2017

FURTHER INVESTIGATING THE UNDERLYING ATTENTIONAL PROCESSES OF BRIEF MINDFULNESS-BASED INTERVENTIONS

Erin Rachelle Yosai

FURTHER INVESTIGATING THE UNDERLYING ATTENTIONAL PROCESSES OF BRIEF MINDFULNESS-BASED INTERVENTIONS

by

ERIN RACHELLE YOSAI, M.S.

Master of Science, Montana State University, Bozeman, MT 2012

Bachelor of Science, Baker University, Baldwin City, KS 2008

Dissertation Presented in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Philosophy

Department of Psychology

The University of Montana

May 2017

Anisa N. Goforth, Ph.D., Chair
Associate Professor of Psychology

Jacqueline Brown, Ph.D.
Assistant Professor of Psychology

Craig McFarland, Ph.D.
Assistant Professor of Psychology

Lindsey M. Nichols, Ph.D.
Assistant Professor of Counselor Education

Jennifer Waltz, Ph.D.
Professor of Psychology

Yosai, Erin, M.S., Summer 2017 Psychology

Abstract

Chairperson: Anisa N. Goforth, Ph.D., NCSP

Mindfulness-based interventions (MBIs) incorporate components of mindfulness into treatment strategies for both general and specialized populations. Within the school setting, research shows that MBIs contribute to student improvement in cognitive functioning, and the brief MBIs (e.g., around 8 minutes) can improve scores on standardized tests (Mrazek et al., 2013; Zenner et al., 2014). However, it is unclear what cognitive processes may be improved through MBI implementation. The current project investigated components of attentional control through working memory capacity, inhibition, mind-wandering, mood, and task-switching as cognitive processes that may be improved by MBIs. University undergraduates (*N*=119) aged 18-25 (*M*=20.11, SD=1.94) participated in a repeated-measures experiment that included six sessions. Participants were randomly assigned to one of three intervention conditions: a brief mindfulness-based intervention, a brief relaxation-based meditation, or a control group. Missing data, attrition rates, and power were a concern within the data set. There were no significant effects of intervention condition on task-switching, working memory capacity, or frequency of mind-wandering. However, results showed that participants who participated in the MBI group showed significant increase in reported attentional focus, ability to inhibit distraction, and positive mood. Implications for school psychology are discussed.

ACKNOWLEDGMENTS

"It takes a village…" regardless of how many times the old proverb has been quoted, it never ceases in its truth. This journey would not have existed without the unending love, support, and mentorship of my family, friends, and professors. To my friends who have laughed (and cried) with me and supported me through this journey- your wholehearted support of me working towards my goals has empowered me in ways difficult to describe. You are all such unique, amazing women, and I love you. To Tuk, who reminded me when to get up from typing and get some fresh air, to find joy in routine, and that the worst days can be cured with sloppy kisses and a belly rub - you forever changed my life for the better. To my parents– your unconditional love, unquestioning support, and willingness to go above and beyond for my emotional and professional happiness – I love you more than words can ever describe. Thank you, thank you, thank you – for all of it.

I would never have had the belief in myself to pursue grad school if it weren't for my undergraduate professors, Dr. Sara Crump, Dr. Marc Carter, and Dr. Wendi Born. This graduate school journey would not have happened if Montana State University, namely Dr. Ian Handley, did not believe in my potential as a psychological researcher. Thank you for fostering my interests and helping me define my path. The faculty of University of Montana has been incredible. Your knowledge, support, and mentorship has allowed me to develop my academic and applied skills as well as passion for serving youth. Thank you to my committee - I have learned so much from you. My highest esteem and gratitude goes to Dr. Anisa Goforth, who saw potential in me and offered me a spot in her new research lab. Your guidance, mentorship, supervision, and willingness to go above and beyond for your students and your field of study is ceaseless. I feel so lucky to be your first student, and to have such an incredible academic role model.

TABLE OF CONTENTS

List of Tables

List of Figures

Further Investigating the Underlying Attentional Processes of Mindfulness-Based Interventions

Chapter 1: Introduction

Introduction

A student's ability to pay attention is an important factor for success in the classroom. Arguably, control of attention is the single-most important contributing factor to a student's ability to learn and memorize information (Willis, 2005). Students must learn within a dynamic classroom environment that requires students to control their attention, switch attention between tasks, and ignore both internal and external distractions (Alloway, 2006). For example, within the classroom students must focus intently on a teacher's words while filtering out private whisperings among classmates, dropped pencils, and shuffling of chairs. Students must also be able to sort through the information they hear, organize and prioritize their thoughts, plan their responses, and complete the work assigned to them.

This ability to control and direct attention is an important component to students' academic success and social-emotional well-being (Alloway, 2006; Brown & Ryan, 2003; Zelazo & Lyons, 2012). A student's ability to regulate their attention has been shown to be associated with increased academic performance and behavioral outcomes, as well as decreased incidences of special education referrals at various tiers of school instruction (Alloway, Gathercole, Adams, & Willis, 2005; Holmes & Gathercole, 2013). *Attentional-control,* or the ability to keep attention focused on the task-at-hand (i.e., in the present moment) rather than other internal or external information, has also been shown to be one of the main contributors to an individual's level of working memory capacity (WMC; Barrett et al., 2004; Engle, 2002).

Working memory (WM) is a foundation to the brain's executive functioning system (Kane & Engel, 2004; Klingberg, 2010). WM is an "active memory," with a limited capacity workspace that is split between storage and processing demands (e.g., Kane & Engel, 2004; Klingberg, 2010; Morrison & Chein, 2011). Important to an individual's WM is the ability to hold and maintain information within the “conscious spotlight of attention,” as well as to shield that information from interference and distraction from internal and external sources (Kane & Engle, 2004, p. ?).

This relationship between the ability to control attention and amount of information that is kept ‘active’ in short-term memory characterizes individual WMC (Engle, 2002). Individuals with a higher WMC are better able to focus attention and more successful at enacting controlled, goal-directed processing compared to those with low WMC (Barrett et al., 2004). Individuals with low WMC allow less appropriate or undesired responses (e.g., intrusive thoughts; mind-wandering) to emerge during task performance. One’s ability to engage in focused processing while suppressing or inhibiting external distractions, therefore, results in changes in task performance (Engle, 2002; Kane & Engel, 2004). For example, fluid intelligence, reading and math comprehension and achievement, complex reasoning and learning abilities are all reliant on higher levels of working memory capacity (National Center for Learning Disabilities, 2014; Kane & Engel 2002).

Generally, researchers have thought that an individual’s WMC is static (Baddeley & Hitch, 1994). That is, researchers have conceptualized the regulation of attention as fixed and unable to change across time. Recent research addressing working memory, however, suggests that regulation of attention may actually change across time, and therefore, be a trainable skill (e.g., Morrison & Chein, 2011; Posner, Rothbart, & Tang, 2015). As a result, there has been an interest in interventions that evidence improvement after exposure to training.

Of specific interest are interventions that incorporate the core components of mindfulness practice. Such *mindfulness-based interventions* (MBIs) have become recognized as a way to help individuals build resilience and strengthen their social and emotional skills (e.g., Burke, 2009; Flook, Goldberg, Pinger, & Davidson, 2015; Schonert-Riechl, Oberle, Lawler, Abbott, Thompson, Oberlander, & Diamond, 2015). Research has shown that MBIs lead people to change their relationship with their personal phenomena (e.g., anxious thoughts) by teaching them to break away (i.e., step back and observe or disengage) from habitual thought patterns or emotional states with non-judgmental reflection, in contrast to reaction (Burke, 2010).

Furthermore, research with children has shown that MBI helps them develop resiliency and other protective factors. Specifically, studies have shown MBIs strengthen children's self-regulatory skills (Burke, 2009; Greenberg & Harris, 2011; Meiklejohn et al., 2012), as well as reduce symptoms of ADHD (e.g., Singh, Singh, Lancioni, Singh, Winton, & Adkins, 2009) and anxiety and depression (e.g., Derosiers, Klemanski, & Nolen-Hoeksema, 2013; Lehr & Diaz, 2010).

Additionally, MBIs influence change across areas of executive functioning and self-regulation. MBIs have been shown to improve affect (e.g., Liehr & Diaz, 2010) and attention (Mrazek, Franklin, Tarchin, Baird, & Schooler, 2013), as well as decrease stress (Coholic, 2011; Semple, Lee, Rosa, & Miller, 2010). Further, experimental evaluations of MBIs in different populations have demonstrated improvement in WMC among Naval Cadets (Jha, Kiyonga, Wong, Gelfand, & Stanley, 2010), as well as reductions in stress among individuals experiencing symptoms of mental health disorders (e.g., Baer, 2003), patients with chronic pain (e.g., Kabat-Zinn, 2003), public school teachers (Meiklejohn et al., 2012), and mental health therapists in training (Shapiro, Brown, & Biegel, 2007). These outcomes are generally well-accepted as resulting in changes in cognitive processes, such as attentional control (Brown & Ryan, 2003) and self regulation (e.g., Greenberg & Harris, 2011; Zelazo & Lyons, 2012).

While there are a substantial number of research studies examining the effectiveness of MBIs in youth and adults, there exists a dearth of research studies examining the connection between and understanding of the processes underlying improvement in cognitive performance as a result of MBIs. Researchers have hypothesized that the construct of *mind-wandering* may provide one explanation to how MBIs affect changes in attentional control, and subsequently, individual WMC (Mooneyham & Schooler, 2013; Mrazek et al., 2012; Schooler, Mrazek, Franklin, Baird, Mooneyham, Zedelius, & Broadway, 2014). Mind-wandering is the day-to-day phenomenon of becoming disengaged from the present external environment and focusing on internal trains of thought (Mooneyham & Schooler, 2013). Mounting evidence suggests that mind-wandering occurs at a significant cost to individual performance in a myriad of domains such as reading comprehension, mood and affect, and working memory (see Schooler et al., 2014). Similarly, research has demonstrated that mind-wandering can be reduced through brief MBIs, and that as a result, scores on tests of WMC have increased (e.g., Jha et al., 2010; Mrazek et al., 2013). As such, mindfulness may provide individuals with a strategy for bringing awareness to lapses in attention and returning attention to the present moment. This strategy reduces mind-wandering and subsequently increases working memory capacity after repetitive practice.

Related to the function of WM and subsequent performance on tasks of WM and executive function are the cognitive processes of inhibition and cognitive flexibility. Inhibition is the ability to withhold a preplanned response, interrupt a process that has al-ready started, avoid interference, and delay a response (Tamm, Menon, Ringel, & Reiss, 2004). For example, a student may engage inhibitory processes when trying to concentrate on what material the educator is teaching. To do so, they may have to avoid interference from their internal thought processes, delay or withhold the urge to talk before raising their hand, or interrupt a daydream to refocus on their reading material. Cognitive flexibility refers to one's individual ability to hold on to information, manipulate that information, and act on it. Further, to quickly and flexibly adapt their actions or responses to changing situations (Davidson, Amso, Anderson, & Diamond, 2006). Together, WMC, inhibition, and task-switching are "key components of both cognitive control and executive functions and have been studied in a wide variety of experimental paradigms with diverse subject conditions" (Davidson et al., 2006, pg. 2). This experiment aims to merge different aspects of cognitive performance that have been improved after exposure to MBI.

The current research study aims to further understand: (a) if MBIs lead to improvement in individual working memory capacity and (b) the processes of executive attention that may improve as a result of MBIs; specifically mind-wandering, attentional control, inhibition and task switching. It is hypothesized that exposure to brief MBIs would increase working memory capacity, inhibition, and task-switching abilities over time.

Chapter II: Literature Review

Literature Review

Overall, the purpose of this research study is to further investigate whether mindfulness-based interventions (MBIs) result in the improvement of individual working memory capacity (WMC), inhibition, and task-switching abilities. In this section, I will first discuss the concepts of mindfulness, as well as mindfulness-based interventions in a school setting. Of specific focus is a recent meta-analysis of school-based MBIs, indicating that one of the most powerful effects of MBI is an improvement in "cognitive performance" (Zenner et al., 2014). Thus, further understanding of the specific cognitive processes underlying this performance improvement is warranted. Secondly, I will discuss the cognitive constructs of working memory capacity and attentional control; as well as inhibition and task switching. Next, I will review recent research that provides preliminary evidence that MBIs improve attentional control, and as a result, may improve individual working memory capacity. This experiment aims to merge different aspects of cognitive performance that have shown improvement in functioning after exposure to MBI. This experiment offers unique information to the literature base through further aiming to parse out and understand the attentional processes improved by MBI by incorporating inhibition and task switching tasks to WMC tasks.

Then, I will delve further into this theory, outlining how MBIs may specifically increase WMC through reducing mind-wandering and increasing mindfulness, two opposite constructs. Finally, I will present the specific research questions and hypotheses of the current research.

Mindfulness and Mindfulness-Based Interventions

Mindfulness

Mindfulness is a component of active meditative practice established as a product of ancient teachings stemming from Buddhist and Eastern religious traditions. Mindfulness practice was secularized and adapted by researchers, clinicians, and theorists over the past decades, and is considered a universal practice. Mindfulness-based teachings, philosophy, and principles are therefore taught and practiced without tying the training of mindfulness to any certain religion (Kabat-Zinn, 1994; Langer & Piper, 1987).

Mindfulness is the ability to practice concentrating one's "spotlight" of attention on the here and now, and being fully engaged in the sensations and happenings of the current moment without judging each experience (Kabat-Zinn, 1990). Mindfulness *practice*, however, is a similar, yet distinct concept. Mindfulness practice is conceptualized as the purposeful, deliberate, and attentive experience of "observing [one's] physical, emotional, and mental experiences with deliberate, open, and curious attention" or simply, "keeping one's consciousness alive to the present reality" (Smalley &Winston, 2010, p. 11). Mindfulness practice is an active process of maintaining open-minded consciousness towards what is happening in the immediate present, without letting one's attention wander away from what is currently taking place. However, if one's attention does wander away from the present moment, one is encouraged to recognize the distraction with non-judgment and to return their attention back the present moment (Kabat-Zinn, 1994).

Further, mindfulness practice challenges one to be aware of impulsive or automatic thoughts that are pulling one away from being completely present in the current moment. Common automatic thoughts may involve ruminating about the past or future, thinking about an upcoming fitness class, or being distracted by the plot line of a favorite television series while one's partner is talking. By being aware of automatic thoughts that are intruding on the present moment, one can acknowledge exactly what thought divided their focus or demanded their attention, and subsequently pull one's attention back to the event that is currently taking place (Coholic, 2011; Derosiers, 2013; Renshaw, 2012).

Overall, mindfulness is a concept that encourages individuals to be fully engaged with the things that are happening in their current environment, without getting distracted by judgmental, internal or external processes. Those who participate in mindfulness practice repeat holding their attention in the present moment, and when it wanders, returning their attention back to the present moment without engaging in internal thought processes that would sweep them away into thinking about the past or future.

Core components of mindfulness. There are three different core components of the mindfulness concept, including *attentive awareness, intentionality,* and *receptive attitude* (see Table 1; Brown & Ryan, 2003; Burke, 2009; Renshaw, 2012). The first component underlying MBI, *attentive awareness*, is the practice of developing one's focus and sustained awareness of what is happening in the immediate present. Awareness is generally one's recognition of the content and quality of one's immediate reality. Awareness can be further defined as processing information that is being received via the five senses (sight, sound, taste, smell, and touch) and the three bodily awareness senses – emotional, vestibular, and kinesthetic awareness (Renshaw, 2012). Attentiveness occurs when awareness of particular stimuli is captivated and focused upon for a sustained period of time. As such, being attentive and aware means being captivated by an object in one's present attention and focusing on all of the unique aspects of that object. The underlying component of *attentive awareness*, therefore, allows those who practice mindfulness to be more aware of all of the sensations in the present environment and achieve a focused, non-judgmental recognition and appreciation of those sensations in a proactive and positive way (Brown & Ryan, 2003; Renshaw, 2012).

Table 1.

*Components of Mindfulness Practice**

Mindfulness Component	**Description**
Attentive Awareness	Individuals work to develop focused, sustained awareness to stimuli in the immediate present (i.e., present moment)
Receptive Attitude	Approaching whatever enters your awareness with curiosity, openness, acceptance, and love.
Intentionality	Practicing mindfulness with intention, motive, and persistence.

**The three dimensions of mindfulness (adapted from Renshaw, 2012)*

The second component of mindfulness practice encourages possessing a receptive attitude towards whatever may be occurring in the present moment. Commonly referred to as the COAL stance, it refers to the practice of fostering an attitude of curiosity, openness, acceptance, and love towards the present situation occurring (Renshaw, 2012; Siegel, 2007). Approaching one's present situation with curiosity encourages one to approach all awareness as if it were fresh—never before seen or experienced. Openness refers to the practice of withholding all moral evaluations and personal expectations from everything that may enter one's awareness while practicing mindfulness (Renshaw, 2012). Acceptance is the practice of welcoming each of the things entering one's awareness – negative or positive—with equal favor, never avoiding or moving away from particular awareness or outcomes (Stahl & Goldstein, 2010). This principle of "mindful love" reinforces the notion of unconditional positive regard. Approaching a present situation with unconditional positive regard means showing acceptance and love for yourself and others just as they are, regardless of making mistakes or doing something perceived as wrong. The aim of self-compassion (self-love) is to cultivate awareness without burdening oneself with blame or other self-criticism that may arise in response to what is happening in one's present environment (Renshaw, 2012). Approaching the present situation with love also encourages one to practice the other components of COAL: looking at the present situation with curiosity, openness, and acceptance without categorizing the situation or yourself as 'good' or 'bad.'

The final component of mindfulness is intentionality. Intentionality is composed of three sub-dimensions: deliberateness, motive, and persistence (Renshaw, 2012). The first two components of mindfulness practice—attentive awareness and receptive attitudes—can be considered a natural trait, dependent on one's disposition and current situation (Kabat-

Zinn, 2003). One's ability to pay attention to their current surrounding is different depending on the individual and situation. For example, one's ability to concentrate on listening to the words of a song may be influenced by how much they like the song, if there are other people in the environment who are making noise, the auditory capabilities of the individual, and many other factors. Approaching the present environment may be an individual difference as well. As a result, one may be more spontaneously mindful in some environments while not mindful in others. However, to practice mindfulness, one must approach it with intention and deliberateness and not just simply recognize attentive awareness and receptive attitude when they spontaneously occur (Renshaw, 2012; Siegel, 2007); rather, one must make a deliberate attempt to practice mindfulness.

The second sub-component of intentionality is motive, which means that one is striving to be proactive and have a purpose or goal when practicing mindfulness. Many mindfulness trainers recommend that mindfulness practice be carried out with a general goal or target (e.g., anxiety reduction) in mind, and thus, a clear purpose for mindfulness practice is enhanced (Renshaw, 2012; Smalley & Winston, 2010; Siegel, 2007). Subsequently, this goal-directed behavior lends itself to the third component of intentionality: persistence. Despite difficulties one may initially have with cultivating mindfulness, one must have a "dogged determination" to continuing mindfulness practice and move toward a goal through adversity—allowing one to practice long enough to reap positive benefits from mindfulness (Renshaw, 2012, p. 4).

As such, mindfulness practice allows a person to proactively practice focusing an open, non-judgmental, deliberate attention to what is happening in the immediate present, without letting conscious awareness "wander away" from the current moment. Approaching the present situation with a receptive attitude means being curious, open, acceptant, and loving to one's present thoughts and actions without labeling them as negative or bad. Mindfulness practice challenges one to be aware of automatic thoughts that are pulling one away from being completely conscious in the present moment. By being aware of automatic thoughts that are intruding on the present, one can acknowledge the specific division of attention and pull one's attention back from what is currently taking place.

Mind-wandering: The Opposite of Mindfulness

Recent research suggests that mindfulness may be an opposite construct of mind-wandering. *Mind-wandering* is defined as an individual's tendency to switch from whatever tasks s/he is working on to an "autopilot" in his/her mind (Mrazek, Smallwood, & Schooler, 2012). When engaging in mind-wandering, individuals do not have a sense of control over the environment they are presently in, and operate without processing novel occurrences that happen in the current environment (Forster & Lavie, 2013; McVay & Kane, 2009; McVay and Kane, 2012). As such, individuals who are mind-wandering may have been captivated by something outside of the task at hand, want to avoid a task, want to attach to a specific thought or emotion, or have descended into automatic, habitual processing. Mind-wandering occurs, therefore, when one is not focusing their attention on the present moment, on purpose, and nonjudgmentally. For this reason, mind-wandering is thought to be the opposite construct of mindfulness.

As previously discussed, mindfulness practice encourages simply letting these automatic, mind-wandering distractions arise freely, noting and exploring the nature of the thoughts, and then letting them pass without judgment (Renshaw, 2012). By not encouraging suppression or demanding change of mind-wandering thoughts, individuals can cultivate a relationship with their thoughts by acknowledging them, and then letting them pass through the mind while returning attention to the present moment. Practicing mindfulness, therefore, consists of the process of: (a) noticing when one's thoughts have wandered, (b) noting the thoughts, feelings, or distractions that have caused one's mind to wander, and (c) then returning one's attention back to the present moment without judgment for mind-wandering. Repeating this process would be the practice of mindfulness. Although this is a simple concept, controlling the wandering mind is not easy (Kabat-Zinn, 1994). Often, individuals can capture their attention in the present moment for a few seconds or minutes at a time, but then may notice that their mind has reverted to internal processing about the past or future, or has been diverted by certain noises in the environment. This occurrence may bring forth feelings of frustration or inadequacy in the individual who is trying to remain mindful, which may further distract them from staying conscious of the present moment. However, those who struggle to keep their mind in the present moment are not alone.

