indeed, mean baseline negative affect at Time 1 was 6.65 before the induction, and

7.27 put of 100 following the introduction, leaving little room for variance in self-report of emotion. Similarly, Time 2 baseline negative emotion within the entire study population group was 1.33 again leaving little opportunity for MBSR participation to have any effect on changes in negative affect associated with completion of the MM.

4.2 General discussion & limitations

This study found mixed results on the effect of mindfulness training on attention and emotion regulation. While the study failed to confirm hypotheses on the attentional and physiological effects of MBSR training, the study did find that MBSR training leads to faster return to self-reported negative emotion for several minutes following a stressor. As mentioned previously, although null results may reflect measurement difficulties, it is important to consider that one possible conclusion of the results from this study is that the influence of a time-limited mindfulness training class on attention and emotion regulation abilities to be relatively nonexistent.

Alternatively, null findings do not fully disprove hypotheses per se. Perhaps the largest limitation facing this study was the use of experimental and physiological measurements which have not before been used in intervention outcome research. As noted previously, studies have used the PASAT to assess attentional capabilities. Additionally, the PASAT-C has been used to induce frustration, one type of emotion dysregulation (Lejuez, 2003). However, the versions of the PASAT used to assess

attention or induce frustration differ substantially. The older, attentionally based PASAT was completed with the subject speaking aloud the answers to an experimenter who held up cards showing numbers for the subject to add together. This version of the PASAT is completed at a moderate pace and includes no stimuli designed to induce emotion dysregulation (e.g., loud sounds). The modified version of the PASAT-C used in this study is computerized, completed with no experimenter present in the room, increases in speed of numbered pairs to be added as the subject works to complete the task, and produces a loud sound each time the subject gives an incorrect response or fails to respond. While the computerized PASAT-C does record data on attention to task (e.g., number of correct answers, incorrect answers, and unanswered questions) no previous studies have reported on the ability of subjects to give accurate responses to the pairs to be added in the computerized PASAT-C. Previous studies have exclusively used the PASAT-C to *induce* frustration and thereby emotion dysregulation. Thus, while it was *theoretically* suitable to use the PASAT-C as a measure of both emotion dysregulation and attention, the suitability of the measure itself to assess these psychological experiences may be suspect.

The second experimental paradigm used in this study was designed to assess attention to breath during a 10 minute mindful breathing exercise. Results from this exercise failed to confirm the hypothesis that mindfulness training improves attention to respiratory behavior and emotion regulation. As noted previously, findings on the

attentional component of this measure were influenced by a ceiling effect during the baseline assessment. This effect rendered the opportunity to compare responses on this task before mindfulness training to responses following mindfulness training virtually impossible.

In addition to the above methodological issues in this study which may have affected treatment outcomes, there are a number of demographic factors which bear discussion for their potential effects on the study findings. First, the participant pool was recruited in part from local yoga centers. This may have influenced the high number of participants with previous meditation experience. Additionally, anecdotal data from the DCIM suggests that many individuals who participate in the MBSR program have at least some (varying from once attending a lecture to individuals who have previously participated in meditation retreats) experience with meditation. Though literature searches reveal no systematic descriptions of the demographics and population numbers of those who practice mindfulness or meditation, a recent article in the popular press estimated that 10 million Americans practice some form of meditation (Stein, 2003). While this number is high, and is estimated to have doubled in the previous 5 years, this number still represents a scant 3% of the U.S. population. This percentage is in stark contrast to the over 60% represented in the population of the current study. It is difficult to speculate about the effects previous meditation experience may have had on this study, especially since tests of covariates revealed previous meditation experience did

not significantly affect responses to the laboratory paradigm used in this study. However, the substantial difference in previous meditation practice between participants in this study compared to the U.S. population in general should be noted, and may call into question the generalizability of the results from this study.

Other unique demographic characteristics of the study population are worthy of note. Over 90% of the study population was Caucasian. This racial characteristic of the study population is particularly notable as it differs dramatically from the ethnic population of Durham, NC which is 54% Caucasian, 37.80% black, 11.60% Hispanic, and 4.10% Asian (U.S. Census data, 2006). Additionally, the gender make up was also disproportionately female. While over 70% of the participants in the study were female, U.S. census data (2001) indicates that only 51.94% of the population of Durham, NC is female. Finally, the income of those in the study was higher than the averages for Durham, NC. The average household income in Durham, NC is $41,160 (U.S. Census, 1999). The modal (44.4%) income group for the study reported a household income of $40,000-$65,000. It can be assumed that since the mean income of citizens of Durham falls at the bottom of this range a number of the people in this income group had a higher income than the city average. Additionally, 19.3% of individuals reported an average income of $65,000-$100,000, well above the city mean. Furthermore, 19.30% of the sample reported a household income of over $100,000, well over twice the average income of a resident of Durham. Over half of the sample reported completion of an

advanced educational degree. Census data indicates that the modal level of education in Durham is completion of some college or an associate's degree (23.60%). The percentage of residents of Durham who have completed a graduate degree is 17.40%, approximately one third of the percent of individuals reporting the same level of education in the sample of the current study. Finally, anecdotal information suggests that the study sample was comparable to other MBSR groups regarding demographic variables, suggesting that while the sample may not be representative of the surrounding area, it is representative of those who enroll in the MBSR program at the DCIM.

The disproportionately high number of Caucasians, females, wealthy, and highly educated individuals in the study are important demographic characteristics that might predict the tendency of individuals from some racial backgrounds to participate in mindfulness programs while others are unlikely to choose formal mindfulness practice as an activity. As with previous meditation experience, pretreatment characteristics which may have moderated participant response to the dependent variables of the study did not reveal statistically significant results. However, the unusual population characteristics may make the results of this study difficult to generalize to other populations. Finally, the feasibility of mindfulness based interventions for racial minorities and men is an important area of future investigation. If mindfulness is considered a broadly beneficial and universal human capacity, and stress is a ubiquitous experience which is deleterious and common to all humans, future studies should

explore the reasons that lead some individuals to participate in mindfulness based interventions, while members of other demographic groups appear to be decidedly not prone to participating in such interventions.

While attentional control may be a mechanism of mindfulness, it may be that the quality of attention which is controlled also needs to be emphasized. Based on the seven core attitudes of mindfulness described in the introduction, it may be important to consider non-judging, patience, beginner's mind, trust, acceptance, and letting go as essential ingredients of the attention which is controlled. Thus, perhaps the attentional mechanism of mindfulness is not merely the ability to control the focus of attention, but to control the focus of attention in a way that incorporates these essential attitudes. Importantly, few of these seven attitudes have come under empirical study. Non-judging (Baer, 2006) and acceptance (Hayes et al., 2004) are the only two of these attitudes which have come under any empirical investigation to date. If accurate assessment of mindful attention is to be undertaken, methods which accurately measure the five other attitudinal components of mindfulness must be created. As has been noted, the sometimes vague and paradoxical qualities which are essential to mindfulness make it particularly difficult to study empirically (Brown & Ryan, 2003).

Another important limitation to the study is that the PASAT-C measured no personally relevant experiences of attention or emotion regulation. The primary measure of attention used in this study (PASAT-C) was designed to assess attention to a

mathematical task while being forced to listen to frustrating distracting noises. This is not a test which examines the presence of the seven essential attitudinal components of mindfulness discussed above. The task in itself may have appeared arbitrary and irrelevant to participants. There was no particularly compelling reason for the participant to bring to bear the effortful attentional mechanism of mindfulness. Indeed, some participants responded to the frustrating task by laughing throughout the task following participation in the MBSR class. These participants reported that mindfulness training led them to this response because instead of forcing themselves to *strive* to perform their best on the task they learned to *accept* the task as a transitory irritation. In this way, the PASAT-C may have become less a test of attention and more a forced experience of distress tolerance (Linehan, 1993), a construct not explored in this study.

While only a few participants laughed during the second test of the PASAT-C, it was a surprising behavior which bears some discussion. Behaviors such as laughter also explain the failure of participants to return to physiological baseline following the task. Additionally, laughter is a behavior related to joy which is considered adaptive for its ability to create an experience of emotional distance between an individual and a stressful stimulus (Bonanno, 1997). This distance can have the effect of decreasing the experience of threat from the stimulus. Thus, laughter may have been an adaptive response to the PASAT-C (if one's goal was to not become distressed by the task), even if laughter was antithetical to performance on the attentional component of the PASAT-C.

Research suggests that individuals who attend to personally relevant (as opposed to arbitrary or personally meaningless) goals experience improved well being and goal performance success (Berg, Janoff-Bulman, & Cotter, 2001). This is particularly important in light of the results of the PASAT-C, which failed to find improved accuracy on a measure of attention. Since the PASAT-C is a goal directed task (respond accurately to as many number pairs as you can) which, importantly, is not related to any personally relevant experience (e.g., personal health, intimate relationships) one hypothesis is that participants may have simply 'given up' on the task. This is not meant to suggest that mindfulness training leads to a reduction in goal directed activity. On the contrary, mindfulness, and MBSR in particular, which emphasize a compassionate quality of attention which is particularly directed to personally relevant experiences such as one's own distress over personal difficulties, or close personal relationships may in fact hone attention to these objects without affecting attentional capabilities to tasks which are personally irrelevant.