Mind-wandering is a common every day experience. So much so that individuals engage in mind-wandering up to 25-50% of their waking hours (Schooler et al., 2014). Usually, when individuals are mind-wandering, they show reduced responsiveness to external stimuli while captured by rich internal activity such as self-involved cognitions, future planning, and goal setting (Schooler, Reichle, & Halpern, 2004; Smallwood & Schooler, 2006).

There are several ways that mind-wandering has been measured in experimental research. Smallwood and colleagues (2014) reported that in most mind-wandering research, college-aged participants are asked to read a passage of text while they are periodically probed regarding the content of their thoughts at a particular moment. For example, participants may be asked to read a passage from *Great Expectations* while randomly being asked to report if they are reading attentively or mind-wandering by computer prompts.

Mind-wandering has also been used in studies to examine participants' ability to sustain attention. One measure, the Sustained Attention to Response Task (SART; Schooler et al., 2014; Manly, Robertson, Galloway, & Hawkins, 1999), is a vigilance task that is commonly used to index mind-wandering using a behavioral approach (Schooler et al., 2014). SART performances are directly impacted through individual levels of mind-wandering, as evidenced by errors withholding a response to a target (errors of commission), failure to respond to a target (error of omission), and variability of reaction times it takes to respond to the task (Schooler et al., 2014). Individuals who experience high levels of mind-wandering consistently perform worse on the SART than those who report lower amounts of mind-wandering.

A self-report prompt is another commonly used tool for probing mind-wandering during similar tasks (McVay & Kane, 2009). These probes instruct participants to report the topic of the thoughts they were thinking about in the moments prior to filling out the measure. Specifically, participants are asked to answer the question, "In the moments prior to this probe, was your attention focused," (a) completely on the task, (b) mostly on the task, (c) on both the task & unrelated concerns, (d) mostly on unrelated concerns or (e) completely on unrelated concerns. Next, participants are asked what they were thinking about through indicating one of the following choices: (a) task (b) task performance, (c) everyday stuff, (d) current state of being, (e) personal worries, (f) daydreams, or (g) other (McVay & Kane, 2009).

Through research and measurement, it has been theorized that mind-wandering may be beneficial to individuals. For example, research studies suggest that engagement in mind-wandering facilitates planning for the future (Schooler et al., 2014; Smallwood et al., 2004), increases creativity (Baird et al., 2012; Dijksterhuis & Muir, 2006; White & Shah, 2006), and relieves boredom (Schooler et al., 2014).

Although these research studies suggest that mind-wandering may be beneficial, there are situations when mind-wandering may hamper an individual's skill levels and personal outcomes. Mind-wandering during complex tasks, for example, can interfere drastically with individual performance on experimental and everyday tasks. Research studies have shown that mind-wandering can have a detrimental cost to reading comprehension due to superficial perceptual encoding (Franklin, Mooneyham, Baird, & Schooler, 2013; Smallwood, McSpadden, Luus et al., 2008). Another disadvantage of mind-wandering is that it is associated with negative change in mood and affect (Schooler et al., 2014). Indeed, inducing negative mood has been shown to increase levels of mind-wandering (Smallwood, Nind, & O' Connor, 2009). In one research study, Killingsworth & Gilbert (2010) used a cell phone application to probe individuals about their thoughts as they went about their day-to-day lives. Generally, results showed a significant association between negative mood and mind-wandering. Indeed, mind-wandering accounted for more than twice as much variance in happiness ratings than did the actual content or nature of the activities in which individuals were engaging. In another study, Killingsworth and Gilbert (2010) conducted a time-lag analysis to investigate mind-wandering and its' association to mood over long periods of time. Results suggest that mind-wandering precedes negative mood, and not vice versa. Consequently, mind-wandering amounts are often accompanied by increased negative mood or affect (Killingsworth & Gilbert, Schooler et al., 2014).

Most pertinent to the current research is the finding that mind-wandering may induce cognitive deficits related to working memory capacity and general intellectual aptitude (Schooler et al., 2014; Mrazek et al., 2012). Recent research has found that individual WMC predicts mind-wandering in individuals (Kane & McVay, 2012). Specifically, Kane & McVay (2012) found that individuals with lower working memory capacity reported more mind-wandering during difficult tasks than individuals with high working memory capacity. Mrazek and colleagues (2012) found that mind-wandering amounts are associated with scores on general intelligence and scores of WMC. As such, higher mind-wandering was associated with poorer scores on the automated OSPAN, a common test of WMC (Unsworth, Heitz, Schrock, & Engle, 2005). Further, structural equation modeling of mind-wandering, SAT scores, the OSPAN, and the Ravens Progressive Matrices test (Raven, 1938) scores showed that mind-wandering predicted 49% of the variance in the test scores (Mrazek et al., 2012). This finding is significant because it implicates mind-wandering as a main contribution to problems of attention. As such, one is better able to understand how to tailor interventions towards students who may struggle to regulate their attention and are more susceptible to be mind-wandering at inappropriate times.

In sum, mindfulness, a meditative process that is centered on keeping one's focus or "spotlight" of attention in the present moment, fully engaged in current experiences, with a nonjudgmental approach. The state of mindfulness encourages individuals to be fully engaged with the things that are happening in their current environment, without getting distracted by judgment, internal, or external processes. On the other hand, mind-wandering is thought to be the opposite construct of mindfulness. That is, when an individual is indeed engaging in internal thought processes or diverted by external distractions they are unable to attend to what is occurring in the present moment because their mind has wandered away. As such, mindfulness practice targets reducing mind-wandering and focusing attention in the here-and-now.

Mindfulness-Based Interventions

Incorporating mindfulness practice into health interventions, clinical practice, and school-based programs have become increasingly popular in the last 30 years (Cullen, 2011). As such, mindfulness-based interventions (MBIs) are programs, curricula, or therapies that incorporate the core components of mindfulness philosophy and practice into treatment strategies for general or specialized populations.

MBIs can vary greatly in appearance and technique. Mindfulness-based interventions that have been developed can be used to enhance attention regulation and human experience in the present moment. For example, there are different kinds of MBIs one may participate in including body-scan meditation (Kabat-Zinn, 1990; Stahl & Goldstein, 2010), arts-based mindfulness practice (Coholic, 2011), yoga or martial arts (Greenberg & Harris, 2011; Santangelo-White, 2012), educational techniques (e.g., Harnett & Dawe, 2012; Greenberg & Harris, 2011; Semple, 2009), or specially developed curriculum (e.g., “Still Quiet Place;” Mieklejohn et al., 2010) to enhance mindfulness. Though the specific details of many MBIs differ, at their core lies the common construct of receptive attention, systematically paying attention, on purpose, in the present moment, and non-judgmentally (Brown & Ryan, 2003; Brown et al., 2007; Kabat-Zinn, 1990)

One of the most commonly used practices at the core of most MBIs is a breathing meditation practice (Kabat-Zinn, 2003). During mindfulness breathing meditation, an individual is asked to sit still and to try to locate the sensation of breath in their body. Locating the breath encourages an individual to concentrate on the sensation of their body as he or she breathes, perhaps choosing to concentrate on feeling the air entering and leaving the nostrils or mouth. After locating the breath, the individual will then focus their attention on their current experience with that breath (Renshaw, 2012). Using the breath as an “anchor,” attentive awareness is directed toward one’s immediate conscious experience while breathing (Smalley & Winston, 2010). Initially, most people experience great strain in focusing on the present moment, and may easily become distracted by other internal or external stimuli (e.g., other people in the room; thinking about an argument with a friend that happened earlier in the day). When this happens, the person is encouraged to focus their attention briefly on the distraction, note the source of the distraction (e.g., thinking about final examinations), and then, with openness and acceptance, redirect their attention back to their breathing (Smalley &Winston, 2010).

Breathing meditation is not easy. Often, individuals may become frustrated at how difficult it may be to bring their attention consistently back to their breath. As a result, it is important to practice the integration of the second component of mindfulness practice, receptive attention in tandem with mindful breathing. Practicing receptive attention encourages individuals to approach MBI with curiosity, openness, acceptance and love, avoiding the categorization of thoughts, feelings, or experiences as “good” or “bad” (e.g., Renshaw, 2012). This practice is in direct contrast to forms of blunted or restricted consciousness that may be experienced through such experiences as rumination, preoccupation regarding the past or future, divided attention, as well as compulsive or automatic behavior (Brown & Ryan, 2003). Practicing redirecting attention back to breath without provoking impatience, anger, or self-criticism is a fundamental skill of mindfulness practice (Brown & Ryan, 2003; Renshaw, 2012; Smalley & Winston 2010).

In sum, in the recent years, many different health, clinical, and educational researchers have adopted the use of mindfulness practice into numerous interventions for many different populations. Mindfulness practice can take many forms, but commonly, all MBIs teach breathing meditation to train attentive awareness (Kabat-Zinn, 2003). These interventions have been shown to combat habitual or automatic functioning in individuals, and this training has led to many improvements in various settings (Brown & Ryan, 2003).

Implementation of MBIs. MBIs have skyrocketed in popularity for use in numerous and varied treatment settings. Initially, MBIs were integrated into a health-based stress reduction programs (see Kabat-Zinn, 1990), and were subsequently adapted for use in components of clinical psychology interventions. For example, mindfulness-based cognitive therapy (MBCT), dialectical behavioral therapy (DBT), and acceptance and commitment therapy (ACT) all integrate components of mindfulness practice, either informally or formally into daily living (e.g., Burke, 2010; Renshaw, 2012). Clinically based MBIs aim to promote individual growth through integrating mindfulness skills into individuals' current skill sets. Using skills learned through MBIs in every day living may help individuals manage countless experiences such as sensory input (e.g., sensitivity to sight, sound, touch, etc.), bodily awareness (e.g., chronic pain, cancer treatment) emotional states (e.g., depression, anger, anxiety), behavior (e.g., obsessive eating habits), and thoughts (e.g., negative self- conceptualization; Renshaw, 2012). Though the specific details of many MBIs differ, at their core lies the common construct of receptive attention, systematically paying attention, on purpose, in the present moment, and non-judgmentally (Brown & Ryan, 2003; Brown et al., 2007; Cullen, 200; Kabat-Zinn, 1990). Overall, MBIs aim to help individuals establish a clear and vivid awareness of their current state of consciousness, as well as to acquire a quality of conscious experience and function that is stands in contrast to the mindless, less 'awake' states of habitual or automatic functioning that may be chronic for many individuals (Brown & Ryan, 2003).

Systematically "paying attention on purpose" is often a skill that is much more easily discussed than practiced. The tenets of MBI accept that an individual's cognition, behavior, and emotions directly affect physiological and behavioral body responses (e.g. Beauchemin, Hutchins, & Patterson, 2008; Brown et al., 2007). For example, if a student is suffering from severe test anxiety, they might experience a variety of thoughts ("I will fail this test. I may as well just drop out of school. I'm not good at anything") at the same time as he or she is engaging in behaviors (e.g., chewing their fingernails, binge eating), and emotions (e.g., sadness, self-directed anger). Each of these experiences is associated with one's physiological or body responses, as regulated by the limbic system. One's heart may be racing, hands sweaty, and legs fidgety. Mindfulness practice assumes that the mind responds to real or presumed dangers in similar ways. That is, one's mind responds to perceived dangers, whether it is physical or psychological (Siegel, 2007). To reduce these uncomfortable experiences, mindfulness practice involves practicing systematically drawing one's attention back to the present. In other words, MBI encourages the individual to notice the feelings, thoughts, and behaviors in a non-judgmental way, while encouraging the individual to disengage from (i.e., "let go of") distracting thoughts and return their attention completely to the present (Brown & Ryan, 2003; Brown et al., 2007; Kabat-Zinn, 2003). Theoretically, by doing so, an individual's ability to respond to perceived dangers in their brain (e.g., failing a test) would be strengthened through an increased cognitive capacity to process information and executive functioning skills (Kabat-Zinn 1990; Meiklejohn et al., 2012). As such, MBIs ideally target strengthening and developing mind-body stress mechanisms that build cognitive resiliency in individuals due to repeated exposure of practice refocusing ones' thoughts, behaviors, and emotions in the face of distraction (Burke 2010; Renshaw 2012; Siegel 2007).

Cognitive Processes of MBIs

Several researchers have investigated the underlying cognitive processes of mindfulness practice in an attempt to operationalize how mindfulness-based skill building works to ease distress and enhance well-being. The current research is focused on investigating individual gains in attentional processes due to MBI. Past research has suggested that MBIs target executive functioning skills like attention control, self-regulation, and insight, as well as other skills, such as acceptance (e.g., Anderson, Lau, Segal, & Bishop, 2007; Greenberg & Harris, 2012). Often, MBIs are used in many ways to help an individual practice employing self-contemplation or self-awareness to build and enhance self-discovery—a skill that can be quite difficult to foster (Smalley & Winston, 2010). Such self-contemplation techniques, as well as other higher-order cognitive processes (e.g., comprehending reading, calculating math problems, and paying attention in the face of distraction), all stem from an individual's executive functioning system. Consequently, it is important to consider the potential benefits of MBIs on students' executive functioning and regulation within the school setting.

Recently, Zenner and colleagues (2014) conducted a meta-analysis to investigate the most effective components of MBIs within a school setting. This meta-analysis looked at 24 research studies that included 1,348 students ranging from grades 1 to 12. The researchers chose five factors to be measured including stress, resilience, emotional problems, cognitive performance, and third party ratings (i.e., teacher and student feedback). Of the 24 studies included in this meta-analysis, all of them incorporated mindful breathing practice as a part of the selected MBI (Zenner et al., 2014), supporting that this practice is the most commonly used component of MBIs within the schools. Results of the meta-analyses showed that MBIs appeared to be a highly acceptable tool to implement in school settings.

Zenner et al., (2014) reported that 89% of kids would recommend MBI to other students, 81% rated MBIs as personally useful, 83% were satisfied with the incorporation of MBIs, and only 5% thought the practice or teaching was too long in duration.

Given that MBIs seem to be a well-accepted tool to use within the school setting, of interest in this meta-analysis was the diversity of instruments used to measure improvements in student functioning. Each of the included research articles differed in their approach to measuring improvement in student functioning, seemingly because MBI research within the schools is a relatively new venture. For example, the selection of measures for emotional problems, resilience, and stress and coping differed throughout all 24 research studies included in the meta-analysis (Zenner et al., 2014). Seventeen different measures of resilience were used across studies, such as the Strengths and Difficulties questionnaire (Joyce et al., 2010), Behavioral and Emotional Engagement vs. Disaffection Scale (Biegel & Brown, 2010), Ego Resiliency Scale (Hennelly, 2011; Huppert & Johnson, 2010), and the Warwick-Edinburgh Mental well-being scale (Hennelly, 2011; Huppert & Johnson, 2010). Interestingly, the most commonly used scale to measure “resilience” across studies was the Positive and Negative Affect Schedule for Children (PANAS-C: Broderick & Metz, 2009; Corbett, 2011; Frankel et al., in press; Mendelson et al., 2010; Schonert-Reichl & Lawlor, 2010). The PANAS-C was categorized as a resiliency measure, and not an emotional problems measure, in this meta-analysis, although the PANAS is typically an indication of the dominant dimensions of emotional affect and experience (Watson & Clark, 1994).

Also diverse were the 13 various measures categorized as emotional problems measurement. For example, measures ranged from the State-Trait Anxiety Inventory for Children (Franko Justo et al., 2011), Children’s Depression Inventory (Joyce et al., 2010), Multidimensional Anxiety scale for Children (Potek, 2012) and the most commonly utilized Difficulties in Emotion Regulation Scale (Broderick & Metz, 2009; Mai 2010; Metz et al., 2013; Potek, 2012).

Finally, and most relevant to the current research, each experiment that tested cognitive performance in students after exposure to MBIs used a different measure. In fact, the only measure that was consistent across two of the six articles that measured cognitive performance was school-based grade reports, in which Mai (2010) reported no significant change (Franco Justo et al., 2011; Mai, 2010). Conversely, the six research studies that included cognitive measures varied widely in their scope and size, ranging from the Torrence Test of Creative Thinking (Franco Justo et al., 2010) to the Attention Network Test for Children (Biegel & Brown, 2010). Further, measures of cognition also included observed, self-caught, and self-report mind-wandering probes (Frankel et al., in press) and the Children's Color Trail Test (Corbett, 2011).

Zenner and colleagues' (2014) meta-analysis provides thorough information detailing the methodology of many of the recent research of MBIs in a school setting. However, most research about the efficacy of MBIs vary in content, outcome measures, intervention duration, and are underpowered. As such, it is important to consider large-scale studies that work to gain insight about underlying processes; and eventually mechanisms, that are benefitted by MBI (Hartnett & Dawe, 2012). It is evident that measures, performance, and processes are still not clear, and that there is not yet an established procedure for assessing gains resulting from MBI. It is promising that MBIs of many forms and functions all generally improve student outcomes in social, emotional, and cognitive domains. However, more powerful and extensive research is essential to help understand the specifics of these gains and how they may be related.

Of main interest, however, is that of all of the five factors analyzed, improvement in cognitive performance reported the highest gains with a 0.80 effect size. This large effect size is quite impressive given the nature of school-based intervention research. Given that MBIs have increased in popularity for use in school settings, it is important to understand *how* MBIs are improving cognitive performance in students. Such knowledge will reinforce an emerging evidence-base and add important details to further specify the way we comprehend MBIs. Thus, it is the goal of the current research to better understand how MBI leads to improvement in cognitive function over time. Specifically, Recent research shows that brief MBIs reduce mind-wandering and increase WMC (see Schooler et al., 2014). Separate research has investigated the effects of MBI on domain-specific attentional processes of task switching and inhibition. As such, this research aims to take these findings one step further, and attempts to parse out in which attentional domain MBIs are facilitating improvement. As such, it is necessary to understand the attentional processes that underlie and influence cognitive performance. Next, I will review three components of executive function are implicated in cognitive performance and that might be positively mediated by MBI.

Working Memory and Its Capacity

Working memory (WM) is a core component of the brain's executive functioning system (Kane & Engel, 2004; Klingberg, 2010). Per Baddeley and Hitch (1994), working memory is defined as a three-part memory system composed of two storage systems: 1) the phonological loop and the visuo-spatial sketch pad, and 2) the central executive system. The phonological loop and visuo-spatial sketchpad receive and transmit sensory information (e.g., auditory or visual) to the brain. The central executive system then holds that information within conscious attention in an active state, facilitates the information held in attention towards processing, and makes connections between long-term memories, retrieval, and subsequent actions. This "active memory" is like a limited capacity workspace that is split between storage and processing demands. Essentially, an individual's working memory is their active memory's workspace, which can only hold a certain amount of information at a time (Miller, 1956; Morrison & Chein, 2011). As information enters the brain, one must process it at the same time as one stores it, requiring active, short-term use of memory and attention. For example, a student who is reading a story is using their active memory to comprehend a sentence from beginning to end. If the student cannot remember the first part of the story, reading a passage may prove difficult to comprehend plot lines, characters, or sequence of events.

Working memory enables individuals to hold onto information that they need, even if they are facing distractions. Engle and colleagues (e.g., Kane & Engle, 2003; Engle 2002) have suggested that executive attention is the component of working memory responsible for the variation between individuals' WMC and higher-order cognition. Specifically, Engle (2002) asserts that working memory is not just short-term memory, but it is also dependent on one's capacity to control attention that is essential to performance during complex tasks. Important to an individual's WMC is the ability to hold and maintain information within the conscious spotlight of attention, as well as to shield that information from interference and distraction from internal and external sources. This relationship between the ability to control attention and the amount of information that is kept 'active' in short-term memory characterizes individual WMC (Engle, 2002).

WMC: An Operational Definition

Barrett, Tugade, and Engle (2008) operationally defined WMC as the number of items one can keep in mind for later recall during a complex memory task. WMC is tested through complex span tasks, or tasks that engage the functioning of working memory through requiring individuals to simultaneously update active information processing while shifting the demands of their attention (Barrett et al., 2008). Barrett and colleagues (2004) described a complex span paradigm as memory span test embedded within a secondary processing task. As such,

> individuals are presented with a form of information for later recall (e.g., words, digits, spatial orientations), and between the presentation of each item, they are required to perform some attention-demanding computation (e.g., reading sentences, doing simple arithmetic problems, counting, mental rotation, and so forth) that can serve as interference for the memory task (Barrett, et al., 2004, p. 6).

Working memory capacity is thus measured as the maximum number of targeted items recalled without error.

Working memory is a continuous construct; individuals with more attentional control outperform those who have fewer resources to be able to control their attention successfully. A wide variety of complex span measures now exist, covering verbal, spatial, arithmetic, and emotional domains (c.f. Barrett et al, 2008; see Daneman & Carpenter, 1980; Kane & Engle, 2003; Kyllonen & Christal, 1990; Turner & Engle, 1989). WMC tasks, therefore, generally expose participants to information for later recall while engrossing them in another attention-demanding task. The ability to engage in focused processing while suppressing or inhibiting external distractions results in higher scores of WM task performance on WM tests. Such attentional-control, or the ability to keep attention focused on the task rather than other internal or external information, is one of the main contributors to an individual's level of WMC (Barrett et al., 2008; Engle, 2002).

WMC and Individual Outcomes

Established empirical evidence suggests that tests of WMC, like the automated OSPAN, are linked to numerous laboratory, school and life outcomes. Individuals who achieve a higher score on tests of WMC are typically better able to focus their attention, and are generally more successful at enacting controlled, goal-directed processing relative to those with low WMC (Barrett, Tugade, & Engle, 2008). Furthermore, individuals with lower WMC are more likely to allow less appropriate or undesired responses to emerge during task performance (Barrett et al., 2008). This ability to inhibit distractions and sustain focus on the task-at-hand proves advantageous in multiple ways.