Failure to return to physiological baseline could be based on any number of affective experiences, some of which are positive affective experiences and anecdotal evidence suggests that at least some participants responded in this way even though they experienced little negative affect, and possibly increases in positive affect as a result of the task.

The findings of this study which suggest that mindfulness training did not

influence self-reported emotion regulation following stressful task are contrary to study hypotheses. As with attention, a hypothesis that must be considered is that mindfulness training does not lead to increased emotion regulation capabilities. However, such a conclusion would contradict theoretical and empirical research (reviewed in the introduction) which suggests mindfulness training *does* improve emotion regulation. As noted in the introduction, only one previously published experimental study has demonstrated an effect of mindfulness on emotion regulation in a non-clinical sample. However, this previous study (Arch & Craske, 2006) did not include an emotionally provocative stimulus.

In addition to the above detailed description of limitations of this study, it is important to note that the small sample size may have diminished the opportunity to find statistically significant results in this study. While there may have been a number of factors contributing to the null findings of this study, an increase in statistical power may have increased the likelihood of discovering findings in accord with study hypotheses.

4.3 Future directions

The findings from this study suggest that methods designed to assess the overt behavioral mechanisms which drive the benefits experienced in mindfulness practice are yet to be discovered. As methods which might illuminate mechanisms of mindfulness

and thereby inform improved methods for teaching and understanding mindfulness would be highly valuable to the research literature, a search for reliable and valid methods to test these dynamic behavioral experiences should continue. In particular, future studies should include assessments of mindful behavior which are sensitive to the seven core attitudes of mindfulness, as these attitudes themselves may be mechanisms essential to mindfulness.

Future studies also need to address the role of mediators of mindfulness based interventions in a manner which includes the important components of mediation referred to in the introduction of this paper. In order to address the effect of an intervention on mediators, multiple assessments of these mediators need to be taken at various time points throughout the active intervention phase. The method of multiple assessment will help determine when the intervention begins having active effects on mediators, and thus time points where the individual is beginning to, or maximizing, the experience of benefit from the intervention. As is mentioned in the introduction to the paper, the novel and dynamic aspects of laboratory assessment carry with them a substantially increased participant burden. Future investigators will need to address the contending issues of participant burden and dynamic laboratory assessment in a manner which satisfies the desire to assess behavior with as much dynamic sensitivity to overt behavior as possible while still not unduly burdening participants, or creating a paradigm so demanding that it renders subject recruitment extremely difficult.

Additionally, future studies need to address mediators of intervention outcomes in a paradigm which *measures* intervention outcomes. Even for well-established interventions, such as MBSR, which enjoy some empirical support, assessment of outcome measures is essential if the mediators are to play the essential role of going "between" the intervention and the outcomes. The current study attempted to make a first step linking a somewhat established intervention to mediators (treated here as outcome variables). However, any full test of the role of mediators in intervention research demands the assessment of all three essential ingredients of the intervention-mediation-outcome process.

A final direction for future studies may be to explore the impact of mindfulness training on indices of impersonal goal-directed attention compared to personally relevant goal-directed attention (such as one's ability to attend in a purposeful present moment way to a distressed friend or family member).

Figures

Figure 1

Hypothesis 1a: Changes in self-report of positive emotion from baseline following the MM

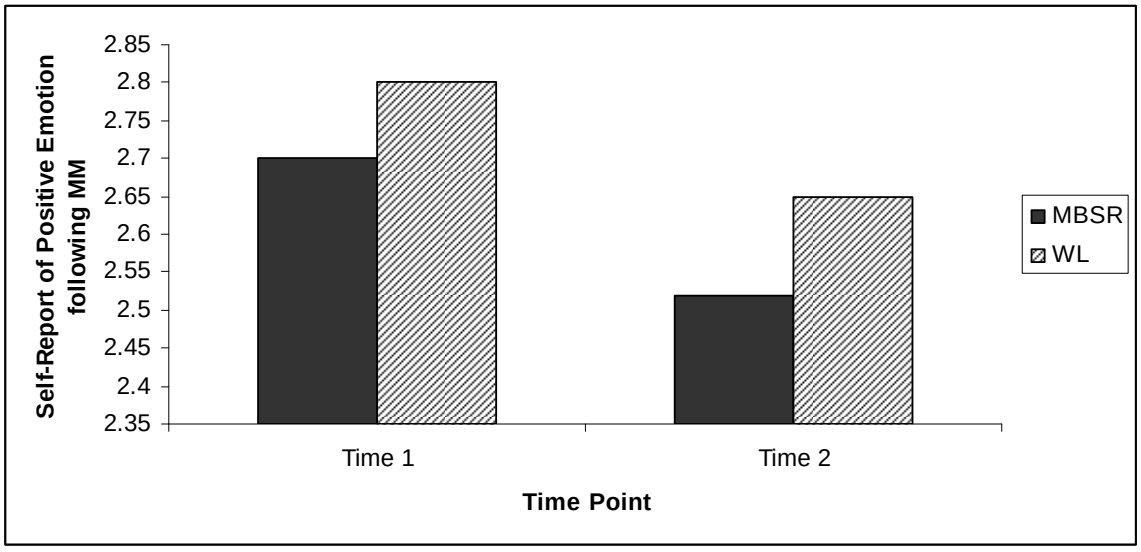


Figure 2

Hypothesis 1b: Changes in self-report of negative emotion from baseline following the MM

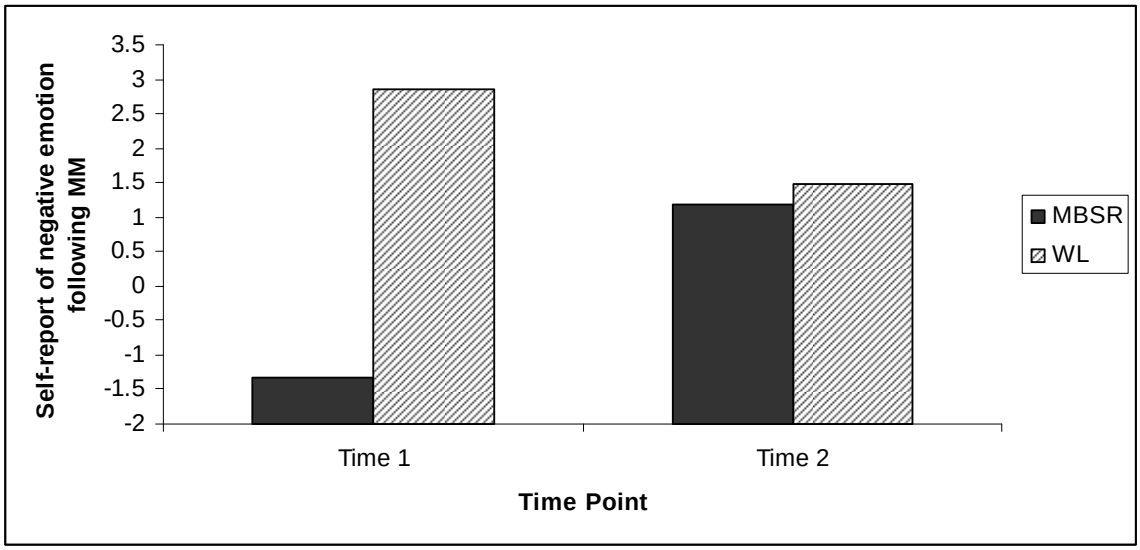


Figure 3

Hypothesis 1c: Change in MM accuracy score between groups from time 1 to time 2

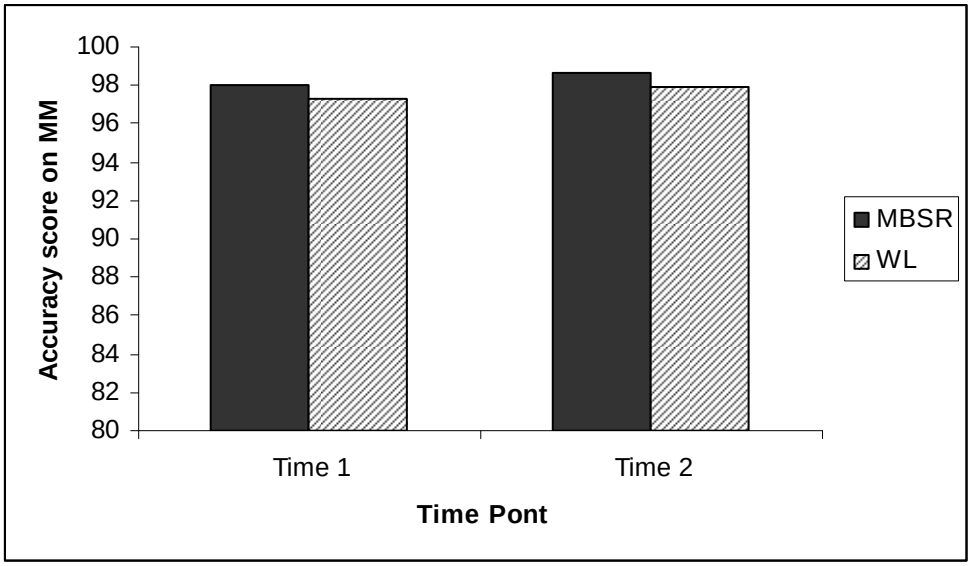


Figure 4

Hypothesis 1d: Change in PASAT-C accuracy score between groups from time 1 to time 2

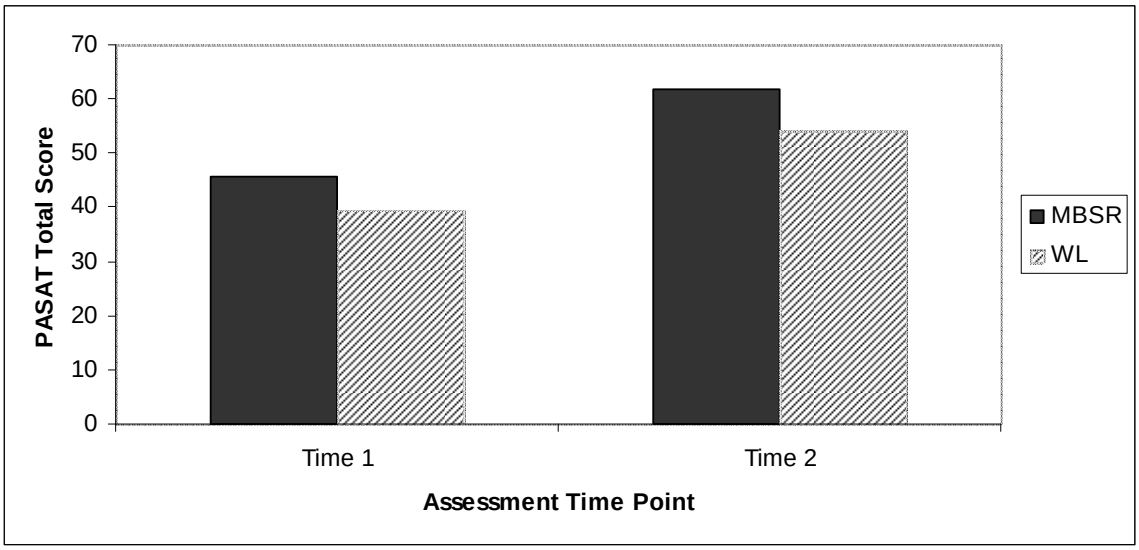


Figure 5

Hypothesis 1e: SCL return to baseline between groups following PASAT-C time 1

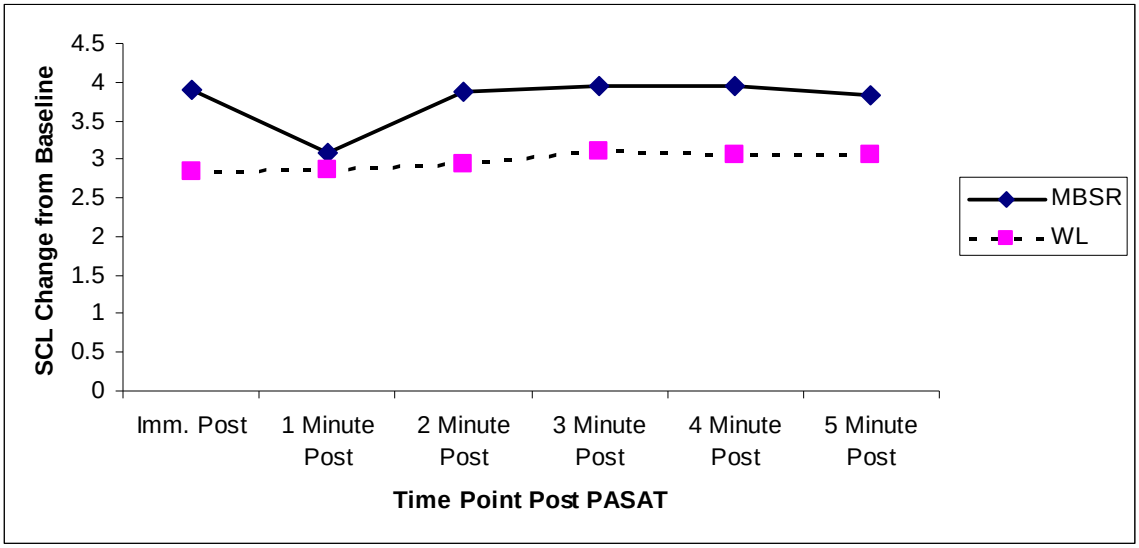


Figure 6

Hypothesis 1e: SCL return to baseline between groups following PASAT-C time 2

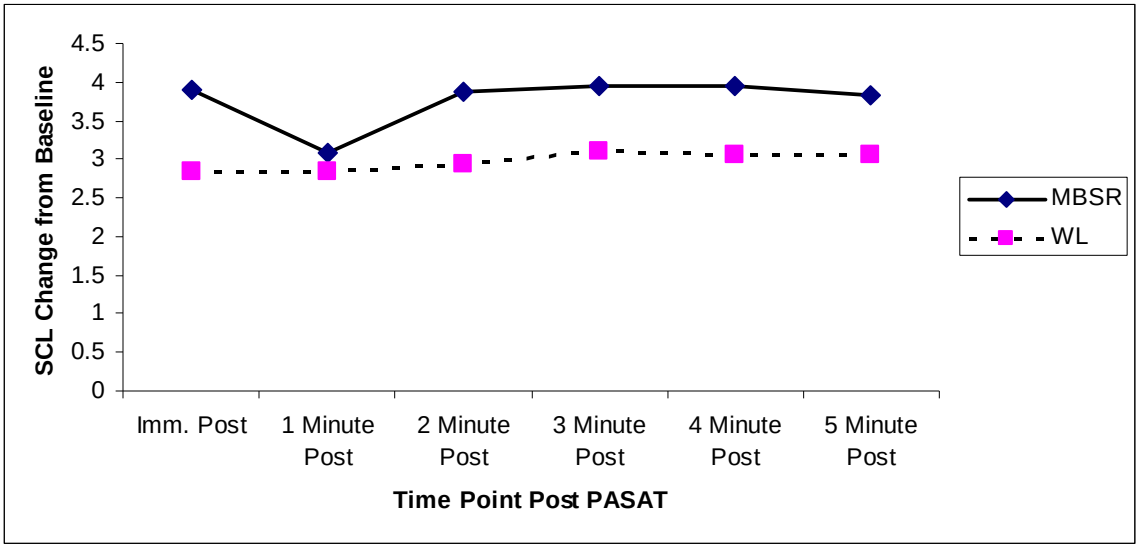


Figure 7

Hypothesis 1f: RR return to baseline between groups time 1

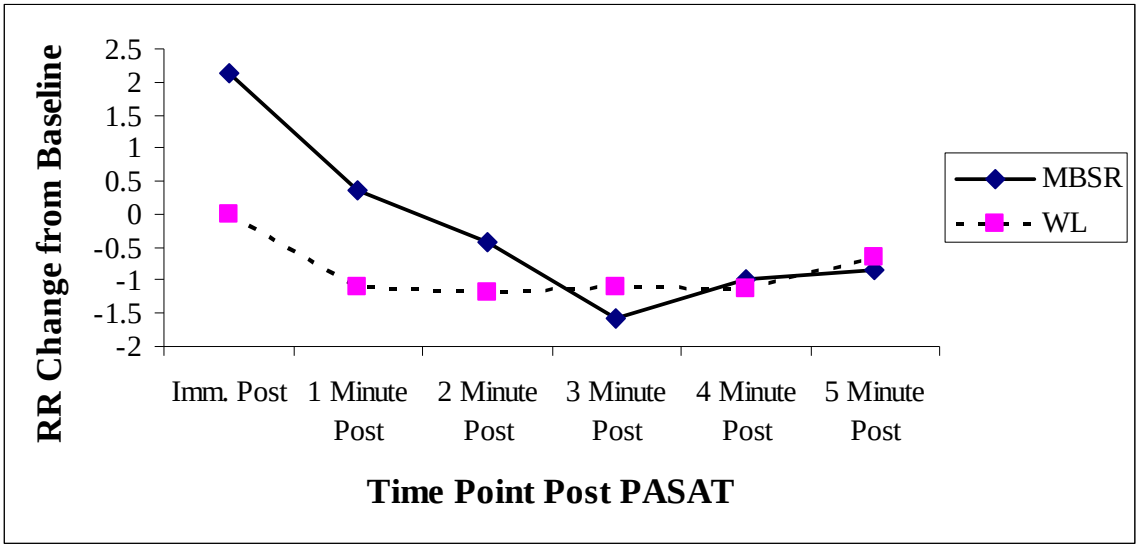


Figure 8

Hypothesis 1f: RR return to baseline between groups time 2

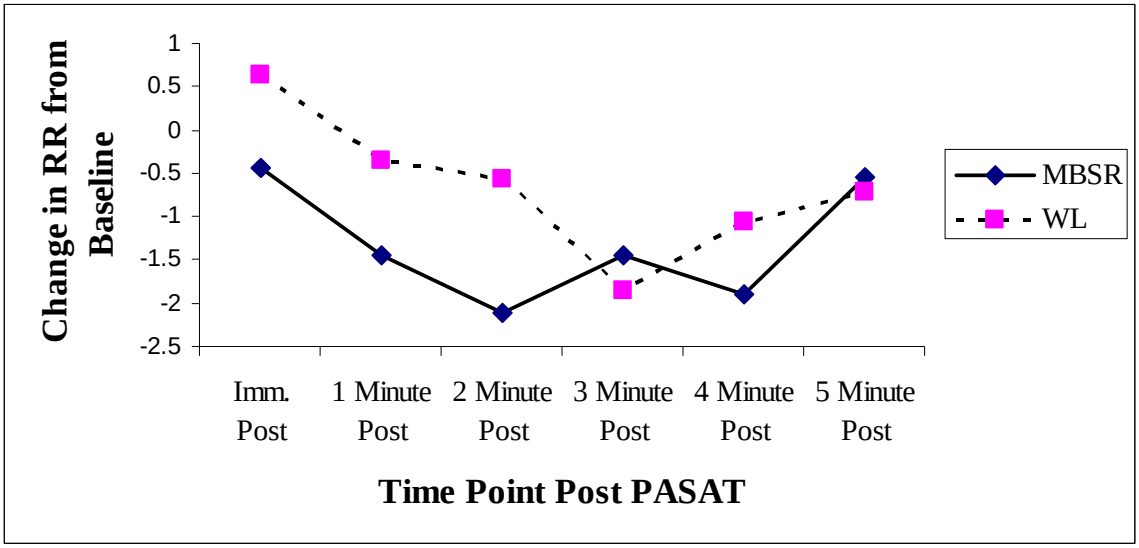


Figure 9