For example, individuals with higher WMC are better able to manage goal-related information and tasks, such as following complex and multi-step instructions (e.g., Conway & Engle, 1994; Kane & Engle, 2003; Tuholski, Engle, & Baylis, 2001). Further, individuals with higher WMC are better able to manage multiple types of information interference (i.e., proactive and retroactive interference; environmental distractions; Kane & Engle, 2000; Rosen & Engle, 1997) and suppress irrelevant or unwanted stimuli like intrusive anxious or depressive thoughts or distracting loud noises in the environment (Macrae & Bodenhausen, 2000; Macrae, Bodenhausen, Schloerscheidt, & Milne, 1999; von Hippel, Silver, & Lynch, 2000). Finally, individuals with higher WMC have stronger information processing strategies (Conway et al., 1999; Kane & Engle, 2000; Rosen & Engle, 1997), and are better able to use strategies in the learning and memorization of new material (Cantor & Engle, 1993; Radvansky & Copeland, 2001).

Experimental and applied research similarly suggests that individual WMC is related to several outcomes within a school setting. Specifically, WMC contributes to higher individual success in multiple academic subjects such as reading comprehension, language comprehension, listening comprehension, problem solving, complex reasoning, strategy adaption, vocabulary, and spelling (e.g., Alloway et al., 2005; Schooler et al., 2014). Consequently, success with difficult tasks such as following directions, note-taking, logic learning, story-telling, and emotional processing are also affected by individual levels of WMC (see Barrett et al., 2008). For instance, Alloway and colleagues (2009) analyzed a large sample of 5-6 and 9-10-year-olds that scored low on tests of working memory. They found that children with low working memory capacity were performing below normative academic levels as compared to their peers, especially in math and reading domains. In fact, a third of the children in the sample were performing at a level so behind that of their classmates that they were already receiving formalized, additional support from the schools in at least one subject area (i.e., special education; Alloway et al., 2009). This finding is consistent with prior research that shows there are substantial working memory problems in students identified with a learning disability (e.g., Gathercole, Alloway et al., 2008; Swanson & Beebe-Frankenberger, 2004). As such, individuals with lower working memory capacity are often disadvantaged in their ability to process information and control knowledge integration as a result of less ability to control internal and external distractions. Research shows that individuals with autism (Andersen, Hovik, Scogli, Egeland & Øie, 2013), Attention-deficit Hyperactivity Disorder (Alloway, Gathercole, Kirkwood & Elliott, 2009; Martinussen & Tannock, 2006), anxiety (e.g., Owens, Stevenson, Hadwin, & Norgate, 2012), and various other developmental and learning disorders have lower WMC (see Alloway et al, 2009; Alloway, Rajendran, & Archibald, 2008).

In sum, individual WMC is closely related with ability to learn and execute a wide array of tasks, and subsequently affects academic and life outcomes. Individuals with higher WMC have numerous processing and regulation advantages over those with lower

WMCs. Individual with lower WMC are more likely to need special education services within the school settings, and may struggle more with every day life functioning (Alloway et al., 2009). Indeed, people with lower WMC seem to be facing many processing and learning disadvantages, and until recently, it was thought that individual WMC abilities where inherent and unable to be changed (e.g., Morrison & Chein, 2011; Shipstead, Redick, & Engle, 2012). However, recent research has investigated if intensive interventions may actually improve individual WMC.

Training Working Memory Capacity

Once thought to be a static trait, recent research has focused on the possibility of individual working memory capacity as something that can be trained and improved (e.g., Dunning & Holmes, 2014; Morrison & Chein, 2011; Shipstead, Redick & Engle, 2012). Generally, working memory training is categorized into two subdomains as interventions that directly instruct, train, and repetitively practice skills to impact WM efficiency (Morrison & Chein, 2011). The first training domain focuses on domain-specific skill enhancement known as strategy training, while the second training domain targets general aspects of WM through core training.

Strategy training. Strategy training consists of direct instruction of effective approaches to encoding, maintenance, and retrieval from WM. Typically, strategy training includes introducing individuals to a skill, teaching them that skill, and subsequently providing practice sessions for skill development (Morrison & Chein, 2011). Strategy training typically targets skills such as rehearsal and elaborate encoding, through teaching individuals strategies like chunking (e.g., St Clair-Thompson, Stevens, Hunt, & Bolder, 2010), mental stories (e.g., McNamara & Scott, 2001), and rehearsing information out loud (Turley-Ames & Whitfield, 2003).

These strategy-based training techniques have been shown to benefit performance of tasks like the Categorization Working Memory task (Caretti, Borella, & De Beni, 2007), simple digit, letter, and word spans (Comblain, 1994), a working memory test battery for children (Lomes, Rasmussen, Pei, Manji, & Andrew, 2008), and complex reading span tasks (MacNamara & Scott, 2001). However, generalization from strategy training seems to be quite broad, and current theory supports that strategy-based training may be conducive to the enhancement of certain skills, rather than an individual's whole WM system (Morrison & Chein, 2011).

Core training. Core training, on the other hand, is designed to improve core WM skills (e.g., inhibition, maintenance, retrieval) through repetitive exposure to demanding WM tasks (e.g., Holmes, Gathercole, & Dunning, 2009; Morrison & Chein, 2011). Core training usually consists of engaging an individual in a large battery of complex working memory tasks. Programs such as Cogmed (Holmes, Gathercole & Dunning, 2009) and Cogito (Schmeidek, Lovden, & Lindenbarger, 2010) are designed to train individual working memory skill across an array of tasks such as backward digit spans, tracking moving objects, perceptual speed tasks, and tests of episodic memory (c.f. Morrison and Chein, 2011, p. 49).

Across research studies, core working memory training, or training that targets the domain general constructs of working memory (i.e., strengthening inhibitory mechanisms) have been shown to produce larger generalization effects to tasks that were not included in the WM training programs (Morrison & Chein, 2011). Core working memory training programs have been shown to have positive generalization effects on tasks outside of training for children with ADHD and children who had low working memory capacity (Holmes & Gathercole, 2013; Gathercole, Alloway, Kirkwood, Elliott, Holmes, & Hilton, 2008; Mezzacappa & Buckner, 2010). Specifically, after receiving core working memory training, children later scored high on independent tests of fluid intelligence, reasoning, and latent measures of memory and working memory capacity, indicating broader improvement outside of what may have been considered practice effects of repeated training (Morrison & Chein, 2011).

School-based WMC training. There has also been increasing interest in the potential benefits of working memory training in the school setting. Research has shown that children with lower working memory capacity have a higher incidence of special education needs at various tiers of instruction (i.e., tertiary, intensive). Further, children with very low levels of working memory capacity were more common in a sample of children with special education needs than in a large sample of typically developing peers (Alloway, Gathercole, Adams, & Willis, 2005). For example, a longitudinal research study by Galloway and colleagues (2003) found that children's verbal working memory capacity at the age of four predicted achievement levels on nationally standardized tests of writing and spelling three years later. Further, children with WM deficits often are rated by teachers as atypically high in inattentiveness and distractibility, as well as seen as underachieving in self-monitoring and problem-solving in the school setting (Alloway et al., 2009). However, research has demonstrated that implementing WM training programs with youth show significant improvement on scores on both trained and novel working memory tasks (Holmes & Gathercole, 2013), are associated with greater school progress across the academic year in math and English (Holmes & Gathercole, 2013), increase teacher-reported positive student behaviors, and increase performance on general verbal and visual-spatial working memory tasks (Mezzacappa & Buckner, 2010). Overall, these studies suggest that children with low WMC face numerous struggles when it comes to learning in a highly distracting classroom environment, but there may be hope in training students to improve their cognitive weaknesses.

Although research in the domain of working memory training has seen positive gains for participants of WM training programs, there is still need for further research demonstrating improvement in overall WMC, and a need to establish the underlying processes that facilitate change in WMC (Shipstead, Redick, & Engle, 2012). The current research study, therefore takes specific interest in an intervention that has been shown to have a number of benefits. Mindfulness based interventions (MBIs) have been gaining in popularity in medical, clinical, and school settings due to a multitude of personal benefits to participants. Of specific interest to this project are the individual cognitive benefits that may result from participation in MBIs. Currently, investigation of MBIs as interventions that specifically increase individual WMC is a nascent research base. Specifically, recent research studies demonstrating the positive effects of MBIs on cognitive functioning have raised questions about the specific cognitive processes underlying this improvement. As such, it may be helpful to integrate previous memory and cognition research to better understand how MBIs benefit cognitive function. Specifically, this research proposes that MBIs may be a strategy-based intervention that that strengthens attentional control (i.e., reduces mind-wandering). It is hypothesized that domain-specific attention processes like inhibition, and task-switching are bolstered through repetitive mindfulness practice, thus strengthening individual WMC.

Association between mind-wandering, mindfulness, and WMC. Understanding how mind-wandering and mindfulness interact is also essential to pinpointing the cognitive processes targeted by MBIs. It may be that MBIs provide “repetitions” for an individual’s working memory system. Previous research posits that MBIs result in a higher endurance in the ability to maintain focus on the task-at-hand and not to succumb to distraction reduces attachment feelings (e.g., anxiety), engagement in, or aversions to distracting thoughts, emotions, or behavior (Schooler et al., 2014). Indeed, recent research supports the notion that exercising mindful attention of the present moment may decrease one's propensity to mind-wander while they should be focused on the task at hand (Mrazek Smallwood, & Schooler, 2012; Mrazek et al., 2013). Specifically, I hypothesize that the practice of realizing when one's mind has become distracted by internal or external stimuli, letting go of that stimuli, and returning one's conscious attention to the task at hand will eventually make an individual's WMC more effective and facilitate greater persistence on higher difficulty cognitive tasks.

In one study, Mrazek, Smallwood, & Schooler (2012) conducted experiments to investigate the relation between mindfulness and mind-wandering. In the experiment, individuals participated in two 10-minute mindful breathing tasks. The first task included mind-wandering sampling probes and the other included intermittent self-report probes on mind-wandering. In the sampling probes, a small bubble appeared on the screen to ascertain if individuals were paying attention, and requiring a response from one of three questions. In the self-report probes, participants were told to hit the space bar every time they caught themselves mind-wandering. Immediately following, each participant completed the complex SART measure. In the SART, the number of errors individuals made accounted for task disengagement. Following all tasks, participants were given the Positive and Negative Affect Scale (PANAS), as well as the Mindful Attention and Awareness Scale (MAAS) to measure disposition to mindfulness and mind-wandering.

Results showed that MAAS scores were negatively correlated with self-reported mind-wandering. There were also associations found between trait mindfulness (as measured by the MAAS), less self-reported mind-wandering, and SART errors. As such, people with higher trait mindfulness scores perform better on a complex attention test and report that their attention wandered less during the time in which they were completing the task. These results suggest that mindfulness and mind-wandering are negatively correlated, wherein levels of self-reported mindfulness increase as self-reported levels of mind-wandering decrease (Mrazek et al., 2012). That is, increased reports of mind-wandering during testing was associated with lower WMC scores. Specifically, for individuals prone to mind-wandering and distraction, a short MBI statistically mediated improvement in WMC and GRE test scores (Mrazek et al., 2012; Schooler et al., 2014). This research suggests that mind-wandering and mindfulness are opposite concepts that suppress the others' function (Mrazek et al., 2012). Mrazek, and colleagues (2012) state that, "given the robust relationship between mind-wandering and impaired task performance (for reviews see Smallwood & Schooler, 2006; Smallwood et al., 2007), the benefits of a straightforward and simple activity [like MBIs] have great practical significance" (p. 5).

In a second study, Mrazek and colleagues (2013) recruited participants to determine if brief MBIs had effects on WMC and performance on GRE test questions. Participants were randomly assigned to one of two conditions: a mindfulness class or a nutrition class. Participants were asked to complete pre-and-post-test GRE Verbal measures, as well as a measure of WMC. WMC was assessed using the automated OSPAN, a complex span task highly predictive of a range of individual performances that operationally measure the ability to maintain select presented information for recall in the face of distraction or interference (Unsworth, Heitz, Schrock, & Engle, 2005). Ultimately, self-reported mind-wandering during testing was negatively correlated with lower WMC span scores, indicating that participants who fail to remain engaged in the task performed more poorly than those who can maintain their attention (Schooler et al., 2014). Most importantly, those who had received the brief MBI exhibited an increase in scores of WM, as measured by the automated OSPAN (Mrazek, Franklin, Phillips, Baird, & Schooler, 2013).

Summary. In sum, evidence has shown that there is a strong relationship between mind-wandering and WMC test performance between and within individuals (Schooler et al., 2014). Schooler and colleagues (2014) assert that mind-wandering "is a general feature of human cognitive architecture, and thus a core component of general intellectual aptitude… which create a demanding task context in which mind-wandering is disruptive [to success] …" (p. 10). However, until recently, little research has investigated interventions that can be implemented to reduce the detriments to performance caused by mind-wandering. Mindfulness-based interventions have shown to be potentially useful for improving executive attention (Zelazo & Lyons, 2012), attentional processes (Brefczynzki-Lewis, Lutz, Schaefer, Levinson, & Davidson, 2006) and general cognitive performance (Zenner et al., 2014). Further, brain efficiency in attentional tasks like inhibition has been shown to increase after exposure to MBI (Kozasa, Sato, Lacerda, Barreiros, Radvany, Russell, Sances, Mello, & Amaro Jr., 2012). Oberle and colleagues (2012) found that trait mindfulness was positively correlated with individuals' cognitive inhibition. That is, individuals who scored higher on trait mindfulness measures showed greater accuracy on a task of inhibitory control, which indicates that they are better able to inhibit external distractions while completing the task at hand. These experiments that test MBIs as a way to improve cognitive performance through the reduction of mind-wandering are intriguing, and preliminary data shows that MBIs not only benefit individuals with individuals who have lower attentional control, but also for those with high attentional control as well (Schooler et al., 2014). Promisingly, recent research demonstrates that WMC may indeed be malleable, and thus, trainable. As such, an investigation of MBIs as a tool for training WMC and other attentional processes is warranted.

Mindfulness-based Interventions as a Training Tool for Working Memory Capacity

Research on mindfulness training's effects on working memory capacity has found that it may be a promising strategy for improving individual task focus and performance (e.g., Jensen, Vangkilde, Frokjaer, & Hasselbach, 2011; Jha, Stanley, Kiyonaga, Wong, & Gelfand, 2010; Mrazek et al., 2013). One specific study examined how MBIs affected working memory capacity and emotional experiences in times of high stress for members of the United States Navy (Jha et al., 2010). Researchers recruited two cohorts of U.S. Marines during a pre-deployment period, and implemented mindfulness training with one of the military conditions while the other military group served as a control group alongside a group of civilians. The experimental group received a mindfulness-training program over an eight-week period, which included two one-hour weekly meetings, thirty minutes of homework a night, and a full day of silent retreat. Results showed that military members who were part of the mindfulness-training group improved their WM scores. Specifically, participants in each of the experimental conditions were administered the automated OSPAN and the Positive and Negative Affect Schedule (PANAS) before and after they engaged in the experiment. Individuals who engaged in mindfulness practice showed moderate gains in OSPAN scores over time, and further, greater time spent practicing mindfulness had a significant positive relationship with improved OSPAN scores (Jha et al., 2010). Further, individuals who were exposed to mindfulness practice also exhibited reductions in negative affect as measured by the PANAS. As such, participants who receive MBIs may experience beneficial reductions in negative affect, as well as an increase in WMC.

As previously mentioned, Mrazek and colleagues (2013) conducted a randomized-controlled experiment to examine the effectiveness of a mindfulness-training program (compared to a nutrition education program) on improving reading comprehension, enhancing WMC, and reducing distracting thoughts. WMC was measured by using the automated OSPAN (Unsworth, Heitz, Schrock, & Engle, 2005). Prior to training, there were no significant differences in GRE accuracy, WMC score, or thought-sampling and self-reports of mind-wandering. However, after intervention, the mindfulness training group showed significant improvement in performance across all variables; improved accuracy on GRE questions, higher OSPAN scores, and less mind-wandering as reported by three different mind-wandering measures. In fact, the change in GRE accuracy scores post mindfulness training saw an average improvement analogous to 16 percentile points after standardized score conversion (Mrazek et al., 2013).

Finally, Mrazek and colleagues (2012) research study showed that mindfulness training not only prevents the deterioration of working memory capacity during times of high stress, but also enhances attention. As previously mentioned, Mrazek, Smallwood, & Schooler (2012) investigated how mindfulness and mind-wandering may be related. Specifically, for individuals prone to mind-wandering and distraction, an eight-minute in duration MBI statistically mediated improvement in OSPAN and GRE test scores. This research suggests that mind-wandering and mindfulness are opposite concepts that suppress the other’s function (Mrazek et al., 2012). All in all, initial research shows that various styles of MBIs all improve WMC, positively affect mood, and reduce reported mind-wandering (Jha et al., 2010; Mrazek et al., 2013; Mrazek et al., 2012).

When considering how mindfulness training may benefit students, Meiklejohn and colleagues (2012) suggest that MBIs with students would enhance their capacity to self-regulate their attention and emotion, as well as buffer the developing brain from excessive traumatic stress. As such, it is theorized that MBIs increase a student's capacity to regulate their attention through practicing the skills of focusing, sustaining, and redirecting attention (Oberle et al., 2012; Napoli et al., 2005). For example, MBIs teach individuals to notice when their mind has wandered away from the task at hand, and return it to present focus. As such, MBIs engage students in sustaining their attention in the present moment, focusing in on task-relevant stimuli, and redirecting their attention back to the task if their mind wanders. Consequently, students may be better able to relate to their internal and external experiences with strategies that are more responsive and less spontaneously reactive. That is, by becoming more responsive to their own thoughts and needs, students can remain present-centered and objective when dealing with any pleasurable, neutral, or stressful situation. This aspect of mindfulness training supports the development of a child's emotional regulation skills, including the ability to be aware of and express their emotions, as well as controls the intensity and duration of emotion-related arousal (Coholic; 2011; Meiklejohn et al., 2012). It is the purpose of the current research to show that in addition to stress reduction and mood enhancement, MBIs and general mindfulness training may also strengthen working memory capacity in students (Mrazek, et al., 2013).

Proposed Models for MBIs as a Tool for Training WMC

Thus far, this review has introduced the cognitive constructs of executive attention as working memory capacity, mind-wandering, inhibition, and task-switching. Working memory capacity has recently been investigated as an ability that can be trained and improved (e.g., Morrison & Chein, 2011; Shipstead, Redick, & Engle, 2012). One way to train WMC is through teaching specific skills designed to improve performance on WM tests (Morrison & Chein, 2011). Such strategy-based training is typically taught through direct instruction and repetitive practices. Until now, MBIs have not been considered as a potential strategy-based way to train attentional control, a cognitive mechanism directly tied to individual WMC.

As previously mentioned, MBIs have been shown to improve functioning in many domains. Figure 1 illustrates these constructs in one image. The image shows that mind-wandering decreases scores on five major aspects of performance and individual functioning (Schooler et al., 2014). Conversely, research shows that MBIs *improve* individual performance in the same domains (Beauchemin, Hutchins, & Patterson, 2008; Burke, 2009; Greenberg & Harris, 2011, Saltzman & Goldin, 2008). The dashed lines in the figure represent newer, emerging research base, while the solid arrows indicate a more established research base. Thus, it seems that MBIs directly decrease levels of mind-wandering through teaching the skill of *attentional awareness*; or controlling your attention to stay in the present moment. Because of staying completely conscious of the present moment, the ability to engage in mind-wandering becomes non-existent.

Accordingly, it seems reasonable that through MBIs, and specifically through teaching attentional awareness, individuals gain a strategy for maintaining attentional control instead of allowing their mind to wander from the task at hand. An individual's ability to control their attention may directly represent their working memory capacity and mediate subsequent performance on WMC tests.