Hypothesis 1g: HR return to baseline between groups following PASAT-C time 1

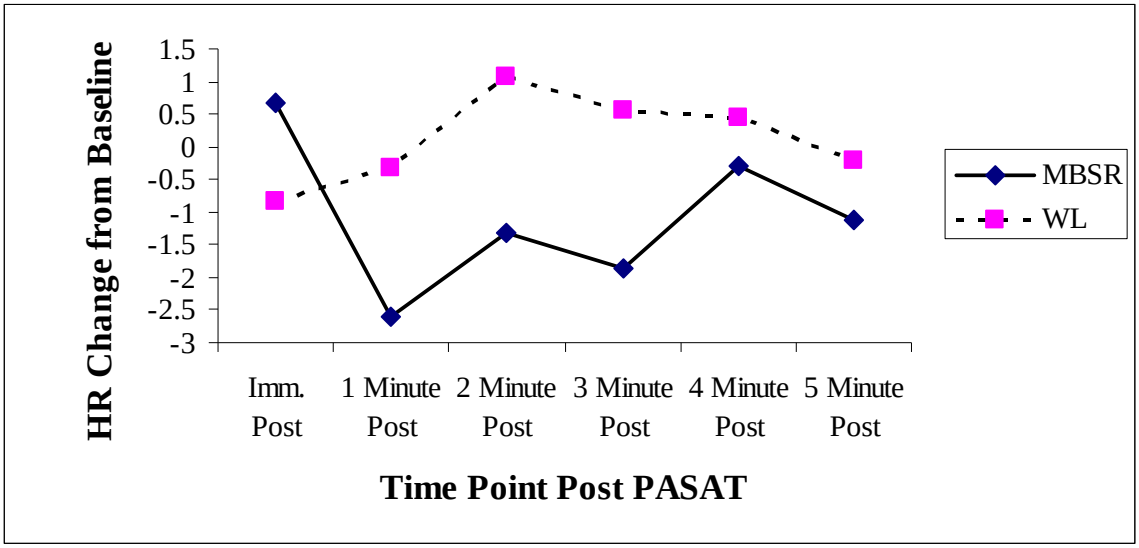


Figure 10

Hypothesis 1g: HR return to baseline between groups following PASAT-C time 2

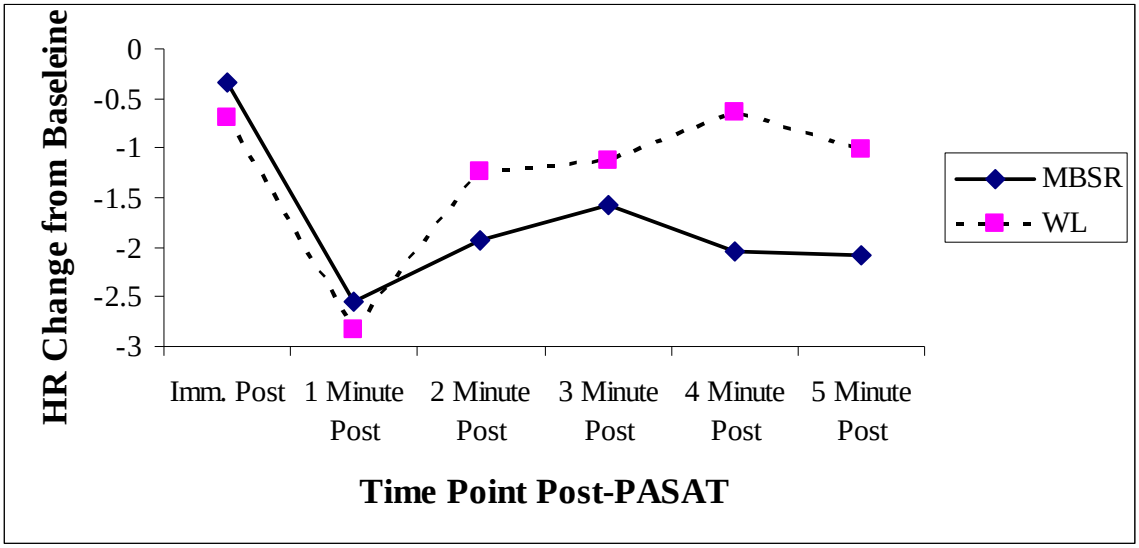


Figure 11

Hypothesis 1h: Change in positive emotions following PASAT-C compared to baseline between groups at time 1

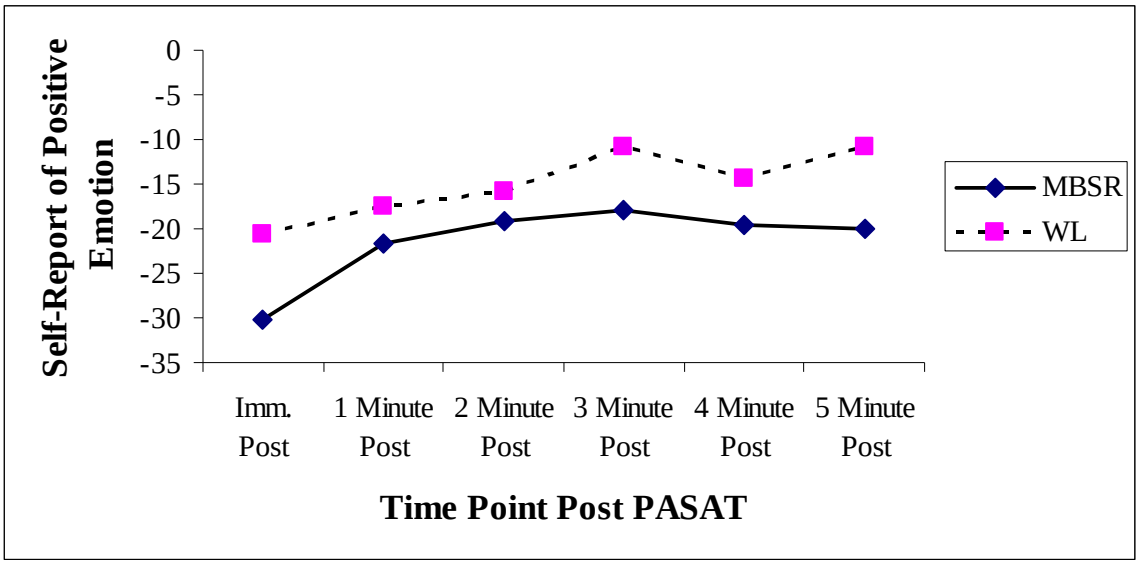


Figure 12

Hypothesis 1h: Change in positive emotions following PASAT-C compared to baseline between groups at time 2

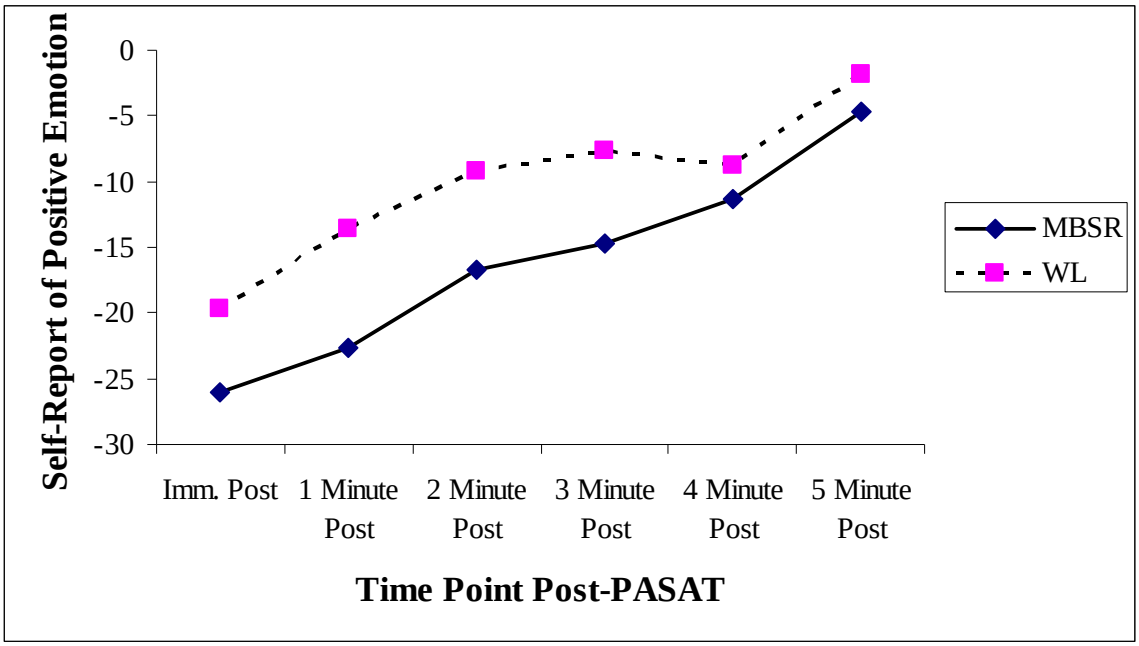


Figure 13

Hypothesis 1i: Change in negative emotions following PASAT-C compared to baseline between groups at time 1

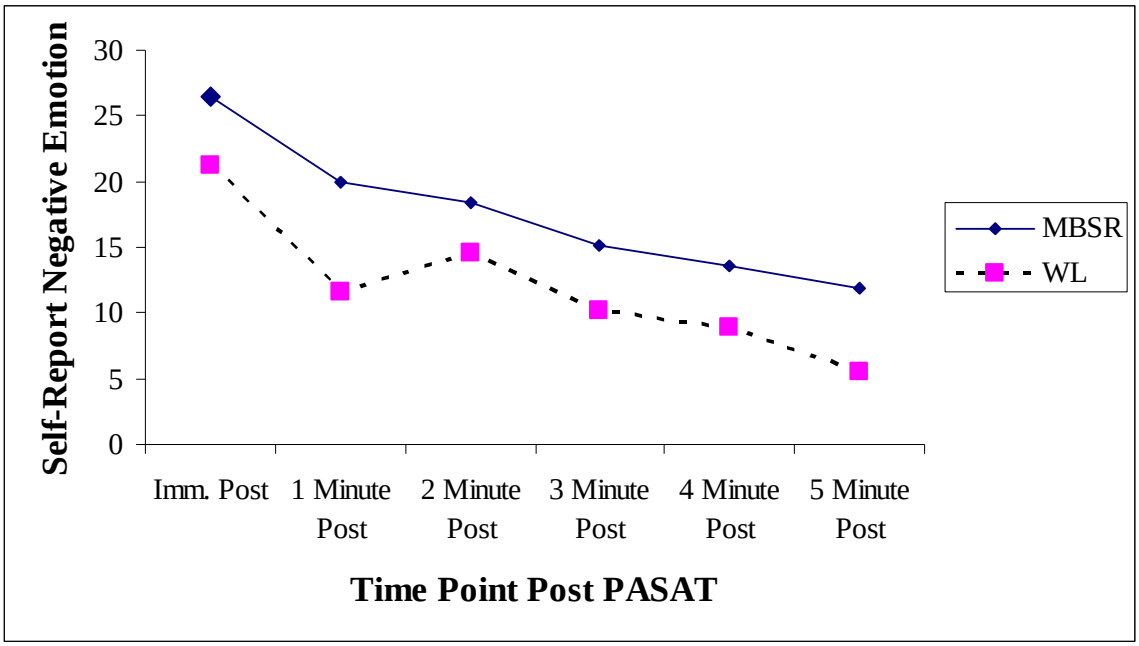
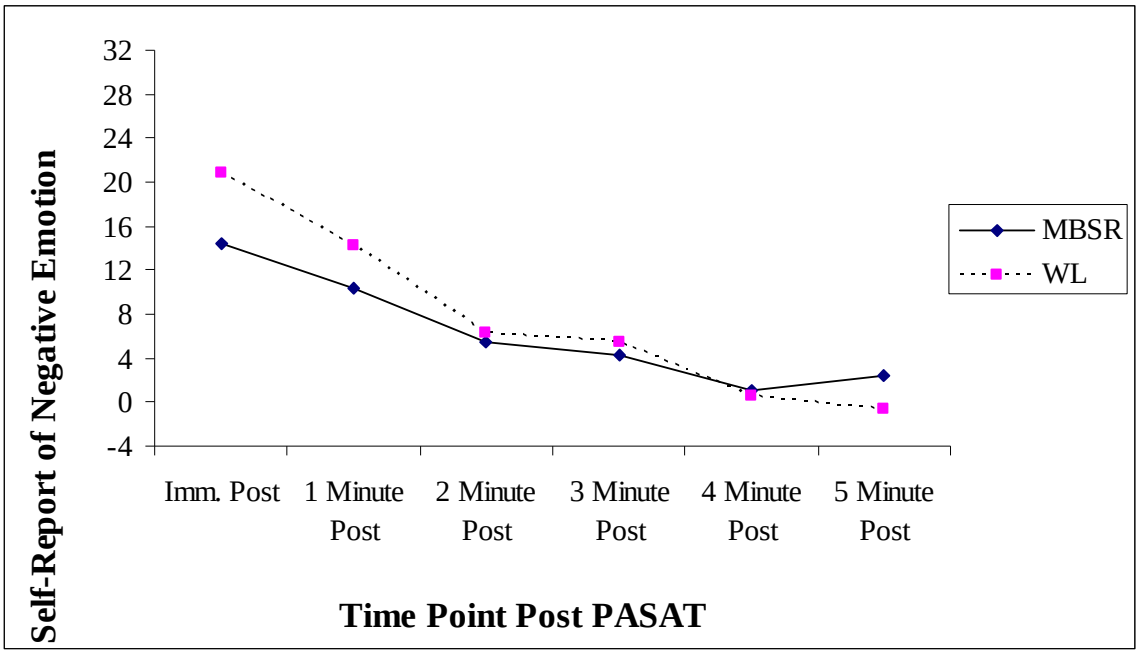


Figure 14

Hypothesis 1i: Change in negative emotions following PASAT-C compared to baseline between groups at time 2



** Immediate post-PASAT-C assessment is significant p<.05

* 1 minute post-PASAT-C assessment is trend level significant p<.10

Tables

Table 1

Demographic Data 1

	%N
Female	83.90
Male	16.10
Caucasian	92.90
Asian American	3.40
Hispanic	3.40
Mean Age	46.41
Age Range	21-87
Household Income	
> $100,000	19.30
$100,000-65,000	19.30
$65,000-40,000	40.40
$40,000-20,000	17.50
<$10,000	1.80

Table 2

Demographic Data 2

	%N
Relationship Status	
Married/ living with partner	44.60
In relationship, not living together	12.50
Divorced/ Separated	25
Never Married	1.70
Widowed	1.80
Education	
Advanced Degree	54.40
Some advanced degree	10.70
4-year college	23.20
Some college	8.90
Finished HS or equivalent	1.80
Previous Meditation Experience	
Yes	67.90
No	32.10

Table 3

Hypothesis 1a: Multiple Regressions testing effect of group on experience of change in positive emotions from before to after MM at Time 2 over and above any incremental changes in positive emotion observed at Time 1