Figure 2 illustrates how the attentional control abilities are tied to both constructs of mind-wandering and mindfulness. The beginning point of Figure 2 is the furthermost left block, symbolizing attentional control. Through the practice of mindfulness, individuals are able to increase their attention in the present moment. As a result, individuals are more vigilant to the stimuli in their current experience. This focus may enable participants to

Figure 1. The Costs of Mind-wandering and Benefits of Mindfulness

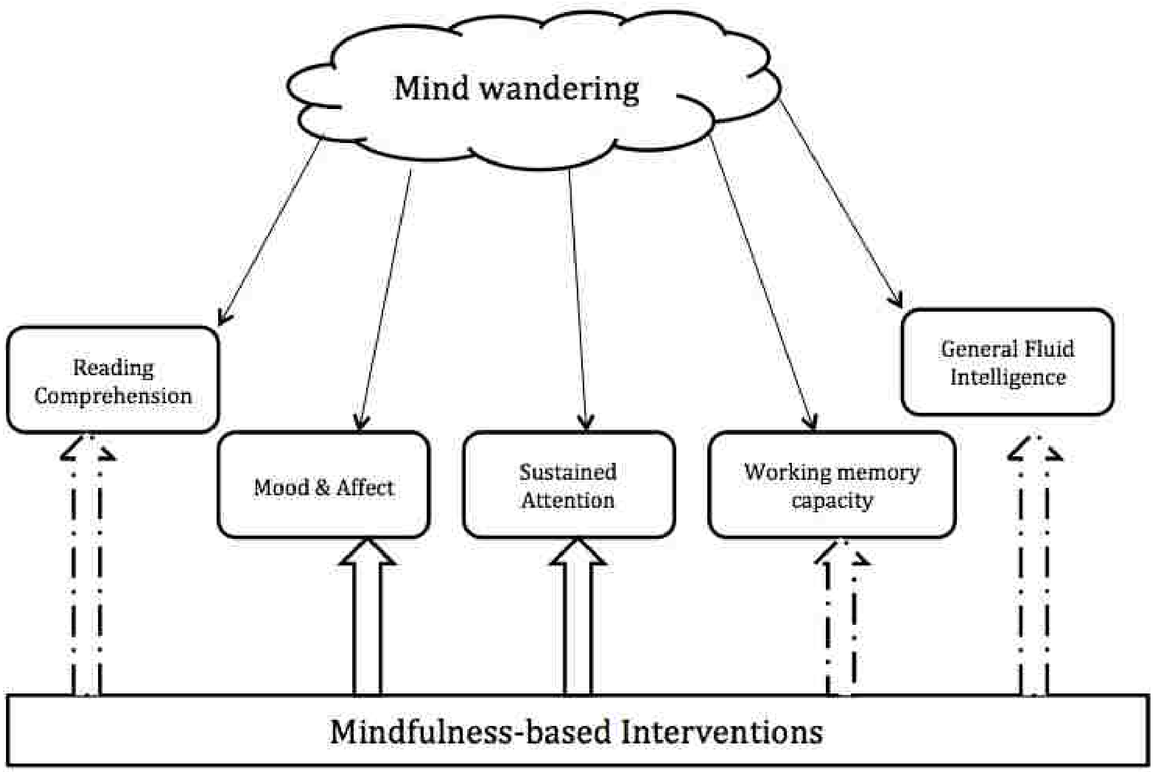


Figure 1. The costs of mind-wandering on performance are reduced by mindfulness-based interventions the solid lines represent a more established research base while dashed lines in the figure represent newer, emerging research bases. Adapted from research by Mrazek et al., 2012; Mrazek et al., 2013; Schooler et al., 2014.

‘catch’ or process more of the information in the present environment that they are in, leading to increased performance on present tasks. For example, participants who are more mindful may have a stronger ability to pay attention to the information presented during a working memory test. Therefore, they are less prone to make errors regarding the information they are presented for recall. Conversely, a lack of attentional control is indicative of increased mind-wandering (Schooler et al., 2014). When mind-wandering, an individual is not paying attention to stimuli in their present environment, instead captured by thoughts of the past or future or distracted by auxiliary aspects of the environment (e.g., a door slamming, footsteps in the hallway). As mind-wandering increases, the ability to ‘catch’ the information in your present environment decreases, as does performance on present moment tasks (Schooler et al., 2014). For example, if one were engaging in mind-wandering during an operational span task, they would be more prone to error. Proneness to error results from lack of focus on the present information being presented, like a math problem, or a letter for later recall. If one misses the presentation of the letter they are supposed to recall at a later moment in time, they will most likely commit errors during the assessment.

Inhibition and Task-switching. Two specific domain-specific components of executive attention beyond attentional control warrant further investigation in this study. The first, inhibition, is an individual’s capacity for withholding a preplanned response, interrupt a process that has already started, avoid interference, and delay a response (Tamm, Menon, Ringel, & Reiss, 2004). Individuals who lack inhibition typically display less ability to sustain their attention, are more distractible, and a more likely to be unable to control their behavior (Tamm et al., 2004). Recent research supports the notion that inhibitory processes may be improved by MBI. Oberle and colleagues (2012) recruited 99 fourth and fifth graders to participate in trials of a computerized inhibitory control task, after measuring trait mindfulness and cortisol levels. They found that trait mindfulness ratings positively predicted greater response accuracy on these inhibition tasks. This finding supports the notion that MBIs have a significant effect on our abilities to inhibit distractions and say attentively aware in the present moment.

Figure 2. Attention control as the key WMC component in mindfulness or mind-wandering

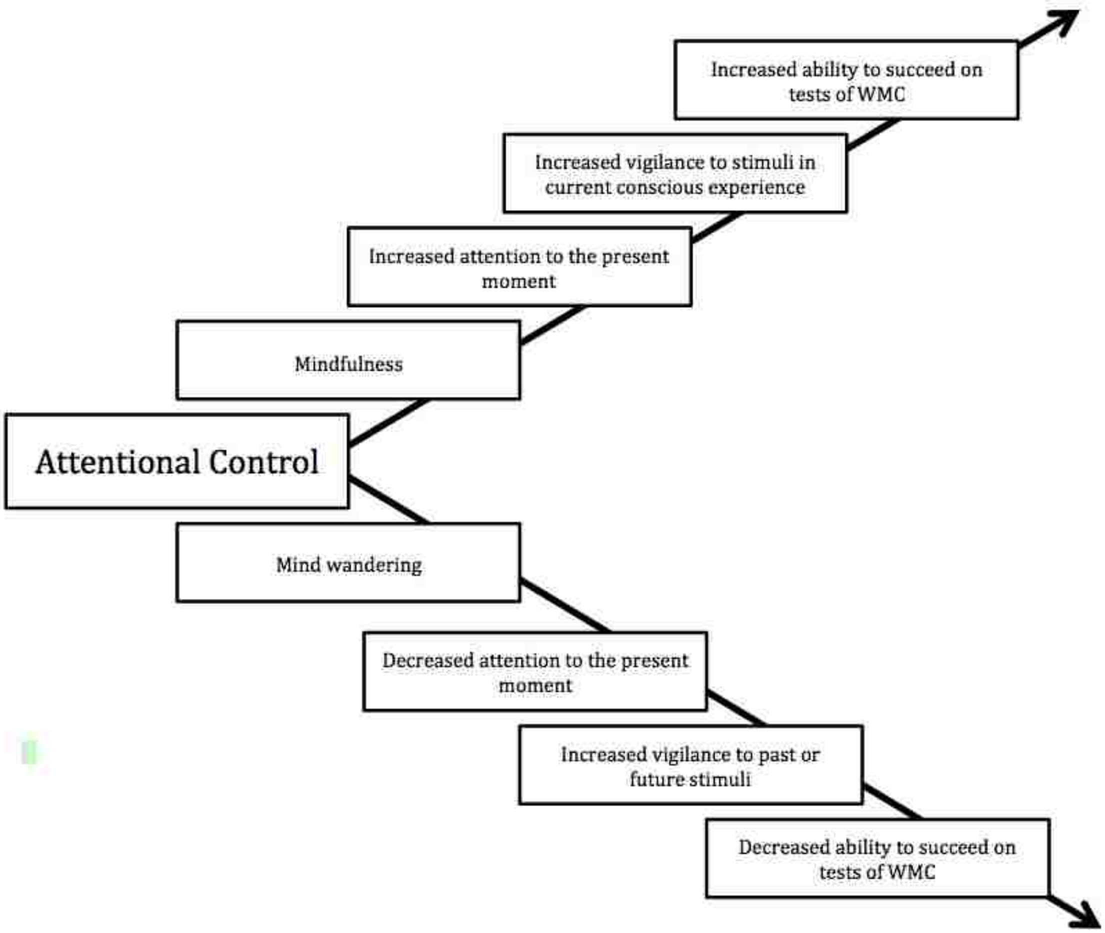


Figure 2. A theoretical model of attentional control as affected by mindfulness and mind-wandering.

Another executive process, related to inhibition, is the ability to not only inhibit information but to switch from one task to another, often times acting according to rules or directions (Davidson et al., 2006). This task-switching, often referred to as cognitive flexibility, refers to one's individual ability to hold on to information, manipulate that information, and switch between multiple sources of information and multiple action rules (e.g., what to do with that information). The skill of switching between tasks can prove difficult because it requires a break in automaticity of one's cognitive processing, and requires both working memory capacity and inhibition to do so (Davidson et al., 2006). Anderson and colleagues (2007) recruited 86 adult participants with no prior meditative training to participate in a wait-list control weekly MBSR experience. Participants were administered pre-and post-measures such as the Vigil Continuous Performance Task that measures task switching, the Stroop task, and a measure of object-detection attention (Anderson et al., 2007). The only reported significant effect, albeit small was of object–detection, suggesting that MBIs indeed influence awareness of the present moment. There was not real change in measured of task-switching or inhibition in participants. This supports the premise that mindfulness increases general awareness but does not enhance attention. However, these results may have been affected by several factors, or they may indicate that awareness is more integral than attentional processes in mindfulness interventions (Anderson et al., 2007). Due to recent research that shows improvement in WMC after exposure to brief MBIs, this matter warrants further investigation.

Of interest to this study is how MBIs' core component of attentive awareness may enhance attentional processes. Brief MBIs guide participants through an active, goal-based, meditation. The meditation provides individuals a goal: to focus their awareness on the present moment, drawing their attention to their breath. The goal extends into guiding the individual to notice when their attention has wandered away from the present moment; in which case, he or she is guided to bring their attention back to the present moment in a non-judgmental way (Kabat-Zinn, 2003). It may be that MBIs facilitate the attentional skills of inhibition and task-switching through the repeated practice of noticing if (when) one's thoughts have wandered from the present moment, and bringing them back. Thus, maintaining attentive awareness in the present moment may facilitate greater response inhibition in the face of distractions.

For example, a student may have difficulty listening to the teacher because a fight they had with their sibling at home has consumed their attention (i.e., mind-wandering). However, through MBI, the student would learn to become aware of instances in which he or she is mind-wandering (i.e., attention not in the present moment), and provide a strategy for 'getting back on track' (i.e., "When your attention wanders, notice and validate the thought, and then gently return your attention to the current moment." [citation?]). This strategy targets both domains of inhibition and task-switching. At first, keeping one's attention in the present moment may prove to be quite difficult and after one's mind wanders it may be difficult to *switch* one's awareness back to the task of mindful meditation. However, after participating in MBI, over time, it becomes easier to keep one's mind in the present moment and *inhibit* internal or external distractions from permeating the current experience. Thus, repeated intervention may improve a greater ability to maintain consciousness in the face of distraction, or improved response inhibition.

Mapping Attentional Processes onto Attentional Awareness

Recent research shows that brief MBIs reduce mind-wandering and increase WMC (see Schooler et al., 2014). Separate research has investigated the effects of MBI on domain-specific attentional processes of task switching and inhibition (e.g. Anderson, Lau, Segal, & Bishop, 2007; Oberle et al., 2012). Bishop and colleagues (2004) propose that one component of mindfulness, attentive awareness, is linked to executive attention skills because it requires self-regulating the focus of attention while inhibiting the urge to elaborate on thoughts and feelings that naturally arise in consciousness. Specifically, they posit that mindfulness involves sustained attention to maintain awareness of current experience, task-switching to bring attention back to the present moment, and inhibition to avoid dwelling or ruminating on thoughts or feelings that are outside of the present moment (Bishop et al., 2004). As such, this project aims to take this research one step further, and attempts to parse out in which domain brief MBIs are facilitating improvement in attentional processing. Figure 3 demonstrates what attentional processes may be exercised by MBIs.

A Proposed Model for the Underlying Attentional Processes of MBIs

All in all, attentional control is a key component of individual WMC, inhibition, task-switching, and subsequent student outcomes. It seems that MBIs teach individuals' attentional awareness, or how to control their attention to stay in the present moment. Consequently, it seems MBIs may improve individual's attentional control through teaching them how to practice maintaining their conscious awareness in the present moment. Figure 4 is a conceptual model that outlines how research in both areas of mindfulness-based interventions and training working memory capacity may converge. To begin, the lower left of the figure shows the three core components, receptive attitude, intention, and attentional awareness, which are taught through MBIs (Renshaw, 2012). Attentional awareness, a core component of mindfulness and to attentional control and the key to individual WMC, is defined as the ability to focus and sustain attention and awareness on the present task (Kane & Engle, 2003; Renshaw, 2012).

Figure 3. Connections between Attentive Awareness and Executive Attention Processes

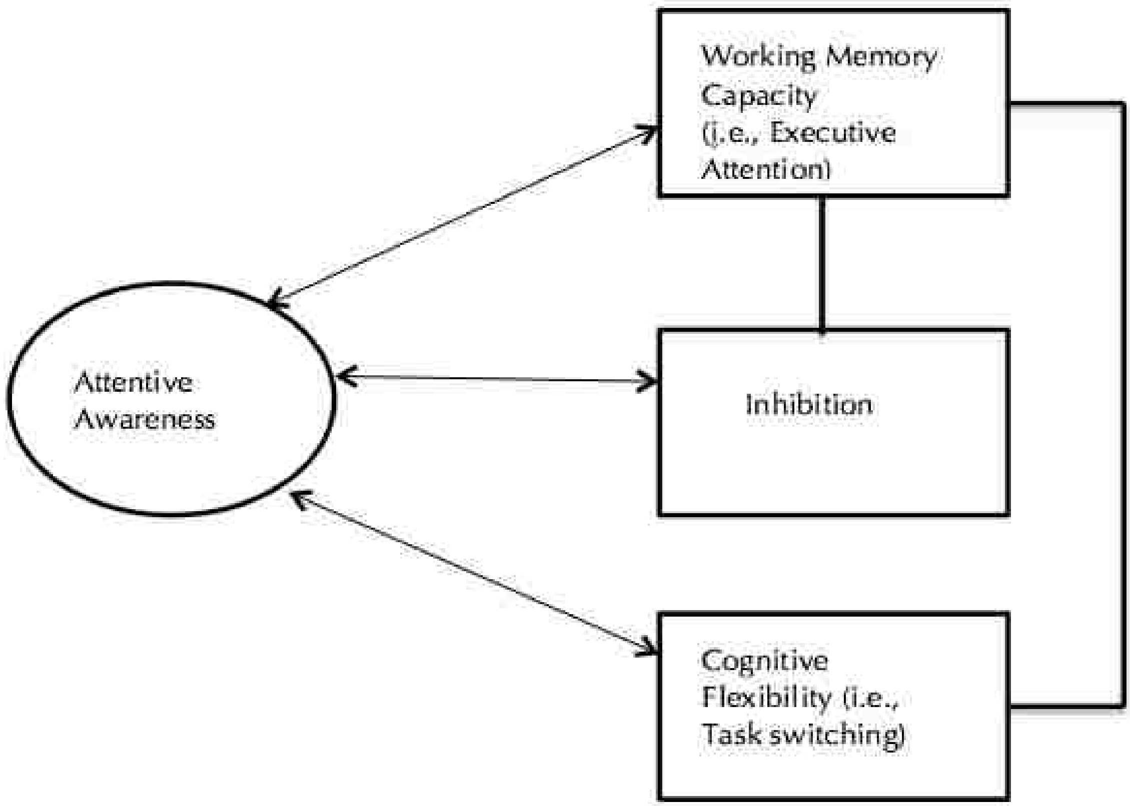


Figure 3. A theoretical diagram illustrating the potential connections between attentional awareness, a core component of MBI, and specific attentional processes.

As such, MBIs may be teaching individuals a strategy for controlling their attention through repetitively practicing returning your attention to the present moment when you've noticed that it has wandered (Greenberg & Harris, 2001; Kabat-Zinn, 2003; Renshaw, 2012). Subsequently, this strategy may improve such attentional processes like WMC, inhibition, and task switching while reducing mind-wandering.

Figure 4. Theory of How MBI May Affect Attentional Control.

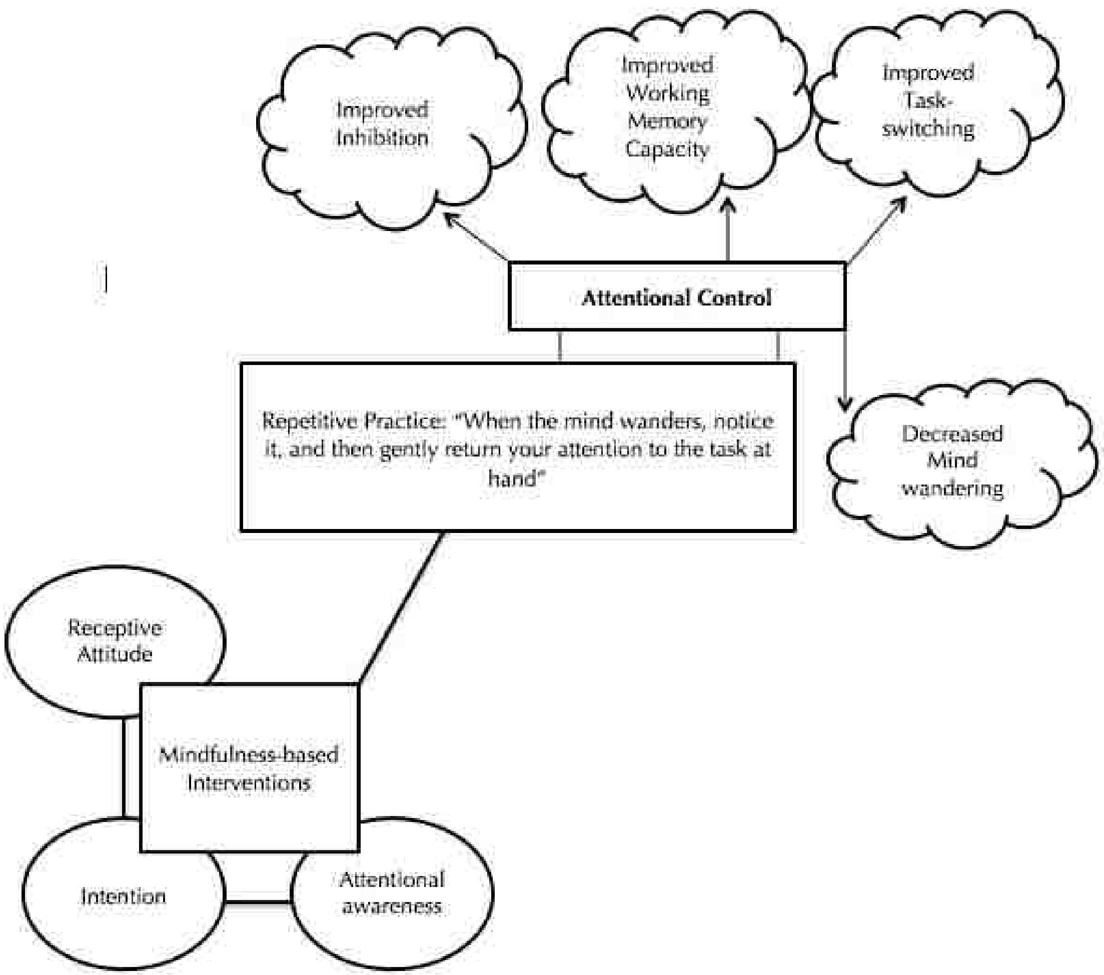


Figure 4. A theoretical model outlining the attentional processes of improvement as a result of mindfulness-based interventions.

Current Study

The current study aims to further investigate which attentional processes are most affected by MBIs. Prior research has singularly examined different components of attentional processing affected by MBI (e.g., Mrazek et al., 2013; Oberle et al., 2012; Anderson et al., 2007). To my knowledge, this is the first experiment that aims to integrate research regarding WMC, mind-wandering, inhibition, and task-switching into one multivariate design. Also, unique to this study is the aim to focus exclusively on the attentional outcomes of MBIs. By understanding attentional processing, this work attempts to further understand how MBIs mediate the relationship between individual attentional ability and outcomes.

Further, this study integrates the use of a comparison and a control group, instead of just a control. Participants in the comparison group will participate in a relaxation-based meditation that engages them in guided imagery; a meditation that encourages students to let their mind wander to a preferred location. As mentioned earlier, MBI provides individuals with a goal to maintain active, conscious attention of the present moment. Arguably, this is a strategy that enables participants to practice controlling their attention. Without providing the strategy or goal, participants will not naturally practice holding their attention in the present consciousness, and eventually will mind wander. As such, participants who do not receive the attentive awareness goal or strategy should not show improvement on later tests of attentional processing. It is the hope that adding the comparison and control group will allow further clarity to why MBIs work so well for improving cognitive performance.

Previous research has used participants that are enrolled in mindfulness-based stress reduction classes, or who have signed up to be a part of an extensive mindfulness intervention that requires hours a day of practice. Recently, however, Mrazek and colleagues (2013) have showed that brief, 8-minute long MBIs have a positive effect on WMC scores. This is relevant to schools, as educators may want to include interventions such as MBIs to provide support for their students. However, finding time in the day to do so is not an easy task. Thus, finding and establishing an evidence-base for brief MBIs may facilitate third-party support for implementation and implementation fidelity. Another important implication of the effectiveness of brief MBIs is their potential to increase learning readiness in students. Learning readiness is defined as a child's ability to show certain skills pertinent to school success. Such skills include the ability to focus, listen, absorb information, do seatwork, and learn in a formal setting from direct instruction (Blaustein, 2005). These skills seem to be related to successful executive and attentional processing. Some children do not develop learning readiness skills at the developmentally appropriate age, and their academic, social, and behavioral life may be adversely affected (Alloway, 2006). However, MBIs may be interventions that can help students develop these skills for learning readiness. Therefore, this study aims to further examine the effects of brief mindfulness-based interventions on components of executive function to discern if MBIs may be helpful for students and other professionals within the realm of education and school psychology.

Research Questions and Hypotheses

The current research aims to establish further evidence that MBIs improve attentional control processes such as WM, inhibition, and task switching, as well as decreasing mind-wandering and negative mood through teaching the strategy of attentive awareness. As such, the overarching research question is as follows:

*Do MBIs increase attentional control as defined by improved Automatic OSPAN, Stroop, and Trail Making Test scores and decreased self-reported mind-wandering compared to participants in the relaxation-based meditation or control group***?**

Specifically, the goal of this experiment was to parse out which process MBI improves attentional functioning. As such, repeated-measures ACNOVAs were conducted with each dependent variable to gauge how each had or had not changed over the course of the intervention. Finally, repeated-measures MANCOVA was conducted in effort to show that MBIs mediate how individual attentional processes may influence a number of student outcomes (i.e. problem solving, reading comprehension, following directions). Consequently, there were six specific research questions:

Research Question 1: Does working memory capacity (as measured by the Automatic OSPAN), change for participants in a mindfulness-based intervention compared to participants in relaxation-based meditations or a control group?

Hypothesis: Participants in the MBI group would demonstrate an increase in WMC as demonstrated by an increase OSPAN scores compared to participants in the RBM and control group.

If MBIs are indeed a strategy-based method of training WMC, the direct instruction of how to return one’s attention to the present moment without judgment would predicate the practice of attentional control. By learning this direct strategy (e.g., noticing one’s mind has wandered and returning it back to the present moment), I hypothesized that individuals involved in this practice would perform better on tests of WMC over time, because they may have learned how to become more focused on the stimuli in the present moment (i.e., engaged in less mind-wandering) than individuals who did not receive the intervention over time. Although practice effects may facilitate improvement on the automated OSPAN over time for all participants, I hypothesized that individuals who receive MBI would show a significant degree of improvement of WMC scores beyond that of practice effects. Further, I hypothesized that individuals in the RBM intervention group would not exhibit a significant change in OSPAN scores over the duration of the experiment. The RBM intervention encourages participants to let their minds wander and to find a safe place for them within their thoughts. As such, after engaging in this intervention, students may have trouble with returning and holding their attention to a complex task like the OSPAN. The purpose of the control group was to simulate every day life, without intervention. As such, without being taught specific skills or given specific instructions, it was expected that individuals would not significantly improve their scores on the automated OSPAN.

H_{Θ}: Intervention type does not change automated OSPAN scores

H_{α}: A specific intervention, MBI, improves OSPAN scores

Research Question 2: Do MBIs change amounts of mind-wandering, as provided by self- report, compared to participants who participate in relaxation-based meditations or a control group?

Hypothesis: Participants in the MBI group would report less mind-wandering than participants in the RBM and control conditions.

Consistent with prior research, individuals who have been exposed to MBIs report less mind-wandering occurrences during a complex task (e.g., Schooler et al., 2014). Given that mindfulness and mind-wandering have been proposed as opposite constructs (Mrazek et al., 2012; Schooler et al., 2014), I hypothesize that participants in the MBI group would report less mind-wandering. If a participant is mindful of the present moment, he or she is unable to be engaged in mind-wandering to internal thoughts or external distractions. The Safe Place guided imagery intervention instructs participants to let their mind wander. As such, it seems logical to predict that engaging individuals in a complex task (i.e. OSPAN) directly after a brief period of mind-wandering may have difficulty transitioning. Consequently, these participants may report more mind-wandering during the complex task, which would be a detriment to their overall performance.

H_{Θ}: Intervention type does not change MW reports.

H_{α}: A specific intervention, MBI, decreases MW reports.

Research Question 3: Do MBIs change self-reported mood ratings (as measured by the PANAS) compared to participants who participate in relaxation-based meditations or a control group?

Hypothesis: Individuals who participate in MBIs would report higher positive affect as measured by the PANAS compared to individuals in the RBM and control conditions.

Recent research shows that individuals who report higher levels of mind-wandering during complex tasks also report higher negative affect on the PANAS (Liehr & Diaz, 2010; Killingsworth & Gilbert, 2010; Schooler et al., 2014). Interestingly, negative affect is not preceded by mind-wandering, but instead, seems to be a side-effect of high amounts of self-reported mind-wandering (Schooler et al., 2014). Thus, it seems as if wandering to future or past thoughts induces negative affect more often than does keeping one's attention focused on the present moment. I hypothesized that individuals who participate in the MBI would report higher positive affect on the PANAS than individuals in the other control conditions. If the RBM and Control intervention conditions do not alleviate mind-wandering, individuals in these group should also exhibit higher levels of negative affect on the PANAS as compared to the control and experimental conditions.

H_{Θ}: Intervention type does not change PANAS scores

H_{α}: A specific intervention, MBI, improves PANAS scores

Research Question 4: Do MBIs change Trail Making Test scores compared to participants who participate in relaxation-based meditations or a control group?

Hypothesis: Individuals who participate in MBIs would improve their ability to switch between tasks, as measured by the Trail Making Test, compared to individuals in the RBM and control conditions. Improvement on task-switching after exposure to MBI has varied between research studies. Heeren and colleagues (2009) found no significant differences in adult task-switching abilities in pre-and-post tests of a Mindfulness-based Cognitive Therapy group versus a wait-list control. These null results were related to two different scores, Part B of the TMT, and the TMT A/ TMT B ratio. However, in a different study older adults showed significant improvement in task-switching after completion of a MBSR program. Their TMT A/ TMT B ratio score significantly improved over time compared to a wait list control group (Moynihan, Chapman, Klorman, Krasner, Duberstein, Brown, & Talbot, 2013). As such, there is certainly potential for task-switching to be improved by MBI. Due to the improvement in a specific population of older adults, there is a need to further investigate and understand how task-switching may be improved in populations in different stages of cognitive development (Gallant, 2016). As such, it is important to understand if children and young adults are also able to improve their task-switching abilities while they're still in a malleable stage of brain development.

H_{Θ}: Intervention type does not change TMT scores

H_{α}: A specific intervention, MBI, improves TMT scores

Research Question 5: Do MBIs change Stroop task scores compared to participants who participate in relaxation-based meditations or a control group?

Hypothesis: Individuals who participate in MBIs would improve their ability to inhibit distraction, as measured by the Stroop Task, compared to individuals in the RBM and control conditions. Previous research differs in their findings using the Stroop to measure inhibition levels in adults after exposure to MBI. Anderson and colleagues (2007) found no change in performance or reaction time in Stroop inhibition scores between a group that was exposed to MBI and a wait-list control group. However, other researchers have found significant improvements on Stroop performance after exposure to MBI. Allen and colleagues (2012) found that adult participants (mean age = 26) randomly assigned to a two hour in duration, six-week long mindfulness group, showed a reduction in Stroop conflict on and affective Stroop measure, as compared to a group who was given readings (2012). In a different study, people experience with MBI showed enhanced Stroop performance compare to non-meditators (Moore & Malinowski, 2009). Teper and Inzlicht (2013) also found higher Stroop scores for adults who practiced meditation or MBI over those who had not. All in all, it seems that adults' inhibition scores, as measured by the Stroop task, are positively correlated with mindfulness practice (Gallant, 2016). Arguably participants aged 18-25 should show the same improvements in interference reduction and increased inhibitory skills.

H_{Θ}: Intervention type does not change Stroop scores

H_{α}: A specific intervention, MBI, improves Stroop scores

Research Question 6: Is there a relationship between intervention type and changes in automated OSPAN scores, Stroop scores, Trail Making scores, mood ratings, and self-reported mind-wandering after exposure to MBIs?

Hypothesis: Participants in the MBI group would show a greater increase in OSPAN, Stroop, Trail Making scores, and mood ratings; as well as a decrease in mind-wandering scores, as compared to individuals in the RBM and control conditions.

Preliminary research has shown that mindfulness and mind-wandering are opposite constructs (see Mrazek et al., 2012; Schooler et al., 2014). Specifically, Mrazek and colleagues (2012) found a negative relationship between scores on the automated OSPAN and reported amounts of mind-wandering, indicating that one cannot be mindful and mind-wandering at the same time. I hypothesize that individuals who receive MBIs would increase their attentional awareness. Consequently, scores on tests of attention should exhibit an increase while reported mind-wandering would decrease.

H_{Θ}: Intervention type does not change attentional task, mood ratings, or reported levels of mind-wandering

H_{α}: A specific intervention, MBI, increases attentional task scores and mood ratings, as well as decreases Mind-wandering over time

Chapter III: Method

Method

Experiment Overview

Attentional control is a skill that is indicative of an individual's ability to perform complex tasks. It is a core component of an individual's working memory, a cognitive construct indicative of success in several areas (e.g., Barrett, Tugade, & Engle, 2008). Individuals who have poor attentional control score lower on tests of WMC, like the automated OSPAN (Kane & Engle, 2007), report higher levels of negative affect on the PANAS and more incidences of self-caught mind-wandering (Schooler et al., 2014). Conversely, evidence shows that MBIs have a positive effect on PANAS scores (Schooler et al., 2014), reduce reported mind-wandering (e.g., Mrazek et al., 2012), and increase automated OSPAN scores (Mrazek et al., 2013). Understanding the precise cognitive processes underlying improvement in attentional control as a result of mindfulness-based interventions would help contribute to a more parsimonious understanding of intervention effects.

The current experiment recruited 123 undergraduate students to participate in this study. Participants completed a number of measures including: (1) the Automated OSPAN (Unsworth, Heitz, Schrock, & Engle, 2005), (2) the Positive and Negative Affect Schedule, (PANAS; Watson, Clark, & Telegen, 1988), (3) the Wechsler Test of Adult Reading (WTAR; Spreen & Strauss, 1998), (4) The Mindful Attention & Awareness scale (MAAS; Brown & Ryan, 2003), (5) computerized probes of self-reported mind-wandering (McVay & Kane, 2009), and (6) a demographic information sheet developed by the researcher. The MAAS and WTAR were analyzed as control variables because intelligence levels and trait mindfulness are correlated with individual WMC (Brown & Ryan, 2003; Schooler et al., 2014).

The experiment took place over the span of 6, 30-45-minute long sessions that were scheduled 5-10 days after the previously scheduled session. Participants were randomly assigned to one of three conditions: Mindfulness-Based Intervention (MBI), Relaxation-Based Meditation (RBM; i.e., a meditation that does not instruct participants to focus their attention on the present moment), and a control condition (reading a selected article printed from an online magazine). MBIs engage individuals in an active goal; to keep their attention on the present moment, and if they find that their mind wanders, to return their attention back to the present moment in a non-judgmental and accepting way (Kabat-Zinn, 2003). However, some relaxation based meditations, and specifically the Safe Place guided imagery meditation that was used in this design, instruct individuals to relax and let their minds wander to a safe or preferred place in their minds (Genevieve, 2012). These instructions should *not have* activated the goal of mindfulness, because they do not instruct the individual to keep their attention in the present moment, and return their attention to the present in the presence of distraction. Individuals in the control condition were asked to read the newspaper, an activity that is representative of a task without an explicit goal.

Participants completed the Automated OSPAN, PANAS, WTAR, MAAS, Stroop, TMT and demographic measures during the initial session, and the Automated OSPAN, PANAS, Stroop, TMT, and mind-wandering probes in the fourth and sixth (final) session. Participants were administered the measures three times to investigate the possibility of an effect after only brief exposure to intervention and then again after the intervention period was complete.

Experiment Variables

The purpose of this experiment was to examine how MBIs affect attentional processes over time. Specifically, the attentional processes of WMC, inhibition, and task-switching were included in subsequent analysis. Individual WMC is highly related to individual levels of intelligence, mind-wandering, and affect (Schooler et al., 2014). As such, these variables also were included in data collection and analysis. Ultimately, multivariate analysis examined change in five different outcome scores over time. The independent variables are (a) intervention group at three different levels: experimental, comparison, and control; (b) mindful attention and awareness scores; (c) affect scores; and (d) intelligence scores. The dependent variables are (1) working memory scores (2) inhibition scores, (3) task-switching scores over the duration of the experiment (4) mind-wandering probes, and (5) mood ratings.

Participants

The overarching goal of investigating whether MBIs lead to improvement in specific components attentional processing better than relaxation (or no) interventions was to extend this line of research into school-aged children. However, this line of research is relatively novel, and initial investigation and validations of this theory warranted further support. Research shows that performance on tasks of working memory plateaus between the adolescence and early adulthood, suggesting that results derived from undergraduates may be like those of high school students (Blakemore & Choudhury, 2006). As such, it is feasible to generalize the current experiment's findings to high school populations. Ideally, this would be the first experiment in a line of research demonstrating the effects of MBIs on attentional control as well as student WMC, and further studies would focus on establishing evidence within younger age conditions.

Participants were recruited through the SONA Experiment Management System (SONA), a computer-based research enrollment system used by the university. The SONA system is a cloud-based website that is designed to manage research-based participation and delegate credited research participation in an efficient way. Each student who completed all sessions of the experiment were awarded 8 research credits, the maximum amount of credits need for course completion. Conversely, students who were not introductory psychology students, but were involved in other undergraduate psychology classes could participate in the research to earn extra credit from their professors.

Participants and Attrition

Upon approval of the Institutional Review Board (IRB) for the Protection of Human Subjects in Research, participants aged 18-25 (*n*=123) were recruited to participate in this research through the introductory psychology course, as well as other undergraduate psychology courses in a university located in the Rocky Mountain region. Five participants were excluded from analysis due to violation of the age restrictions, leaving the final participant count at *N*= 118 (see Table 2).

Over the course of the experiment, many participants dropped out of the experiment. It is believed that the repeated-measures design created fatigue for some students, who chose not to finish the experiment. Additionally, researchers credited participants with their needed credits after each singular session was completed. As such, if there were people who completed their needed credits for the semester, some chose not to finish the experiment. This is believed to be the main cause of the high attrition rates. As such, n = 59 participants dropped out of the study during various sessions, resulting in an 50% attrition rate, and only *n*= 59 participants who completed the entire repeated measures design.

Demographics

All Participants (*n=123)* in this data set were undergraduate students, ages 18-25. Due to researcher error, four participants completed their second OSPAN, Stroop, and TMT measures in the third session, instead of in the fourth. These participants were still determined eligible for inclusion in analysis. Five participants were excluded from analysis due to not meeting the inclusion criteria, such as being older than the age requirement, leaving the initial participant count at *N*= 118. A complete summary of demographic information see Table 1. All in all, most participants were between the ages of 18-20, female (75% of respondents), had previous experience with mindfulness-based intervention (70% of respondents, e.g., yoga, meditation), and practiced mindfulness approximately once a week (46% of respondents).

Due to attrition rates, there was a significant amount of missing data within the data set. Not only did participants often drop out at some point during the experiment, but also sometimes would not complete data collection through accidental error, choosing deliberately not to answer certain questions, or through experimenter or technological error. Missing data was addressed through list-wise deletion methods.

Conditions

Participants were randomly assigned to one of three experimental conditions. Participants in the first experimental condition participated in Mindfulness-Based Intervention (MBI), participants in the comparison condition participated in Relaxation-Based Meditation (RBM), and participants in control condition received no intervention. Instead, participants in the control condition were asked to read a magazine article while listening to white noise for an equal duration of time.

Experimental condition. Participants in the experimental condition received 6-sessions of MBI training, each approximately 8 minutes in duration. Participants in the experimental condition received a pre-recorded mindful breathing meditation. Mindful breathing meditation is thought to be fundamental to mindfulness practice, and therefore, is the core of most MBIs (Grossman, 2010; Renshaw, 2012). The mindful breathing meditation was specifically chosen for this experimental condition because it is one of the most basic components of most MBIs. This practice of locating the breath in the present moment can also be completed while sitting quietly at the testing station. Breathing meditations are typically practiced for two to forty-five minutes and can be implemented in a group or individual setting. The intent of mindful breathing meditations is to develop attentive awareness to the present moment, using the breath as an anchor (Renshaw, 2012; Smalley & Winston, 2010). Often, individuals struggle to reign in their thoughts during mindful breathing practice because other stimuli like smells, sounds, or wandering thoughts sidetrack them. When this occurs, individuals are encouraged to bring mindfulness to situation by acknowledging and categorizing the thought (e.g., worry about future) and returning their attention to the present moment nonjudgmentally (Kabat-Zinn, 1990). Easier said than done, mindful breathing meditation becomes more difficult to engage in the more distracted individuals become. As such, mindful breathing meditation encourages individuals to approach their experiences with a non-judgmental attitude, and retrain themselves to reorient their attention without negative affect or judgment (Renshaw, 2012).

All that is necessary to perform a breathing meditation is a quiet room where one can sit comfortably in a chair. Breathing meditations begin by asking the participant to be still and locate the sensation of breathing in their bodies (Renshaw, 2012). Once they have located their breath sensation, individuals are asked to pick a place in their body, like their nostrils, chest, or stomach, to feel their movement of breath. As individuals are guided through the meditation, they are advised that if their mind gets distracted, to return their focus of attention to their breath without judgment.

Table 2.

Demographic Information for Participants: Means, Standard Deviations and Percentages for Age Gender and Previous Exposure to Mindfulness-based Interventions

Demographics	N	*M*	*SD*	Percentage of Participants
Age	87	20.11	1.94	
Gender	118	1.77	.48	
Male	29			24.8%
Female	88			74.6%
Transgender	1			0.8%
Previous Exposure to Mindfulness Practice	117	1.3	.46	
Yes	82			69.5%
No	35			29.7%
Frequency of participation in Mindfulness Activities				
Once a week	37			46.3%
2-3 times a week	30			37.5%
4-5 times a week	10			12.5%
more than 5 times a week	3			3.8%

The meditation script alternates between guiding individuals to focus on the feelings and sensations of their and encouraging individuals to notice when their mind wanders from their breathing for the designated duration (see Appendix A). Participants received a manipulation check after participating in the intervention. This check probed the participants regarding their engagement in the activity, and the extent to which they felt they extended effort (See Appendix).

Comparison condition. Participants in the comparison condition participated in relaxation-based meditation (RBM) called Safe Place. This meditation was similar to duration to the mindful breathing practice (8 minutes). Safe Place meditation encourages the "letting go" of the mind through creating a safe and peaceful place in your imagination. The process of letting the mind "go" to a place of imagining or creativity encouraged the individual to engage in mind-wandering, and depart from the present moment of awareness or conscious attention (Genevieve, 2014; see Appendix B for a guided script).

Relaxation-based meditation was chosen as the comparison condition because the goal of the intervention differs from MBI. Guided imagery instructs individuals to relax, and to let their minds wander to a safe or preferred place in their minds (Genevieve, 2012). These instructions should *not* activate the goal of mindfulness, because they do not instruct the individual to keep their attention in the present moment, and to return their attention to the present in the presence of distraction. Consequently, meditation that encourages the mind to drift away from the current moment may be opposite to the goal of MBI. Including a comparison condition that parses out differences between active, present-focused meditation to meditation that does not include the key components of mindfulness practice (i.e., sustained attention in the present moment; non-judgmental attitude) was essential for a richer understanding of the processes underlying successful intervention. Thus, including an intervention that does not facilitate attentional control may contribute data that further demonstrates advantages of the interventions focused on active attention over those that encourage ‘escape’ (Renshaw, 2012; Schooler et al., 2014)

The comparison group interventions, therefore, were designed to remove specific elements of MBI that were thought to be the most influential on improvement throughout the intervention. The experimental group received the full MBI, an intervention that encourages active attention, non-judgmental approach to practice, and cultivating intentional practice. Further, the comparison group removed two aspects of MBI: the instruction of active, controlled attention, as well as the removal of prompts for practicing without judgment. Participants in the comparison group were still be encouraged to practice with the element of intention, as full participation in the general meditation required a goal for completion.

Control condition. Some emerging experiments in this domain have included the use of an inactive control group, with which to compare intervention effects with natural improvement across time (Jensen et al., 2011, Mrazek et al., 2012). As such, participants in the control condition did not receive any component of mindfulness-based intervention. Participants assigned to this group were encouraged to read an article, an activity that is thought to require attention, but is not taxing enough on participants to the point in which they would be extending significantly more mental effort than the meditation conditions. This technique has been used in one prior study examining the relationships between mind-wandering and MBI, which serves as a model to this research (Mrazek, Smallwood, & Schooler, 2012). After engaging in this task, individuals would be administered the OSPAN; mirroring the procedures used for both meditation comparison conditions. This control condition would remove all three components of MBI: intention, non-judgment, and attention. Consequently, it is the hope that removing the components of MBI results in data from the control condition that accounts for change in WMC because of natural practice and learning effects. Hopefully, these results would aid in further establishing the exact components of the intervention that influences change in attentional processing across time.

Experimental Procedure

Once participants consented to participate in the study, they were randomly assigned to one of three conditions (MBI *n*=41; RBM *n*= 41; Control *n*=41). Inclusionary criteria included individuals who consented to participate between the ages of 18 and 25, due to the similarity of executive functioning development of high school students and function during that age (Blakemore & Choudhury, 2006).

The current experiment examined improvement in WMC after exposure to intervention. Thus, how high or low everyone's WMC score was not necessarily grounds for exclusion from analysis. However, following OSPAN guidelines, participants who commit more than 15 math errors (85% accuracy criterion) on the Automated OSPAN task were excluded from the analysis (Unsworth, Heitz, Schrock, & Engle, 2005). No participants involved in this study met this criterion, so no participants were excluded from analysis based on their OSPAN scores. Further, participants who indicate on the demographics form that they had suffered mild to moderate TBI or lived with significant cognitive delay (*n* = 0) were excluded from analysis; as such conditions may have slowed or hindered cognitive improvement. Students who reported being diagnosed with ADHD were not excluded from analysis, as MBI has been shown to facilitate improvements in regulatory outcomes in individuals with ADHD (e.g., Van de Weijer-Bergsma, Formsma, de Bruin, & Bögels, 2012). Those who were excluded from analyses were provided information about the study and regarding mindfulness and resources that they could explore online, on campus, or in the community.