Variable		B	Std. Error B	β
Step 1				
	Time 1 Pos. Emo. Post-MM	.48	.14	.46
Step 2				
	Group	-5.58	6.76	-.11

Dependent Variable: Time 2 positive emotion score change above baseline

Table 4

Hypothesis 1a: Descriptive statistics of changes in self-report of positive emotions from Pre to Post MM at assessment time points 1 and 2

	Group	N	Mean	Std. Deviation	Std. Error Mean
Assessment 1 Self-Report of Positive Emotions above Baseline following MM	MBSR	26	2.70	11.14	2.32
	WL	27	2.80	10.90	2.27
Assessment 2 Self-report of Positive Emotions above baseline Following MM	MBSR	24	2.52	5.03	1.09
	WL	25	2.65	17.93	4.01

Table 5

Hypothesis 1b: Multiple Regressions testing effect of group on experience of change in negative emotions from before to after MM at Time 2 over and above any incremental changes in negative emotion observed at Time 1

Variable		B	Std. Error B	B
Step 1				
	Time 1 Neg. Emo. Post-MM	.40	.20	.28
Step 2				
	Group	-.67	3.85	-.11

Dependent Variable: Time 2 negative emotion score change above baseline

Table 6

Hypothesis 1b: Descriptive statistics of changes in self-report of negative emotions from pre to post MM at assessment time points 1 and 2

	Group	N	Mean	Std. Deviation	Std. Error Mean
Assessment 1 Self-Report of Negative Emotions above Baseline following MM	MBSR	24	-1.33	3.98	.81
	WL	25	2.84	6.74	1.35
Assessment 2 Self-report of Negative Emotions above baseline Following MM	MBSR	22	1.18	5.24	1.12
	WL	24	1.48	12.88	2.63

Table 7

Hypothesis 1c: Multiple Regressions testing between group accuracy scores on MM at Time 1 and Time 2 Assessment

Variable	B	Std. Error B	β
Step 1			
Time 1 MM Score	-.07	.12	-.10
Step 2			
Group	-.76	.91	-.15

Dependent Variable: Assessment 2 accuracy score on MM

Table 8

Hypothesis 1d: Descriptive statistics for between group scores MM at time 1 and time 2 assessment

	Group	N	Mean	Std. Deviation	Std. Error Mean
Assessment 1 MM					
Accuracy Score	MBSR	17	98.04	3.95	.96
	WL	18	97.30	3.86	.91
Assessment 2 MM					
Accuracy Score	MBSR	19	98.63	2.79	.64
	WL	19	97.95	2.27	.52

Table 9

Hypothesis 1d: Multiple Regressions testing between group Accuracy scores on PASAT-C at Time 1 and Time 2 Assessment

Variable	B	Std. Error B	β
Step 1			
Time 1 PASAT-C Score	1.12	.10	.86
Step 2			
Group	-.51	3.50	-.01

Dependent Variable: Assessment 2 accuracy sore on PASAT-C

Table 10

Hypothesis 1d: Descriptive statistics for between group scores PASAT-C at time 1 and time 2 assessment

	Group	N	Mean	Std. Deviation	Std. Error Mean
Assessment 1					
PASAT-C Accuracy Score	MBSR	25	45.72	14.87	2.97
	WL	30	39.40	17.07	3.12
Assessment 2					
PASAT-C Accuracy Score	MBSR	20	61.65	23.69	5.30
	WL	29	54.38	20.88	3.88

Table 11

Hypothesis 1e: Repeated measures ANOVA for SCL return to baseline emotion X group at time 1 and time 2 assessments

Time 1

Source	df	F	η	p
Within Group				
SCL	5	3.10	.28	.01
Between Group				
Group X SCL	5	.34	.1	.89

Time 2

Source	df	F	η	p
Within Group				
SCL	5	1.76	.22	.13
Between Group				
Group X SCL	5	.89	.7	.49

Table 12

Hypothesis 1e: Multiple regression analysis on the contribution of group to increases in SCL over baseline following the PASAT-C at time 2 assessment over and above any increases at time 1

Variable		B	Std. Error B	F	β	Sig.
Step 1						
	Time 1 SCL	-.05	.60	.06	.04	.80
Step 2						
	Group	-1.24	.87	.94	.24	.17

Dependent variable: Time 2 SCL emotion self-report

Table 13

Hypothesis 1e: Summary of Descriptive Group Statistics Analysis for between group scores on change in SCL compared to baseline score after PASAT-C at Time 1

Time Point	Group	Mean	Std. Deviation	N
Immediately Following	MBSR	2.45	2.41	17
	WL	2.33	2.57	20
One Minute Post-PASAT-C	MBSR	2.98	1.78	17
	WL	2.91	1.24	20
Two Minutes Post-PASAT-C	MBSR	2.98	1.71	17
	WL	3.03	1.28	20
Three Minutes Post-PASAT-C	MBSR	3.06	1.46	17
	WL	3.01	1.19	20
Four Minutes Post-PASAT-C	MBSR	2.69	1.70	17
	WL	3.04	1.20	20
Five Minutes Post-PASAT-C	MBSR	3.10	1.42	17
	WL	3.08	1.24	20

Table 14

Hypothesis 1e: Descriptive statistics for between group scores on change in SCL compared to baseline score after PASAT-C at time 2

Time-Point	Group	Mean	Std. Deviation	N
Immediately Following	MBSR	3.90	3.02	15
	WL	2.85	1.92	21
One Minute Post-PASAT-C	MBSR	3.08	3.18	15
	WL	2.85	1.94	21
Two Minutes Post-PASAT-C	MBSR	3.88	2.88	15
	WL	2.93	2.02	21
Three Minutes Post-PASAT-C	MBSR	3.94	2.91	15
	WL	3.09	2.08	21
Four Minutes Post-PASAT-C	MBSR	3.95	2.10	15
	WL	3.06	2.10	21
Five Minutes Post-PASAT-C	MBSR	3.82	2.85	15
	WL	3.06	2.03	21

Table 15

Hypothesis 1f: Repeated Measures ANOVA for RR return to baseline emotion X group at time 1 and time 2 assessments

Time 1

Source	df	F	η	p
Within Group				
RR	5	.72	.25	.61
Between Group				
Group X RR	5	.92	.28	.47

Time 2

Source	df	F	η	p
Within Group				
RR	5	3.09	.36	.012
Between Group				
Group X RR	5	.11	.22	.37

Table 16

Hypothesis 1f: Summary of multiple regression analysis on the contribution of group to changes in RR compared to baseline following the PASAT-C at Time 2 assessment over and above any changes at time 1

Variable		B	Std. Error B	F	β	Sig.
Step 1						
	Time 1 RR	-.18	.23	.58	-.15	.45
Step 2						
	Group	1.36	1.75	.59	-.15	.45

Dependent variable: Time 2 change in RR compared to time 2 baseline RR

Table 17

Hypothesis 1f: Descriptive statistics for change in RR compared to baseline for 6 minutes following end of PASAT-C at Time 1

	Group	N	Mean	Std. Deviation	Std. Error Mean
Immediately Following	MBSR	15	1.33	4.34	1.12
	WL	20	.70	3.25	.73
One Minute Post-PASAT-C	MBSR	17	.24	4.13	1.00
	WL	20	-.25	3.64	.81
Two Minutes Post-PASAT-C	MBSR	16	-.38	4.16	1.04
	WL	18	-1.06	3.17	.75
Three Minutes Post-PASAT-C	MBSR	16	-1.19	3.54	.89
	WL	17	-.29	3.64	.88
Four Minutes Post-PASAT-C	MBSR	8	-.88	3.83	36
	WL	10	-1.40	4.40	1.39
Five Minutes Post-PASAT-C	MBSR	16	-.88	4.18	1.04
	WL	14	-.86	3.42	.91

Table 18

Hypothesis 1f: Descriptive statistics for change in RR compared to baseline for 6 minutes following end of PASAT-C at Time 2

Time Point	Group	Mean	Std. Deviation	N
Immediately Following	MBSR	-.44	4.50	9
	WL	.64	3.20	14
One Minute Post-PASAT-C	MBSR	-1.44	2.01	9
	WL	-.36	2.27	14
Two Minutes Post-PASAT-C	MBSR	-2.11	3.25	9
	WL	-.57	2.90	14
Three Minutes Post-PASAT-C	MBSR	-1.44	3.21	9
	WL	-1.86	3.03	14
Four Minutes Post-PASAT-C	MBSR	-1.89	2.85	9
	WL	-1.07	2.34	14
Five Minutes Post-PASAT-C	MBSR	-.56	2.96	9
	WL	-.71	2.61	14

Table 19

Hypothesis 1g: Repeated Measures Analysis of Variance of for HR Return to Baseline Emotion X Group at Time 1 and Time 2 Assessments