In the first session, participants were introduced to the research assistant and given an informed consent form (see Appendix I). Participants were told that they were participating in a study titled the Attention and Relaxation Techniques (AaRT) Project. After consenting, participants were administered the OSPAN probe and then 6 separate measures. The *Wechsler Test of Adult Reading* (WTAR), *The Trail Making Test* (TMT), and the Stroop Test were administered orally, as per standardization instructions. The *Positive and Negative Affect Schedule* (PANAS), the *Mindful Attention Awareness Scale* (MAAS), and the demographic measures were administered electronically via the Qualtrics data and surveying program. Due to the possibility that stereotype threat may be activated by demographic questionnaires and subsequently affect performance on working memory tasks (Steele, 1997; Hutchison, Smith, & Ferris, 2013; Steele, 1997), participants engaged in the OSPAN task directly after signing informed consent and then completed the subsequent measures. Following the first session, participants attended 5 more 25- to 40-minute intervention sessions per week for a total of six weeks. In other words, participants completed the intervention (i.e., MBI, RBM, control) a total of six times. The total duration of the experiment lasted no longer than six sessions in an eight-week period for each participant.

Throughout the duration of the intervention sessions, participants entered the research lab, sat down at their computer station, and began their randomly assigned intervention. After engaging in the intervention, participants completed three measures, a mind-wandering probe, a manipulation check, and the PANAS. They were encouraged to sign-up for their next session before leaving. During Session 4, participants also completed the OSPAN, TMT, and Stroop to obtain a mid-point scores. The final session took place after participants completed all five other sessions. During this final session, individuals completed a final OSPAN test, TMT, and Stroop task that served as post-intervention scores of attentional processing. After completing the final OSPAN, participants completed their final measures including the PANAS, manipulation check, and intervention acceptability measures. Participants were then debriefed. Figure 5 demonstrates each phase of the experiment.

Figure 5. Illustration of Experimental Procedures.

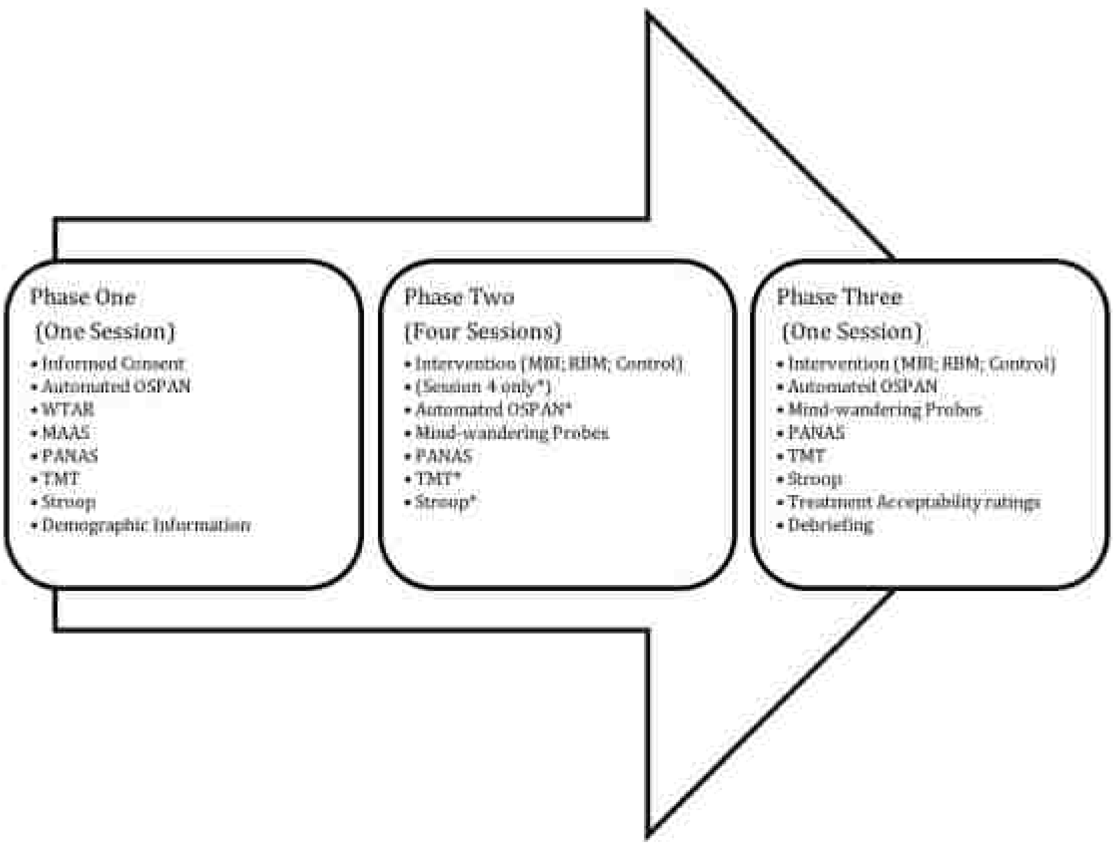


Figure 5. The flow of the experimental procedures each participant would complete. The * denote which measures would be provided in session four, in contrast to sessions two, three, and five.

Experiment Materials and Measures

This study was approved of the Institutional Review Board (IRB) for the Protection of Human Subjects in Research. Participants completed the experiment on desktop computers at individual workstations located in the psychology department on the university campus. Dependent on room availability, up to 6 participants could engage in their assigned intervention during the same thirty-minute period. The room in which they participated in the experiment was approximately 20’ X 15’ in size and the experimental workstations are in separate smaller 7’ X 5’ rooms with doors to ensure privacy and quiet. Within this smaller, semi-private room, each participant was seated on a hard-backed wooden chair and at a desk that housed a computer.

Each workstation included a pair of on-ear headphones that the participant wore to complete the experiment. The on-ear headphones fit to minimize background noise, which is advantageous when in a setting that may have, at times, included unavoidable background noise. The headphones possessed a minimal frequency range of 12 Hz-22, 000 Hz so that participants could audibly process all aspects of the recorded intervention. The headphones had a connecting cord of at least 1-meter-long so that the participant could find a restful position in which to sit. After choosing their preferred position, participants in the MBI and RBM conditions were instructed to listen while the audio recording of the intervention began. To control for differences in auditory experience, participants in the control condition were asked to wear earphones that were playing white noise.

Instruments and Measures

Working memory capacity. Participants completed the shortened Automated Operations Span (OSPAN) task, which is a shortened version of the psychometrically valid and reliable indicator of working memory capacity (Foster, Shipstead, Harrison, Hicks, Redick & Engle, 2014). Unsworth and colleagues (2005) developed the automated OSPAN task as a reliable, valid and automated (i.e., easily administrable in the field) tool that measures individual WMC. This automatic WMC task allows for less experimenter bias, paces the task directly based on individual performance, and records a variety of measures for analysis (Unsworth, Heitz, Schrock & Engle, 2005).

The shortened automated OSPAN task consists of three practice trial sessions and the testing session. In the first practice section, participants are trained on the first aspect of the OSPAN task, the letter span. During the letter span task, a letter appears on the computer screen for 800 millisecond intervals, and participants are required to recall all the letters they are presented (Unsworth et al., 2005). At recall, participants are presented a matrix of twelve letters, and they must click the box next to the letter that was presented, in order of appearance.

The second task trains participants on the math portion of the task. Participants are presented a math operation. For example, a participant may be presented a problem: (3*2) +1 = ?. The participant is then instructed to solve the problem as quickly as he or she can while clicking the mouse to advance to the next screen (Unsworth et al., 2005, pg. 500). The next screen presents a digit (e.g., 7) and participants respond by clicking *True* or *False*, depending on their answer.

The trial period of the math span serves two functions. First, the trial period serves to familiarize participants with the math task. This familiarization is important because it would allow for less error during the final testing trial. Second, the investigator can record reaction time data and calculate how long it takes for each participant to solve the problem. Specifically, after the math span practice, the computer program calculates everyone's mean time required to solve the equation, adds to it 2.5 standard deviations of the time, and then uses the calculated time as the time limit for the math portion of the testing session (Unsworth, et al., 2005).

The final practice session combines the letter and math span, just as it does in the actual trial. After completing the series of practice sessions, the final test consists of 75 letters and 75 math problems that are presented in "sets" of three to nine. This means that while doing the actual testing portion of the OSPAN, participants would be required to solve three to seven sets of math and letter spans before being asked to recall the letters. To ensure that participants are attempting both math and letter spans, an 85% accuracy criterion is imposed on the OSPAN. The shortened version of the test that was used cut the number of practice and test trials by 67%, and still found 90% of variance of measurement accounted for, which means the shortened OSPAN can maximize accuracy while minimizing time demands for testing (Foster et al., 2014).

The automated OSPAN provides different scores for analysis. The Number Correct (TNC) score reports the total number of letters that were recalled in the correct order during the trials. The other measures are error measures and center around the total number of math task errors, speed errors (e.g., # of times the participant ran out of time before solving the math span), and accuracy errors (e.g., # of wrong math answers). Overall, the shortened OSPAN took about 20-25 minutes to complete. The OSPAN is a reliable and valid indicator of WMC that can be applied to several research domains. Specifically, the automated OSPAN's internal consistency is 0.78, and is highly reliable in test retest samples (α=.83; Unsworth, Heitz, Schrock, & Engle, 2005). As for validity, the automated OSPAN has been found to be predictive of higher-order cognitive abilities and low-level attention abilities (McVay & Kane, 2009; Redick, Broadway, Meier, Kuriakose, Unsworth, Kane, & Engle, 2012).

Cognitive Flexibility. The *Trail Making Test* (TMT; Reitan, 1958) is one of the most widely accepted and used neuropsychological test that provides data regarding individual cognitive flexibility, scanning, speed searching, and executive functions (Tombaugh, 2004). The TMT typically took less than three minutes to complete. First, the two-part test instructed individuals to draw lines that connect 25 encircled numbers distributed across a sheet of paper (see Appendix). Then, on the second part of the task, individuals are told to alternate the connecting lines between letters and numbers (Tombaugh, 2004). This instruction requires individuals to switch task goals in their minds from simply connecting numbers, to alternating between numbers and letters (i.e., 1, A, 2, B, 3, C). Individuals are instructed to connect the circles as quickly as they can, without lifting the pen from the paper. As they are completing the activity, the assessor is timing them and would correct them if they make an error (i.e., connecting the line to a circle that is not the next in sequence). They can correct the errors, but these errors affect their timing scores. Including the TMT would enable further understanding of which processes if change in WMC and cognitive processing is due to the strengthening of attentional processes that facilitate ease of switching attention between two different tasks with different instructions; a skill necessary to academic and career success. Reliability was calculated for the current study using Cronbach's alpha, with Trail Making A (r = .793), and Trail-Making B (r= .763).

Inhibition. The *Stroop Task* (1935) is a demonstration of inhibitory processing through the requirement of reacting to opposing instructions or tasks. The Stroop Task required participants to read the name of a color (e.g., "blue", "green", or "red") printed on screen. Sometimes, the color name is shown in congruent ink, but sometimes it is printed in a color not denoted by the name (e.g., the word "red" printed in blue ink instead of red ink). Typically, naming the color of the word takes participants a longer amount of time and leaves them more prone to errors than when the color of the ink matches the name of the color. The Stroop task is one of the most widely accepted valid and reliable measures of cognitive performance, and has been used in research since 1935 (see Macleod, 1991). The Stroop task is informative to this project because of response inhibition (i.e. inhibiting the wrong color response; saying red when the ink is blue). Inhibiting automatic, unwanted responses demands a high amount of controlled attention to maintain task goals (Lamers, 2010). As such, MBIs may better enable participants to be more efficient at inhibiting the wrong responses, and focusing on the task at hand.

Intelligence. The *Wechsler Test of Adult Reading* (WTAR) is a brief assessment tool that provides an estimation of an individual's intellectual and memory abilities. The WTAR is the only reading assessment that is normed with the *Wechsler Adult Intelligent Scale* and *Wechsler Memory* scales, meaning that the WTAR serves as an effective method for predicting full-scale IQ and memory performance (Spreen & Strauss, 1998). Although the WTAR is most often used as a measure for pre-morbid neurological decline (e.g., Alzheimer's disease), it is incorporated in the present research as another way to assess participant intellectual abilities in conjunction to the OSPAN.

The WTAR takes approximately 5 minutes to administer and complete. The test is composed of 50 irregularly spelled words. The administrator would present a word card and prompt the participant to recite the word with proper pronunciation until all 50 words have been attempted. If the participant mispronounces 12 consecutive words, the administration of the WTAR is over. Each correct pronunciation is given a score of 1, with 50 as the maximum raw score. The raw score is standardized by age and compared to the scores predicted for the participant's demographic classification (Donnell, Pliskin, Holdnack, Axelrod, & Randolph, 2007). In standardized samples, WTAR scores were shown to correlate highly with measures of verbal IQ (r = .75), verbal comprehension (r = .74), and full scale IQ (r = .73; Spreen & Strauss, 1998). Further, the WTAR's validity was found to be stable from assessment to assessment (r = 0.97*;* Green Melo, Christensen, Ngo, Monette, & Bradbury, 2014).

Using WTAR scores in conjunction with OSPAN scores may help inform data analyses of the current project. Typically, high WMC scores are strongly correlated with scored of general intelligence. Further, individuals with pre-existing specific learning disorders were found to perform poorly on the WTAR relative to those without learning disorders (Donnell et al., 2007). As previously mentioned, those with learning disorders often have lower WMCs (Alloway et al., 2009). As such, WTAR scores may help to strengthen the validity that participant OSPAN scores are indicative of their abilities in non-experimental settings.

Mindful attention and awareness. The *Mindful Attention and Awareness Scale* (MAAS) is a 15-item measure that was constructed to assess dispositional mindfulness, which is defined as an innate state of consciousness characterized by the presence or absence of awareness regarding what is occurring in the current moment (Brown & Ryan, 2003). Individuals are asked various questions assessing the extent to which that person attends to their present experiences without distraction (e.g., *I drive places on "automatic pilot" and wonder why I went there*; Schooler, Mrazek, Franklin, Baird, Mooneyham, Zedelius, & Broadway, 2014). Individuals were asked to rate the frequency of each question on a 6-point likert-type scale in a way that truly reflects their experience, and not just what they think their experience should be (Brown & Ryan, 2003). Higher scores on the MAAS are an indicator of higher levels of trait mindfulness, and in turn, lower levels of self-reported mind-wandering within the individual (see Schooler et al., 2014). The MAAS would be administered to participants electronically via the Qualtrics data and surveying program.

Through a series of psychometric development studies, the MAAS exhibited good internal consistency ($\alpha \geq .82$), strong four-week test–retest reliability (interclass $r = .81$), and was positively correlated with number of years of meditation practice ($r = .36$, $p < .05$; Brown & Ryan, 2003). Scores on the MAAS were also significantly higher among individuals who have had experience with meditation relative to individuals who had no experience with mindfulness practice (Cohen's $d = .50$; Brown & Ryan, 2003). The MAAS seems to be the most well accepted trait mindfulness scale available for use in the literature. In fact, the MAAS has been cited in over 3,000 peer-reviewed articles, and its inclusion in mindfulness research seems to be a standard amongst researchers (Schooler et al., 2014). Including the MAAS in the current research would be useful in analyzing the relationship between the variables of mindfulness and higher levels of WMC. As prior research demonstrates, participants who are included in the MBI experimental group or who have experience with meditative practice should score higher on the MAAS (Mrazek et al., 2012). Reliability was calculated for the current study using Cronbach's alpha, ($\alpha = .853$).

Demographic information. A 10-item questionnaire was developed for this study, and was administered electronically via the Qualtrics data and surveying program. Participants were asked to provide their age, gender, ethnicity, and area of origin (see Appendix H). Participants were also asked if they have had prior exposure to meditative practice. Research has shown that long-term meditators have strengthened neural pathways that correlate to areas of the brain associated with executive functioning (Brefczynski-Lewis, Lutz, Schaefer, Levinson & Davidson, 2006). Potentially, these data can be analyzed to further understand the relationships between mindfulness interventions and higher OSPAN sores. Prior research (e.g., Alloway et al., 2009) has also shown that individuals who score lower on tests of WMC have higher incidence of learning difficulties or mental health issues. As such, questions about participants' prior special education eligibility, if they are currently using disability school services through the university, and if they suspect they may have learning or emotional disability, were included to inform data analyses.

Mind-wandering. Participants were asked to participate in a Self-Catching Task that asked them to indicate their frequency of mind-wandering during the experiment. Participants were administered the mind-wandering probe in sessions two through six of the experiment, and the data from session two, four, and six were included in the present analysis. After the participant is finished with the intervention (and, in session 4, the attention measures), a computer-based probe of mind-wandering were be introduced. This probe instructed students to think back to the activity they just completed (i.e., the intervention) and report what they were thinking about in the moments prior to filling out the measure. Participants first answered the question, "In the moments prior to this probe, was your attention focused," (a) *completely on the task*, (b) *mostly on the task*, (c) *on both the task & unrelated concerns*, (d) *mostly on unrelated concerns,* or (e) *completely on unrelated concerns*. Next, participants reported what they were thinking about through indicating one of the following choices: (a) *task*, (b) *task performance*, (c) *everyday stuff*, (D) *current state of being*, (e) *personal worries*, (f) *daydreams*, or (g) *other* (McVay & Kane, 2009).

Self-report mind-wandering probes also demonstrate strong external validity and reliably predicting a host of changes in individuals. These include behavioral markers such as gaze duration (Reichle, Reineberg, & Schooler, 2010), reaction time (Cheyne, Solman, Carriere, & Smilek, 2009), and performance errors (see Mrazek, Franklin, Phillips, Baird, & Schooler, 2013; Schooler et al., 2014; Smallwood et al., 2004). Further, Schooler and colleagues have found that self-reported mind-wandering can also predict changes in physiological measures such as pupil dilation (Smallwood et al., 2011) and heart rate (Smallwood et al., 2004), as well as in brain activity as exhibited by functional magnetic resonance imaging, electroencephalograms, and event-related potential techniques (Smallwood et al., 2014). Internal consistency of self-reported mind-wandering probes is considered strong, with α =.885 (McVay & Kane, 2009). Reliability was calculated for the current study using Cronbach's alpha, (α = .716).

Of specific interest to this experiment is the initial research that shows there is a negative association between MBIs and self-reported amounts of mind-wandering during tasks that require sustained attention (Mrazek et al., 2012; Schooler et al., 2014). Mrazek and colleagues (2012) found that an 8-minute long MBI reduced indicators of self-reported mind-wandering in participants to a significantly higher degree than participants who were involved in a passive relaxation or reading activity. It is the purpose of this research to replicate these findings in effort to build support for the hypothesis that MBIs reduce mind-wandering events and facilitate higher WMCs in participants.

Mood. Following the intervention, participants completed the Positive and Negative Affect Schedule electronically via the Qualtrics data and surveying program (PANAS; Watson, Clark, & Telegen, 1988). The PANAS is a 20-item measure that consists of two, 10-item scales that measure the individual's current positive and negative affect. The items on the scale are twenty words (e.g., *guilty, alert, active*), and participants were asked to rate to what extent they felt a certain way in the present moment from 1 (*very slightly* or *not at all*) to 5 (*extremely*). Past research shows the PANAS exhibits high internal reliability for both the positive affect part of the scale (α = 0.90) and the negative affect part of the scale (α = 0.84-0.87). The PANAS also has moderate to high test-retest reliability, which is considered stable for measures of affect that generally stabilize and increase in reliability over time (Watson, Clark, & Tellegen, 1988). As for validity, the PANAS has high internal validity, with affect scales strongly showing item validity and low correlations to the opposite affect scale The PANAS also showed high external validity to measures of related constructs of anxiety, depression, and general psychological dysfunction (e.g., Beck Depression Inventory; Watson, Clark, & Tellegen, 1988). Reliability was calculated for the current study, and The *Positive and Negative Affect Scale* was also reliable across domains, showing overall reliability (α = .844); positive affect scale (α =.889) and the negative affect scale (α = .843).

Interestingly, recent research has shown that mind-wandering typically induces more negative affect in individuals (Schooler et al., 2014.) As such, having data that lends insight to participants' rates of negative affect and its relationship to WMC may support the validity of the hypothesis of attention and MBI.

Chapter IV: Results

Results

This experiment investigated which attentional processes may be most affected by repeated exposure to brief MBIs. This experiment integrated WMC, mind-wandering, inhibition, task-switching, and mood measures into separate repeated-measures ANCOVA, as well as a multivariate repeated-measures ANCOVA to understand how MBIS may affect the relationship between individual attentional abilities and intervention outcomes.

Preliminary Analyses

Missing data. There was a significant amount of missing data within the data set due to attrition. Multiple factors accounted for the missing data, including an item non-response on a single or multiple survey tools, a mid-response dropout by a participant on one of the questions (e.g., not completing the PANAS probe), human error by either the participant or research assistant, or computer or software failure. The pattern of the missing values is quite arbitrary, with missing data occurring in any of the variables at any given time during the duration of the experiment. When data is missing at random, researchers suggest list-wise deletion or multiple imputation for the most accurate results (Boyko, 2013; Cheema, 2014). As such a missing value analysis was conducted through available SPSS software. This tool described the pattern of missing data, where the data was located, and how extensive and extreme the missing data was. Analysis showed a 50% attrition rate in recorded Stroop, TMT, and OSPAN data by session 6, in which these measurements were key. Models of multiple imputation are not yet available for repeated measures MANCOVA design. Therefore, list-wise deletion was used for data analysis even though losing all the missing data through complete list-wise deletion lead to lower powerful results that may be more biased. Additionally, sample sizes were drastically reduced and validity and reliability must be carefully considered during interpretation (Boyko, 2013).

Nonetheless, the nature of the completed data using list-wise deletion allows the researcher to see preliminary data of the experimental premise and design.