Time 1

Source	df	F	η	p
Within Group				
HR	5	.37	.13	.87
Between Group				
Group X HR	5	.67	.17	.65

Time 2

Source	df	F	η	p
Within Group				
HR	5	2.17	.21	.06
Between Group				
Group X HR	5	.57	.14	.72

Table 20

Hypothesis 1g: Summary of multiple regression analysis on the contribution of Group to increases in HR over baseline following the PASAT-C at time 2 Assessment over and above any Increases at Time 1

Variable		B	Std. Error B	F	β	Sig.
Step 1						
	Time 1 HR	.45	.20	.58	.38	.03
Step 2						
	Group	.78	1.90	.59	.07	.69

Dependent Variable: Time 2 HR

Table 21

Hypothesis 1g: Post-PASAT HR Descriptive Statistics at Time 1

Time Point	Group	Mean	Std. Deviation	N
Immediately Following	MBSR	.66	5.51	14
	WL	-.82	6.30	11
One Minute Post-PASAT-C	MBSR	-2.61	4.24	14
	WL	-.32	4.13	11
Two Minutes Post-PASAT-C	MBSR	-1.32	2.4	14
	WL	1.06	3.54	11
Three Minutes Post-PASAT-C	MBSR	-1.85	2.99	14
	WL	.57	4.4	11
Four Minutes Post-PASAT-C	MBSR	-.29	3.08	14
	WL	.44	5.05	11
Five Minutes Post-PASAT-C	MBSR	-1.11	3.39	14
	WL	-.21	8.68	11

Table 22

Hypothesis 1g: Descriptive statistics for change in HR following the PASAT-C compared to baseline HR at time 2

Time Point	Group	Mean	Std. Deviation	N
Immediately Following	MBSR	-.34	5.14	15
	WL	-.70	4.82	15
One Minute Post-PASAT-C	MBSR	-2.54	4.84	15
	WL	-2.83	5.72	15
Two Minutes Post-PASAT-C	MBSR	-1.94	4.59	15
	WL	-1.24	4.89	15
Three Minutes Post-PASAT-C	MBSR	-1.57	5.02	15
	WL	-1.13	4.26	15
Four Minutes Post-PASAT-C	MBSR	-2.05	4.58	15
	WL	-.64	4.8	15
Five Minutes Post-PASAT-C	MBSR	-2.08	4.04	15
	WL	-1.02	4.36	15

Table 23

Hypothesis 1h: Repeated measures ANOVA for positive emotion return to baseline emotion X group at time 1 and time 2 Assessments

Time 1

Source	df	F	η	p
Within Group				
Emotion	5	5.54	.33	<.001
Between Group				
Group X Emotion	5	1.46	.18	.223

Time 2

Source	df	F	η	p
Within Group				
Emotion	5	16.89	.55	<.001
Between Group				
Group X Emotion	5	1.46	.13	.66

Table 24

Hypothesis 1h: Summary of Multiple regression analysis on the contribution of group to increases in positive emotion following the PASAT-C at time 2 Assessment over and above any increases at time 2

Variable		B	Std. Error B	F	β	Sig.
Step 1						
	Time 1 Positive Emotion	.02	.18	.13	.02	.91
Step 2						
	Group	-2.40	8.42	.09	-.05	.77

Dependent Variable: Time 2 Positive Emotion Self-Report

Table 25

Hypothesis 1h: Descriptive statistics for change in self-reported positive emotions following the PASAT-C compared to baseline at time 1

Time Point	Group	Mean	Std. Deviation	N
Immediately Following	MBSR	-30.27	31.08	24
	WL	-20.56	26.56	18
One Minute Post-PASAT-C	MBSR	-21.77	31.99	24
	WL	-17.44	19.74	18
Two Minutes Post-PASAT-C	MBSR	-19.10	31.77	24
	WL	-15.83	22.53	18
Three Minutes Post-PASAT-C	MBSR	-17.9	32.74	24
	WL	-10.75	25.35	18
Four Minutes Post-PASAT-C	MBSR	-19.60	30.17	24
	WL	-14.33	19.34	18
Five Minutes Post-PASAT-C	MBSR	-20.10	30.51	24
	WL	-10.92	19.464	18

Table 26

Hypothesis 1h: Descriptive statistics for change in self-reported positive emotions following the PASAT-C compared to baseline at time 2

Time Point	Group	Mean	Std. Deviation	N
Immediately Following	MBSR	-26.02	21.12	21
	WL	-19.70	24.46	20
One Minute Post-PASAT-C	MBSR	-22.6	19.55	21
	WL	-13.65	32.7	20
Two Minutes Post-PASAT-C	MBSR	-16.64	17.7	21
	WL	-9.13	27.87	20
Three Minutes Post-PASAT-C	MBSR	-14.69	17.48	21
	WL	-7.60	26.48	20
Four Minutes Post-PASAT-C	MBSR	-11.38	17.46	21
	WL	-8.80	30.05	20
Five Minutes Post-PASAT-C	MBSR	-4.74	12.82	21
	WL	-1.88	24.13	20

Table 27

Hypothesis 1i: Repeated measures ANOVA of negative emotion return to baseline emotion X group at time 1 and time 2 assessments

Time 1

Source	df	F	η	p
Within Group				
Emotion	5	24.28	.60	<.001
Between Group				
Group X Emotion	5	.231	.07	.95

Time 2

Source	df	F	η	p
Within Group				
Emotion	5	107.2	.69	<.001
Between Group				
Group X Emotion	5	1.93	.24	.09

Table 28

Hypothesis 1i: Summary of Multiple regression analysis on the contribution of group to changes in negative emotion immediately following the PASAT-C at time 2 assessment over and above any predictive value of time 1 self-report of negative emotion

Variable		B	Std. Error B	F	β	Sig.
Step 1						
	Time 1 Negative Emotion	.22	.11	4.03	.30	.05
Step 2						
	Group	12.78	4.53	6.34	.40	.01

Dependent Variable: Time 2 negative emotion self-report immediately following PASAT-C

Table 29

Hypothesis 1i: Summary of multiple regression analysis on the contribution of group to changes in negative emotion one minute after the PASAT-C at time 2 assessment over and above any predictive value of time 1 self-report of negative emotion

Variable		B	Std. Error B	F	β	Sig.
Step 1						
	Time 1 negative emotion 1 minute after PASAT-C	.24	.11	5.59	.346	.02
Step 2						
	Group	9.61	4.28	5.04	.242	.03

Dependent Variable: Time 2 negative emotion self-report 1 minute following PASAT-C

Table 30

Hypothesis 1i: Summary of multiple regression analysis on the contribution of group to changes in negative emotion two minutes after the PASAT-C at time 2 assessment over and above any predictive value of time 1 self-report of negative emotion

Variable		B	Std. Error B	F	β	Sig.
Step 1						
	Time 1 negative emotion 2 minute after PASAT-C	.17	.09	3.37	.27	.07
Step 2						
	Group	4.07	3.47	5.846	.17	.25

Dependent variable: Time 2 negative emotion self-report 2 minutes following PASAT-C

Table 31

Hypothesis 1i: Mean comparisons between groups on self-report of negative emotion following the PASAT-C at Time 1

Time Point	Group	Mean	Std. Deviation	N
Immediately Following	MBSR	26.52	25.42	25
	WL	21.22	18.35	20
One Minute Post-PASAT-C	MBSR	20.00	23.88	25
	WL	11.55	14.34	20
Two Minutes Post-PASAT-C	MBSR	18.35	21.50	25
	WL	14.55	21.02	20
Three Minutes Post-PASAT-C	MBSR	15.08	20.93	25
	WL	10.23	19.97	20
Four Minutes Post-PASAT-C	MBSR	13.63	20.38	25
	WL	8.93	17.82	20
Five Minutes Post-PASAT-C	MBSR	11.83	20.34	25
	WL	5.58	16.56	20

Table 32

Hypothesis 1i: Mean comparisons between groups on self-report of negative emotion following the PASAT-C at Time 2

Time Point	Group	Mean	Std. Deviation	N
Immediately Following	MBSR	14.45	15.33	21
	WL	20.91	14.47	22
One Minute Post-PASAT-C	MBSR	10.29	11.72	21
	WL	14.23	15.93	22
Two Minutes Post-PASAT-C	MBSR	5.44	7.84	21
	WL	6.35	12.52	22
Three Minutes Post-PASAT-C	MBSR	3.96	10.65	21
	WL	4.23	10.39	22
Four Minutes Post-PASAT-C	MBSR	1.06	4.19	21
	WL	.62	12.46	22
Five Minutes Post-PASAT-C	MBSR	2.50	5.45	21
	WL	-.68	12.17	22

Appendices

Appendix A

Brief Synopsis of Weekly Mindfulness Based Stress Reduction Classes

Week 1: Rationale of mindfulness as an aid to mental and physical health based on its ability to help individuals "live more fully in the present moment of life." Participants practice mindful eating with small food (e.g., raisin) and mindful breathing exercises. During these exercises participants are encouraged to focus completely on sensations associated with the apparently simple preset moment tasks (smell, sight, sound, feeling of eating a raisin); sensation of breathing on the body as one inhales and exhales. Participants asked to practice mindful breathing at home over the course of the next week for at least 45 minutes per day six days per week.