Standardization. For each analysis, scores were centered around the mean of the measure score. When data is centered, the scale in which it is measured stays the same and the values change. The scale is shifted so that the mean value is zero, and each unit is scaled to one (Field, 2009). The intercept changes, but the regression coefficient for that variable will not, allowing each scale to be more easily interpretable and understood on a normal distribution. Specifically, all outcome variables: 1) OSPAN total correct scores, 2) Stroop reaction time and accuracy scores, 3) TMT timed scores, 4) PANAS positive affect scores and negative affect scores, and 5) mind-wandering probes were standardized for outcome comparison. The covariate scales, MAAS and WTAR were also centered around the mean.

Correlations. Pearson correlation analyses were conducted to determine if the WTAR scores correlated with Total OSPAN Scores across sessions (see Table 3). WTAR scores and OSPAN scores were significantly positively correlated across session one (r = .26, p = .005), and session four (r = .25, p = .03). However, WTAR scores and OPSAN scores for session six were not significantly correlated, (r = .19, p = .183). Of note, the WTAR is scored through calculating standardized scores for age conditions 18-19 and 20-24. Twenty-nine participants did not indicate their age on the demographics form. Thus, their WTAR scores were determined using the average age (M= 20.11, SD = 1.94). Although this addition may affect the validity and reliability of the results, it was considered appropriate due to the number of participants who omitted submitting their age but completed the experiment.

Initial analyses of differences across conditions. One-way ANOVAs were conducted to examine differences based on age, gender, trait mindfulness, mood, WTAR scores, Stroop accuracy scores, TMT B scores, and OSPAN total correct scores between conditions. There was a significant age difference between conditions *F* (2, 84) = 7.61, *p* = .001, where participants in the RBM condition (*M*= 19.13, SD = 1.34*)* were significantly younger than those in the MBI (*M* = 20.61, SD = 1.78) and Control (*M*= 20*.75, SD* = 2.20) conditions. There was also a significant difference in reported trait mindfulness on the MAAS, *F* (2, 155) = 3.08*, p = .05*, where the RBM condition (*M*= 3.37, SD= .765*)* reported higher trait mindfulness than the MBI (*M* = 3.03, SD= .097) and Control (*M*= 3.04, SD= .189) conditions. Thus, the participants in the RBM condition were younger and reported being more mindful than the MBI and Control conditions at the outset. This is worth considering throughout data analysis and interpretation, as their reported mindfulness level may affect the outcomes of the intervention.

PANAS scores were not significantly different across conditions in session one for either positive (MBI: *M*= 25.68, SD = 7.06; RBM: *M*= 27.98, SD = 7.25; Control: *M*= 27.18, SD = 6.98) or negative totals (MBI: *M*= 17.39, SD = 6.28; RBM: *M* = 18.77, SD = 7.12; Control: *M* = 16.55, SD =14.72). Regarding frequency, more women participated in the experiment than did men and transgender people (*N* = 88, *N* = 29, *N*= 1). However, differences in gender distribution was not significant across conditions (MBI: *M* = 1.76, SD = .431; RBM: *M* = 1.90, SD = .304; Control: *M* = 1.65, SD =.622). Initial scores on tests of cognition, including the WTAR (*MBI: M* = 103.84, SD = 11.49; *RBM: M*= 105.23, SD = 11.84; *Control: M* = 105.47, SD =11.21), TMT B (*MBI: M*= 46, SD = 17.18; *RBM: M*= 42.94, SD = 15.65; *Control: M* = 48.49, SD =17.01); OSPAN (*MBI: M*= 53.72, SD = 14.2; *RBM: M*= 54.29, SD = .16.14; *Control: M* = 55.73, SD =1.77), and Stroop total accuracy (*MBI: M* = .85, SD = .133; *RBM: M*= .84, SD = .12; *Control: M* = .87, SD =.09) were also statistically nonsignificant across the three conditions.

Table 3.

Covariate and Dependent Variable Correlations Across Sessions

		1	2	3	4	5	6	7	8	9
1. WTAR Score	Pearson Correlation	1								
	Sig. (2-tailed)									
	N	117								
2. MAAS Score	Pearson Correlation	-.030	1							
	Sig. (2-tailed)	.744								
	N	117	118							
3. Positive PANAS Session 1	Pearson Correlation	-.049	.304**	1						
	Sig. (2-tailed)	.597	.001							
	N	117	118	118						
4. Positive PANAS Session 2	Pearson Correlation	-.127	-.120	.412**	1					
	Sig. (2-tailed)	.247	.271	.000						
	N	85	86	86	86					
5. Positive PANAS Session 3	Pearson Correlation	-.103	-.118	.390**	.636**	1				
	Sig. (2-tailed)	.376	.311	.001	.000					
	N	76	76	76	70	76				
6. Positive PANAS Session 4	Pearson Correlation	-.005	-.197	.374**	.519**	.647**	1			
	Sig. (2-tailed)	.971	.109	.002	.000	.000				
	N	67	67	67	60	62	67			
7. Positive PANAS Session 5	Pearson Correlation	-.195	-.177	.256*	.362**	.572**	.576**	1		
	Sig. (2-tailed)	.136	.175	.048	.007	.000	.000			
	N	60	60	60	54	55	57	60		

8. Positive PANAS Session 6	Pearson Correlation	-.059	-.153	.470**	.631**	.476**	.452**	.480**	1	
	Sig. (2-tailed)	.652	.245	.000	.000	.000	.000	.000		
	N	60	60	60	54	55	57	55	60	
9. Negative PANAS Session 1	Pearson Correlation	-.255**	.410**	.067	.040	-.033	-.033	.111	.110	1
	Sig. (2-tailed)	.006	.000	.470	.716	.779	.794	.398	.405	
	N	117	118	118	86	76	67	60	60	118

10. Negative PANAS Session 2	Pearson Correlation	.040	.252*	-.145	-.023	-.075	-.035	-.135	.006	.405**
	Sig. (2-tailed)	.714	.019	.183	.833	.535	.793	.329	.968	.000
	N	85	86	86	86	70	60	54	54	86
11. Negative PANAS Session 3	Pearson Correlation	.066	.308**	.000	-.103	-.214	-.224	-.065	-.053	.412**
	Sig. (2-tailed)	.571	.007	.997	.395	.063	.080	.636	.700	.000
	N	76	76	76	70	76	62	55	55	76
12. Negative PANAS Session 4	Pearson Correlation	-.024	.266*	.087	.085	.052	-.021	-.024	.133	.282*
	Sig. (2-tailed)	.846	.029	.486	.519	.691	.865	.860	.323	.021
	N	67	67	67	60	62	67	57	57	67
13. Negative PANAS Session 5	Pearson Correlation	.140	.228	.055	.291*	.241	.047	-.068	.073	.156
	Sig. (2-tailed)	.289	.083	.678	.034	.079	.728	.608	.598	.239
	N	59	59	59	53	54	56	59	54	59
14. Negative PANAS Session 6	Pearson Correlation	.072	.302*	-.002	-.099	-.043	-.103	-.137	-.164	.054
	Sig. (2-tailed)	.590	.020	.987	.482	.755	.451	.323	.215	.687

	N	59	59	59	53	54	56	54	59	59
15. TMT A Session 1	Pearson Correlation	.027	-.133	-.056	-.245*	.015	-.034	-.085	-.385**	.004
	Sig. (2-tailed)	.771	.152	.552	.024	.895	.782	.520	.002	.966
	N	117	117	117	85	76	67	60	60	117
16. TMT A Session 4	Pearson Correlation	.004	-.037	.025	-.241	.060	.042	.038	-.302*	.144
	Sig. (2-tailed)	.973	.757	.838	.053	.630	.735	.776	.020	.230
	N	71	71	71	65	66	66	59	59	71
17. TMT A Session 6	Pearson Correlation	-.075	.105	-.141	-.197	.027	-.039	.016	-.274*	.104
	Sig. (2-tailed)	.567	.424	.284	.149	.843	.778	.908	.039	.429
	N	60	60	60	55	57	56	53	57	60
18. TMT B Session 1	Pearson Correlation	-.189*	.017	-.025	-.256*	-.019	.026	.009	-.293*	.190*
	Sig. (2-tailed)	.042	.858	.785	.018	.872	.837	.946	.023	.041
	N	117	117	117	85	76	67	60	60	117
19. TMT B Session 4	Pearson Correlation	-.286*	-.057	-.123	-.204	-.046	.094	.178	-.190	.236*
	Sig. (2-tailed)	.016	.638	.307	.103	.711	.453	.177	.149	.047
	N	71	71	71	65	66	66	59	59	71
20. TMT B Session 6	Pearson Correlation	-.394**	-.059	-.038	-.125	.064	.094	.161	.031	.241
	Sig. (2-tailed)	.002	.657	.775	.363	.638	.489	.251	.819	.064
	N	60	60	60	55	57	56	53	57	60
21. Stroop Congruent RT	Pearson Correlation	-.177	-.127	.001	-.110	-.156	-.042	-.061	-.247	.030

Session 1	Sig. (2-tailed)	.059	.178	.992	.317	.177	.733	.645	.057	.750
	N	114	114	114	85	76	67	60	60	114
22. Stroop Congruent RT Session4	Pearson Correlation	-.149	-.066	-.013	-.107	.013	.024	-.144	-.225	-.015
	Sig. (2-tailed)	.219	.585	.913	.400	.919	.851	.284	.093	.899
	N	70	70	70	64	64	64	57	57	70
23. Stroop Congruent RT Session 6	Pearson Correlation	.035	-.046	-.014	-.153	-.037	.109	-.017	-.080	-.040
	Sig. (2-tailed)	.799	.740	.922	.290	.797	.452	.911	.572	.769
	N	55	55	55	50	51	50	48	52	55
24. Stroop Incongruent RT Session 1	Pearson Correlation	-.107	-.096	-.157	-.126	-.205	-.032	-.027	-.131	-.021
	Sig. (2-tailed)	.256	.310	.095	.251	.076	.797	.839	.317	.827
	N	114	114	114	85	76	67	60	60	114
25. Stroop Incongruent RT Session 4	Pearson Correlation	-.384**	-.200	.054	-.019	.031	-.061	-.012	-.051	.152
	Sig. (2-tailed)	.001	.096	.655	.879	.805	.630	.931	.708	.209
	N	70	70	70	64	64	64	57	57	70
26. Stroop Incongruent RT Session 6	Pearson Correlation	-.126	-.093	.081	-.101	.014	.013	-.047	-.145	.092
	Sig. (2-tailed)	.361	.498	.557	.487	.922	.930	.753	.305	.504
	N	55	55	55	50	51	50	48	52	55
27. Stroop Total Accuracy Session 1	Pearson Correlation	.132	.078	-.005	-.203	-.154	-.015	.021	.035	.086
	Sig. (2-tailed)	.163	.409	.957	.063	.186	.906	.873	.793	.368
	N	113	113	113	84	75	67	60	60	113
28. Stroop	Pearson	.306**	-.039	.145	.021	-.106	.073	-.157	-.068	.024

Total Accuracy Session 4	Correlation									
	Sig. (2-tailed)	.009	.747	.227	.868	.399	.565	.244	.617	.842
	N	71	71	71	65	65	64	57	57	71
29. Stroop Total Accuracy Session 6	Pearson Correlation	.062	-.208	.010	-.095	-.233	.035	-.172	-.395**	-.037
	Sig. (2-tailed)	.655	.127	.941	.513	.099	.810	.241	.004	.786
	N	55	55	55	50	51	50	48	52	55
30. OSPAN Session 1	Pearson Correlation	.263**	-.089	-.039	.003	.011	.197	-.086	.196	-.208*
	Sig. (2-tailed)	.005	.354	.685	.978	.925	.118	.524	.145	.028
	N	111	111	111	81	72	64	57	57	111
31. OSPAN Session 4	Pearson Correlation	.248*	-.103	-.032	.174	.123	.320*	-.034	.212	-.197
	Sig. (2-tailed)	.042	.402	.796	.175	.341	.011	.804	.120	.108
	N	68	68	68	62	62	62	55	55	68
32. OSPAN Session 6	Pearson Correlation	.188	-.107	.026	.258	.210	.287	.000	.197	.135
	Sig. (2-tailed)	.186	.456	.858	.084	.152	.053	.999	.180	.345
	N	51	51	51	46	48	46	44	48	51

Correlation Values, Continued

		10.	11.	12.	13.	14.	15.	16.	17.	18.
10. Negative PANAS	Pearson Correlation	1								

Session 2	Sig. (2-tailed)								
	N	86							
11. Negative PANAS Session 3	Pearson Correlation	.469**	1						
	Sig. (2-tailed)	.000							
	N	70	76						
12. Negative PANAS Session 4	Pearson Correlation	.269*	.523**	1					
	Sig. (2-tailed)	.038	.000						
	N	60	62	67					
13. Negative PANAS Session 5	Pearson Correlation	.169	.204	.366**	1				
	Sig. (2-tailed)	.227	.139	.006					
	N	53	54	56	59				
14. Negative PANAS Session 6	Pearson Correlation	.007	.183	.137	.542**	1			
	Sig. (2-tailed)	.962	.186	.315	.000				
	N	53	54	56	53	59			
15. TMT A Session 1	Pearson Correlation	.151	.147	-.029	-.065	-.045	1		
	Sig. (2-tailed)	.169	.206	.818	.623	.735			
	N	85	76	67	59	59	117		
16. TMT A Session 4	Pearson Correlation	.142	.018	-.089	-.209	-.174	.698**	1	
	Sig. (2-tailed)	.259	.884	.479	.116	.192	.000		
	N	65	66	66	58	58	71	71	
17. TMT A Session 6	Pearson Correlation	-.006	-.033	-.126	-.048	.010	.452**	.550**	1

	Sig. (2-tailed)	.965	.810	.355	.734	.939	.000	.000		
	N	55	57	56	52	56	60	60	60	
18. TMT B Session 1	Pearson Correlation	-.017	-.039	-.120	-.199	-.005	.472**	.395**	.454**	1
	Sig. (2-tailed)	.879	.739	.332	.130	.970	.000	.001	.000	
	N	85	76	67	59	59	117	71	60	117
19. TMT B Session 4	Pearson Correlation	-.126	-.022	.058	-.151	-.023	.368**	.520**	.376**	.601**
	Sig. (2-tailed)	.317	.858	.646	.258	.864	.002	.000	.003	.000
	N	65	66	66	58	58	71	71	60	71
20. TMT B Session 6	Pearson Correlation	-.140	-.090	-.149	-.111	-.103	.083	.339**	.418**	.467**
	Sig. (2-tailed)	.309	.506	.274	.433	.448	.526	.008	.001	.000
	N	55	57	56	52	56	60	60	60	60
21. Stroop Congruent RT Session 1	Pearson Correlation	-.010	-.067	-.031	-.054	.004	.188*	.145	.170	.286**
	Sig. (2-tailed)	.926	.566	.806	.683	.979	.045	.227	.194	.002
	N	85	76	67	59	59	114	71	60	114
22. Stroop Congruent RT Session4	Pearson Correlation	.006	-.112	-.029	.111	.162	.227	.142	.128	.442**
	Sig. (2-tailed)	.960	.378	.818	.414	.234	.059	.243	.337	.000
	N	64	64	64	56	56	70	69	58	70
23. Stroop Congruent RT Session 6	Pearson Correlation	.117	-.084	.021	-.027	-.124	.387**	.478**	.383**	.360**
	Sig. (2-tailed)	.419	.557	.884	.857	.386	.004	.000	.004	.007
	N	50	51	50	48	51	55	54	54	55
24. Stroop Incongruent	Pearson Correlation	-.156	-.180	-.120	-.163	-.125	.124	-.011	-.031	.274**

RT Session 1	Sig. (2-tailed)	.154	.120	.335	.216	.347	.189	.931	.817	.003
	N	85	76	67	59	59	114	71	60	114
25. Stroop Incongruent RT Session 4	Pearson Correlation	-.085	-.036	-.006	-.006	.044	.157	.151	.157	.470**
	Sig. (2-tailed)	.507	.780	.964	.963	.745	.195	.215	.240	.000
	N	64	64	64	56	56	70	69	58	70
26. Stroop Incongruent RT Session 6	Pearson Correlation	.101	.036	-.090	-.046	-.099	.348**	.405**	.242	.332*
	Sig. (2-tailed)	.487	.802	.534	.754	.491	.009	.002	.077	.013
	N	50	51	50	48	51	55	54	54	55
27. Stroop Total Accuracy Session 1	Pearson Correlation	.149	.224	-.014	-.104	.080	.048	.151	.130	.024
	Sig. (2-tailed)	.175	.054	.912	.433	.547	.615	.208	.321	.801
	N	84	75	67	59	59	113	71	60	113
28. Stroop Total Accuracy Session 4	Pearson Correlation	.035	.104	.076	.041	.123	.093	.134	.218	-.038
	Sig. (2-tailed)	.783	.411	.549	.766	.366	.441	.271	.100	.753
	N	65	65	64	56	56	71	69	58	71
29. Stroop Total Accuracy Session 6	Pearson Correlation	-.091	.050	-.227	-.060	-.046	.080	.147	.143	.074
	Sig. (2-tailed)	.528	.728	.113	.686	.750	.563	.290	.303	.593
	N	50	51	50	48	51	55	54	54	55
30. OSPAN Session 1	Pearson Correlation	.118	.121	.197	.086	.055	-.127	-.291*	-.070	-.163
	Sig. (2-tailed)	.292	.312	.118	.527	.690	.182	.016	.604	.086
	N	81	72	64	56	56	111	68	57	111

31. OSPAN Session 4	Pearson Correlation	.000	.032	.113	-.066	-.074	-.033	-.195	-.073	-.006
	Sig. (2-tailed)	.999	.803	.381	.638	.593	.791	.114	.593	.961
	N	62	62	62	54	54	68	67	56	68
32. OSPAN Session 6	Pearson Correlation	.083	.120	.288	-.008	-.206	.050	-.045	-.028	.223
	Sig. (2-tailed)	.581	.417	.052	.958	.164	.728	.755	.847	.116
	N	46	48	46	44	47	51	50	50	51

Correlation Tables Continued

		19.	20.	21.	22.	23	24.	25.	26.	27.
19. TMT B Session 4	Pearson Correlation	1								
	Sig. (2-tailed)									
	N	71								
20. TMT B Session 6	Pearson Correlation	.565**	1							
	Sig. (2-tailed)	.000								
	N	60	60							
21. Stroop Congruent RT Session 1	Pearson Correlation	.325**	.327*	1						
	Sig. (2-tailed)	.006	.011							
	N	71	60	114						
22. Stroop Congruent RT Session4	Pearson Correlation	.294*	.250	.334**	1					
	Sig. (2-tailed)	.014	.058	.005						

	N	69	58	70	70					
23. Stroop Congruent RT Session 6	Pearson Correlation	.390**	.229	.435**	.409**	1				
	Sig. (2-tailed)	.004	.096	.001	.002					
	N	54	54	55	53	55				
24. Stroop Incongruent RT Session 1	Pearson Correlation	.286*	.140	.643**	.148	.206	1			
	Sig. (2-tailed)	.016	.285	.000	.221	.131				
	N	71	60	114	70	55	114			
25. Stroop Incongruent RT Session 4	Pearson Correlation	.394**	.384**	.505**	.695**	.497**	.242*	1		
	Sig. (2-tailed)	.001	.003	.000	.000	.000	.044			
	N	69	58	70	70	53	70	70		
26. Stroop Incongruent RT Session 6	Pearson Correlation	.369**	.285*	.533**	.263	.815**	.208	.606**	1	
	Sig. (2-tailed)	.006	.037	.000	.057	.000	.128	.000		
	N	54	54	55	53	55	55	53	55	
27. Stroop Total Accuracy Session 1	Pearson Correlation	-.010	.020	-.177	-.028	-.074	-.283**	-.129	-.192	1
	Sig. (2-tailed)	.932	.882	.060	.816	.594	.002	.289	.161	
	N	71	60	113	70	55	113	70	55	113
28. Stroop Total Accuracy Session 4	Pearson Correlation	.000	-.026	.091	-.131	.186	-.125	-.146	.106	.062
	Sig. (2-tailed)	.999	.844	.448	.281	.181	.298	.229	.451	.611
	N	69	58	71	70	53	71	70	53	70
29. Stroop Total	Pearson Correlation	.077	.053	.132	.030	-.076	-.048	.128	.024	.267*

Accuracy Session 6	Sig. (2-tailed)	.578	.704	.337	.833	.580	.728	.360	.860	.049
	N	54	54	55	53	55	55	53	55	55
30. OSPAN Session 1	Pearson Correlation	-.206	-.237	-.099	-.105	-.004	-.001	-.257*	-.201	.191*
	Sig. (2-tailed)	.093	.076	.304	.397	.975	.990	.036	.149	.047
	N	68	57	110	67	53	110	67	53	109
31. OSPAN Session 4	Pearson Correlation	-.165	-.127	-.063	-.039	.045	-.001	-.143	-.065	.056
	Sig. (2-tailed)	.183	.350	.609	.757	.747	.991	.251	.643	.652
	N	67	56	68	66	53	68	66	53	68
32. OSPAN Session 6	Pearson Correlation	-.011	.089	-.165	-.061	-.093	-.103	-.076	-.090	.053
	Sig. (2-tailed)	.940	.539	.248	.679	.526	.471	.603	.539	.713
	N	50	50	51	49	49	51	49	49	51

Correlation Tables, Continued

		28.	29	30.	31	32.
28. Stroop Total Accuracy Session 4	Pearson Correlation	1				
	Sig. (2-tailed)					
	N	71				
29. Stroop Total Accuracy Session 6	Pearson Correlation	.211	1			
	Sig. (2-tailed)	.130				
	N	53	55			
30. OSPAN Session 1	Pearson Correlation	.158	-.124	1		

	Sig. (2-tailed)	.197	.376			
	N	68	53	111		
31. OSPAN Session 4	Pearson Correlation	.208	-.084	.857**	1	
	Sig. (2-tailed)	.095	.552	.000		
	N	66	53	66	68	
32. OSPAN Session 6	Pearson Correlation	.077	-.126	.660**	.788**	1
	Sig. (2-tailed)	.601	.390	.000	.000	
	N	49	49	48	49	51

Change in Working Memory (OSPAN) Across Sessions

A repeated-measures ANCOVA was conducted to determine if intervention group predicted change in OSPAN scores. See Table 4 for the means and standard deviations for each condition across sessions. Of note, Mauchley's Test of Sphericity was significant ($\chi^2(2) = 7.89$, $p < .019$), which indicated that the variance of the differences in scores between conditions and across sessions were not equal. Consequently, the results lack power and the F-ratios and degrees of freedom were adjusted using the Huynh – Feldt correction ($\varepsilon = .97$) to more accurately interpret results. The Huynh – Feldt correction is recommended for all epsilon values greater than .075 (Field, 2009). Overall, there was not a main effect of session $F(1.95, 81.29) = .99$, $p = .38$, nor intervention group, although approaching significance, $F(2, 42) = .066$, $p = .94$. There was no significant interaction of session number by intervention group, $F(3.87, 81.29) = .921$, $p = .45$. Pairwise comparisons showed that there was no significance between OSPAN scores at session one and session 4 ($p = .45$); however, the difference between initial and final session scores were approaching significance ($p = .08$). As such, the null hypothesis must be rejected because scores did not significantly change across sessions. Figure 6 displays the distribution of scores across session, and trends suggest that individuals who received the MBI or RBM intervention consistently improved their scores over time.