Week 2: Theme emphasized is *noticing stress*. When does it come? How do you know its there (do you have certain thoughts or feeling states?). Body scan meditation is practiced for at least 45 minutes under the guidance of instructor. During exercise, participants focus on sensations in each separate area of their body. Group discussion with instructor follows. Participants asked to practice body scan at home over the course of the next week for at least 45 minutes per day six days per week.

Week 3: Themes emphasized are the pleasure and power of the present moment. A combination of mindful breathing and gentle yoga exercises are conducted for 45 to 90 minutes. Group discussion with instructor follows. Participants asked to practice yoga exercises at home over the course of the next week for at least 45 minutes per day six days per week.

Week 4: Themes emphasized include responses to stress. In particular, it is highlighted that maladaptive responses to stress, as opposed to stress itself are often the cause of difficulty in individual's lives. A combination of "choice-less awareness" and walking meditation are practiced. Participants asked to practice choice-less awareness at home over the course of the next week for at least 45 minutes per day six days per week.

Week 5: Themes emphasized include the differences between *responding* and *reacting* to stress. Also explored is the relationship between stress and physical health as well as the effectiveness of honoring and expressing personal feelings effectively. Finally, participants are encouraged to explore the role of trust in self which may be a necessary component of developing kindness and compassion for the self. The group participates in extended yoga, sitting, or loving-kindness practices. Participants asked to practice a

meditation on recognizing unpleasant feelings, thoughts or sensations at home over the course of the next week for at least 45 minutes per day six days per week.

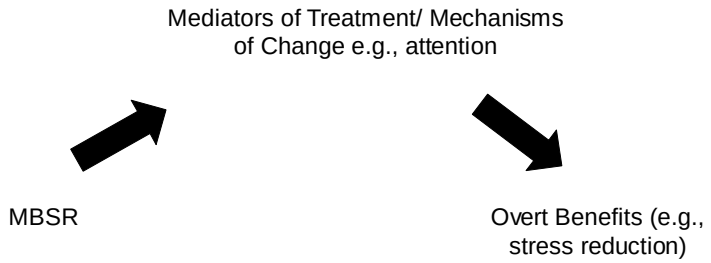
Week 6: Themes emphasized include how to maintain one's 'center' in interpersonal interactions as well as learning to recognize when interpersonal interactions are becoming stressful. Also discussed is the contribution mindfulness may play in skillful assertiveness and expression in interpersonal interactions. The group participates in extended choiceless awareness and loving-kindness practices. Participants asked to practice any of the meditation techniques learned in the preceding 5 weeks of the course for at least 45 minutes per day six days per week. Participants are also encouraged to take the experience of mindfulness found in formal practice and find opportunities for 'informal' practice of the same skills throughout daily life (e.g., in conversations, sitting in traffic, etc.).

Week7: Themes emphasized focus on ownership, confidence in, and commitment to formal mindfulness practice. Participants are encouraged to note the 'seamless' quality of life that can emerge as one sees links between formal and informal mindfulness practices throughout the day. The group participates in extended choiceless awareness and loving-kindness practices. Participants asked to practice any of the meditation techniques learned in the preceding 5 weeks of the course for at least 45 minutes per day six days per week. Participants are also encouraged to take the experience of mindfulness found in formal practice and apply it in informal practices throughout their daily lives.

Week 8: Themes emphasized include keeping the momentum and discipline learned in the MBSR class forward following the class. There is a review of the range of mindfulness practices which have been taught in MBSR. Particular attention is paid to the closing of the MBSR program and the relationships which have been formed throughout the program. Course evaluations are completed.

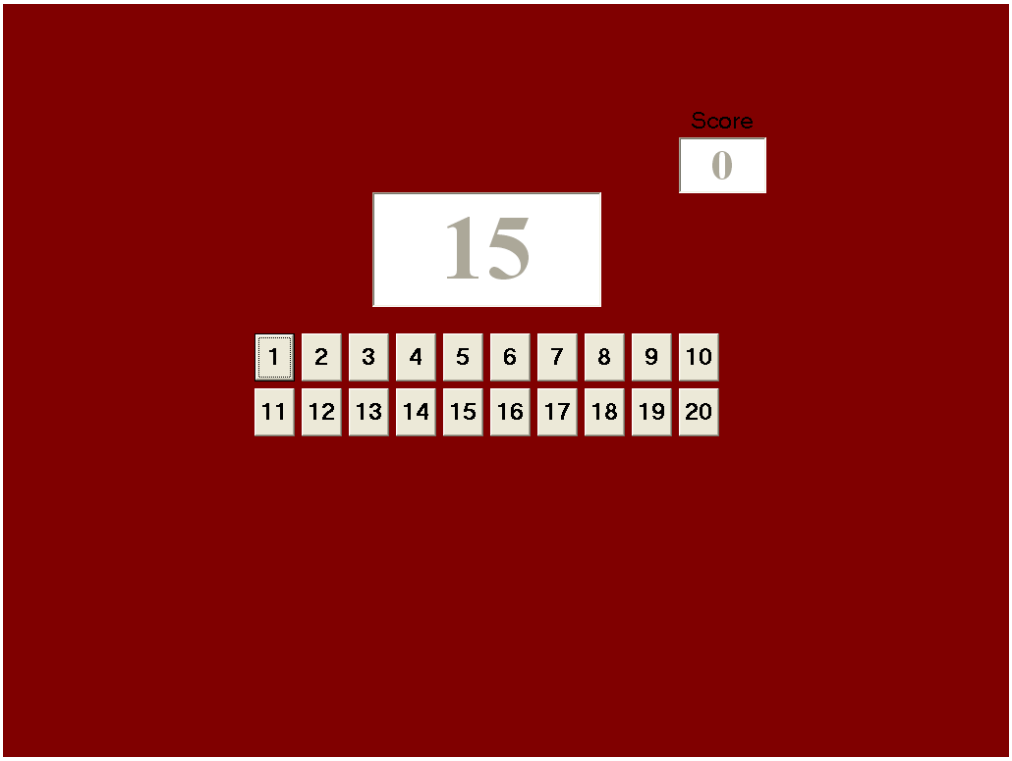
Appendix B

Visual description of relationships between MBSR, *mechanisms of change* (treated as *outcome variables* in this study), and overt benefits (previously established and *not* assessed in this study.



Appendix C

Example screen from PASAT-C



Appendix D

Brief Emotion Check

Please report your current experience of the following emotions on a scale of 1-100, 1 being the lowest possible experience of the emotion, 100 being the highest.

Excited (1-100) Angry (1-100)

_____ _____

Frustrated (1-100) Satisfied (1-100)

_____ _____

Happy (1-100) Depressed (1-100)

_____ _____

Appendix E

Procedures for Experimental Testing

1. Greet participant in lobby.
2. Sit participant at experimental computer.
3. Attach physiological sensors:
   1) Have participant swab areas on chest under right clavicle and left rib cage with alcohol swab.
   2) Instruct participant in how to attach sticker based electrodes to these areas on the body.
   3) Secure elastic respiration band around participant's chest (let participant self-secure if possible).
   4) Apply "contact gel" to electrodermal sensors.
   5) After confirming the participant's non-dominant hand, attach sensors to ring and index finger of non-dominant hand.
4. Ask participant if they are comfortable.
5. Tell participant that for the following three minutes there will be an uninstructed measurement period "just to confirm the sensors are working."
6. Leave room, go to room where data is displayed on computer.
7. Confirm sensors are working correctly (if one is not, return to participant room and fix).
8. Leave participant alone in testing room for three minutes.
9. Return to room, ask participant to complete "Pre-MM" Emotion Check.
10. Orient participant to MM, place "Post-MM" Emotion Check on table, tell participant to complete post MM attention check at end of MM.
11. Answer any questions and leave room for the duration of the MM (10 minutes).
12. Following the completion of the MM, return to testing room.
13. Orient participant to PASAT.
14. Answer any questions and leave room for the duration of the PASAT (9-10 minutes).
15. Unattach participant from physiological sensors.
16. Give participant questionnaires & self addressd stamped envelope to fill out and mail back (e.g., FFMQ) and let participant leave.

Total time from arrival: 35-45 minutes.

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Biography

Andrew Griffin Ekblad was born in Houston, Texas. He completed a B.S. in Human & Organizational Development and English (emphasis in creative writing) from Vanderbilt University, post-baccalaureate study in psychology at the University of Washington and a M.A. in Psychology & Neuroscience from Duke University. He has received internally and externally funded academic awards in psychology research, mentoring and poetry writing.