Change in Mind-wandering Across Sessions

A repeated-measures ANCOVA determined if intervention group predicted change in self-reported mind-wandering. Mind-wandering was collected over 5 sessions, and the repeated measures ANCOVA included all five scores in analyses. Separate scores for each of the questions were calculated and analyzed. As such, there are three different mind-wandering results to analyze and interpret.

Question one. The first question was, "*In the moments before this task and prior to this probe, your attention was focused on… 1) completely on task, 2) mostly on task, 3) on both task and unrelated thoughts, 4) mostly on unrelated concerns, and 5) completely on unrelated concerns."* The means and standard deviations for the first question of the mind-wandering probe question are found in Table 5. Overall, the main effect of reported mind-wandering across sessions was approaching significance, $F(4,156) = 2.30$, $p = .06$ but not between intervention conditions $F(2,42) = 1.58$, $p = .22$. Additionally, the interaction between conditions by session was not significant $F(8,156) = 1.71$, $p = .10$. Figure 6 displays the change in reported mind-wandering over sessions for each intervention group, which shows trends that indicate reduce mind-wandering as the sessions progress. Especially interesting was the continuous decrease in reported mind-wandering for the MBI group, while the control and RBM group were more variable in reporting how on task they were.

Question two. The second question was, "*Report what you were thinking about during the task and in the moments before this probe appeared… 1) Task: thinking about task and appropriate response, 2) Task performance: evaluating my performance on the task, 3) Every day stuff: recent or impending life events, 4) Current state of being (i.e. hunger), 5) Daydreaming: having fantasies disconnected from reality, or 6) other: only for thoughts not fitting other categories."* Due to the categorical nature of the variable, repeated measures ANCOVA was not an option for data analysis. A Friedman's test indicated there was no significant change in participant's reported thoughts across sessions χ^2 (4, n=47) = .44), $p = .99$.

Table 4.

OSPAN Means and Standard Deviations

	N	Session 1 M*(SD)*	Session 4 M*(SD)*	Session 6 M*(SD)*	Total M*(SD)*
MBI	16	52.7(15.35)	56.25(15.84)	57.94(16.11)	55.81(15.77)
RBM	13	53.25(20.14)	55.77(20.58)	57.15(21.13)	54.97(20.62)
Control	18	58.11(14.59)	54.61(20.99)	59.62(16.56)	57.44(17.38)

Figure 6.

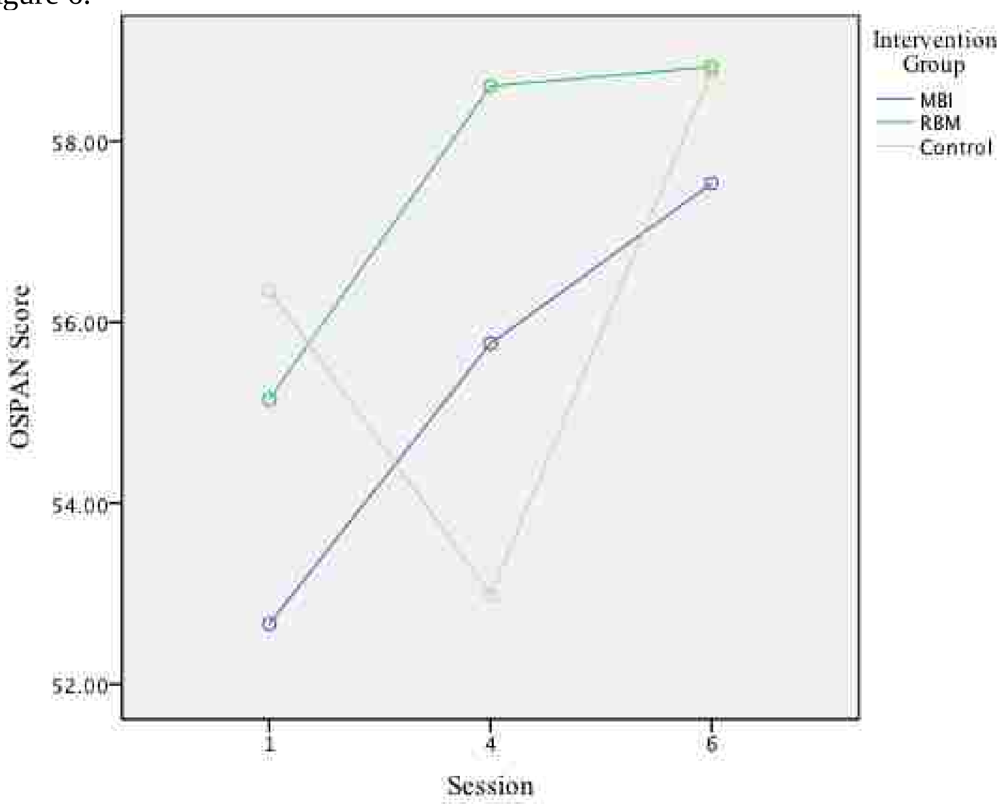


Figure 6. OSPAN scores of each participant during the initial, middle, and final session.

Each line represents a different intervention condition.

A Kruskal-Wallis test revealed a statistically significant difference in reported thoughts only in the first session χ^2 (2, *n*=91) = 9.69, *p* = .008, whereas all other sessions were non-significant (Session 3: χ^2 (2, *n*=76) = 3.96, *p* = .138; Session 4: χ^2 (2, *n*=67) = 3.06, *p* = .22; Session 5: χ^2 (2, *n*=60) = 3.06, *p* = .36; Session 6: χ^2 (2, *n*=60) = 3.81, *p* = .15). Mann-Whitney tests were run to determine which conditions were significantly different from each other in session two. A Bonferroni adjustment was implemented to account for multiple comparisons between the three conditions, indicating true significance would be $p < .017$. The Mann-Whitney test indicated that the content of participants' reported thoughts in the MBI and RBM conditions were not significantly different (*p* =.18). Further, the content of reported thoughts between the MBI and control conditions were not significant (*p*= .08). However, Mann-Whitney indicated that the content of reported thoughts between the Control (*M* = 25.89) and RBM (*M* = 39.64) was significant, U = 276.00; *p* = .002) during the session where they initially received their assigned intervention (Session 2). This result indicates that the Control group reported thoughts that were significantly more related to the task at hand than were the RBM participants after receiving their intervention for the first time. Perhaps the RBM followed the direction of letting their mind-wander to a preferred/safe location, and reported it on the probe.

Question three. The third question was, "*How frequently do you think that your mind wandered during this task? … 1) zero times, 2) one to four times, 3) five to nine times, 4) 10-14 times, and 5) more than 15 times."* The means and standard deviations for all mind-wandering probe questions are found in Table 7. Overall, there was not a significant main effect across sessions *F*(4, 156) = .23, *p* =.92 or between intervention conditions *F*(2, 39) =1.09, p =*.56*. Additionally, the interaction of conditions by sessions was not significant $F(8, 156) = .74$, $p = .65$. Pairwise comparisons indicated no significant differences in reported mind-wandering between intervention conditions; however, there were significant differences across sessions (See Table 8). Of note, there was a significant effect of the trait mindfulness covariate between intervention conditions, $F(1, 39) = 2.45$, $p = .049$, indicating that the frequency of reported mind-wandering may have been more affected by trait mindfulness of the participant rather than the intervention they received. See Figure 7 for the trending change in reported frequency of mind-wandering over time. All the mean scores for each intervention group and session were between "2" and "3" indicating all participants caught themselves mind wandering between: 2) *one to four* or 3) *five to nine* times. In addition to more data, a more parsimonious probe may have captured more powerful differences across sessions.

Change in Positive and Negative Mood Across Sessions

Repeated-measures ANCOVA was conducted to determine if intervention group predicted change in positive and negative PANAS scores across all six sessions. See Tables 9 and 10 for means and standard deviations for each positive and negative mood across sessions.

Positive mood. Positive affect scores resulted in no main effect across session $F(5,195) = 1.39$, $p = .26$, or between intervention conditions $F(2,39) = 1.01$, $p = .38$. However, the interaction of intervention conditions by session was significant, $F(10, 195) = 2.19$, $p = .02$, $\eta 2_p = .10$, indicating the type of intervention received affected mood ratings across time. There was also a significant interaction between the covariate of intelligence (WTAR score) on positive mood ratings across session $F(5, 195) = 2.525$, $p = .031$, $\eta 2_p = .061$.

Table 5.

Means and standard deviations of question one on the mind-wandering probe

	N	Session 2 M*(SD)*	Session 3 M*(SD)*	Session 4 M*(SD)*	Session 5 M*(SD)*	Session 6 M*(SD)*	Total M*(SD)*
MBI	13	2.54*(.88)*	2.85*(1.14)*	2.54*(1.05)*	2.23*(.83)*	1.92*(.76)*	2.41*(.93)*
RBM	13	2.23*(.83)*	2.30*(.95)*	2.15*(.80)*	2.00*(.57)*	1.85*(.55)*	2.11*(.74)*
Control	18	1.83*(.62)*	2.38*(.92)*	1.83*(.78)*	2.16*(1.04)*	2.05*(.80)*	2.05*(.83)*

Figure 7.

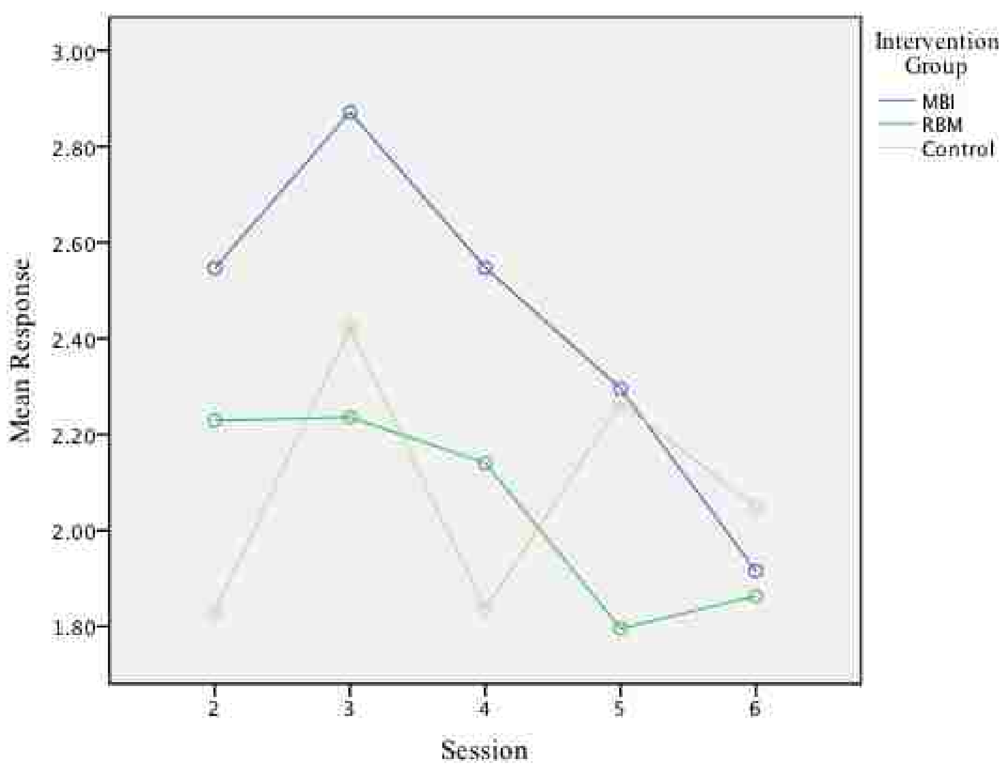


Figure 7. Mean responses by session for the question, “In the moments before this task and prior to this probe, your attention was focused on…”

Table 6.

Means and Standard Deviations of Mind-wandering probe: Question Three

	N	Session 2 M*(SD)*	Session 3 M*(SD)*	Session 4 M*(SD)*	Session 5 M*(SD)*	Session 6 M*(SD)*	Total M*(SD)*
MBI	13	2.42*(.31)*	2.46*(.78)*	2.31*(.48)*	2.31*(.63)*	1.92*(.49)*	2.28*(.54)*
RBM	15	2.44*(.61)*	2.53*(.99)*	2.33*(.49)*	2.20*(.68)*	2.27*(.59)*	2.35*(.67)*
Control	19	2.37*(.28)*	2.53*(.84)*	1.95*(.71)*	2.16*(.89)*	2.47*(.96)*	2.29*(.74)*

Table 7.

Pairwise Comparisons of Change in Reported Frequency of Mind-wandering across Sessions

(I) session	(J) session	Mean Difference (I-J)	Std. Error	Sig.
2	3	-.09	.11	.41
	4	.22*	.10	.037*
	5	.19	.12	.12
	6	.19	.12	.13
3	2	.09	.11	.41
	4	.31*	.13	.022*
	5	.28	.15	.06
	6	.28	.14	.06
4	2	-.22*	.10	.037*
	3	-.31*	.13	.022*
	5	-.03	.12	.84
	6	-.03	.10	.79
5	2	-.19	.12	.12
	3	-.28	.15	.06
	5	.03	.12	.84
	6	-.003	.11	.98
6	2	-.19	.12	.13
	3	-.28	.14	.06
	4	.03	.10	.79
	5	.003	.11	.98

Figure 8.

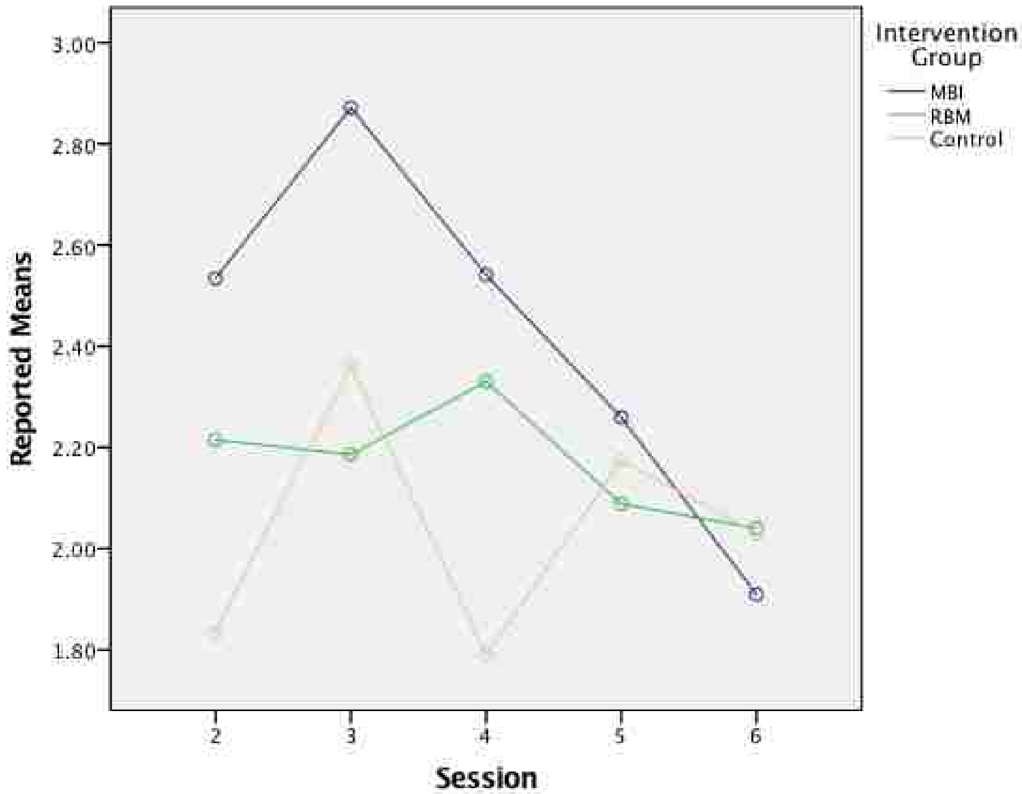


Figure 8. Participant response to the question, “How frequently do you think your mind wandered during this task?”

That is, intelligence could significantly predict positive mood, more so than the intervention. That said, Figure 9 shows the change in mood ratings of each intervention group across over time, indicating trends for each intervention group: the MBI condition did not report the highest positive mood score in the first session, but rated themselves much more positively across the remaining sessions than did the RBM and Control conditions. Pairwise comparisons across sessions and between conditions were not significant.

Negative mood. Negative affect scores violated the assumptions of Sphericity ($\chi^2(2) = 37.73$, $p = .001$) and were adjusted using the Greenhouse- Geisser correction ($\varepsilon = .695$). There was no significant main effect of mood ratings across session $F(5, 185) = 1.639$, $p = .152$, or between intervention conditions $F(2,37) = 1.874$, $p = .168$. Further, there was no significant interaction between negative mood ratings across session by intervention conditions $F(10, 185) = .564$, $p = .842$. However, there was a significant effect of the covariate *Trait Mindfulness* (MAAS scores) between-subjects $F(1, 37) = 13.301$, $p = .001$, $\eta 2_p = .265$, indicating that self-rated trait mindfulness better predicted negative mood ratings than did the intervention received or session probed.

Pairwise comparisons were conducted to examine differences in negative mood ratings between intervention conditions and across sessions. See Table 11 for mean differences between conditions. The difference in mood ratings between the MBI and RBM conditions was approaching significance ($p = .06$). Additionally, there were significant differences in negative mood ratings across sessions (See Table 12). Overall, negative mood ratings in the first session were significantly higher than in subsequent sessions. Second session ratings were significant lower than in the first session and significantly higher than the sixth session. Similarly, session three, four, and five mood ratings were significantly lower than mood ratings in the first session, and significantly higher than final session ratings. Finally, final sessions ratings were significantly different than every other session's ratings. See Figure 10 to see change in negative ratings over time.

Change in Task-Switching (TMT) Across Sessions

The Trail Making Test had two parts, A and B. Of specific interest for this experiment were the Trail Making B scores, because the task induced the challenge of cognitive-switching. Table 13 displays the means and standard deviations for seconds taken to complete the TMT A between intervention conditions and across sessions. Trail Making A scores violated the assumptions of sphericity ($\chi^2(2) = 6.275$, $p = .043$) and were adjusted using the Huynh- Feldt correction ($\varepsilon = .998$). Results showed no main effect of intervention group $F(2,55) = .668$, $p = .517$, or across sessions $F(2,110) = .020$, $p = .981$. Further, there was not a significant interaction intervention conditions by session, $F(4,110) = .579$, $p = .679$. Pairwise comparisons (see Table 14) indicate no significant differences in TMT A scores between intervention conditions, but significant reductions in time taken to complete the TMT A at each session. This difference can be explained by practice effects (See Figure 10).

Table 14 displays the means and standard deviations for seconds taken to complete the TMT B between intervention conditions and across sessions. Trail Making B showed no significant main effect between intervention conditions $F(2,55) = .76$, $p = .47$, or across sessions, $F(2, 110) = 1.95$, $p = .15$. There was not a significant interaction between intervention conditions across sessions, $F(4,110) = .793$, $p = .53$.

Table 8.
PANAS Positive Score Means and Standard Deviations

	N	Session 1 M*(SD)*	Session 2 M*(SD)*	Session 3 M*(SD)*	Session 4 M*(SD)*	Session 5 M*(SD)*	Session 6 M*(SD)*	Total M*(SD)*
MBI	12	27.17*(6.88)*	30.50*(5.52)*	30.42*(8.47)*	32.08*(8.47)*	29.17*(6.93)*	31.17*(7.03)*	30.01*(7.28)*
RBM	15	28.87*(7.40)*	26.47*(7.28)*	26.000*(7.29)*	24.27*(7.74)*	24.40*(5.45)*	27.29*(10.63)*	26.28*(7.76)*
Control	17	25.47*(8.03)*	26.82*(6.29)*	28.23*(8.19)*	29.35*(8.78)*	27.88*(8.89)*	27.53*(8.54)*	27.55*(8.12)*

Figure 8.

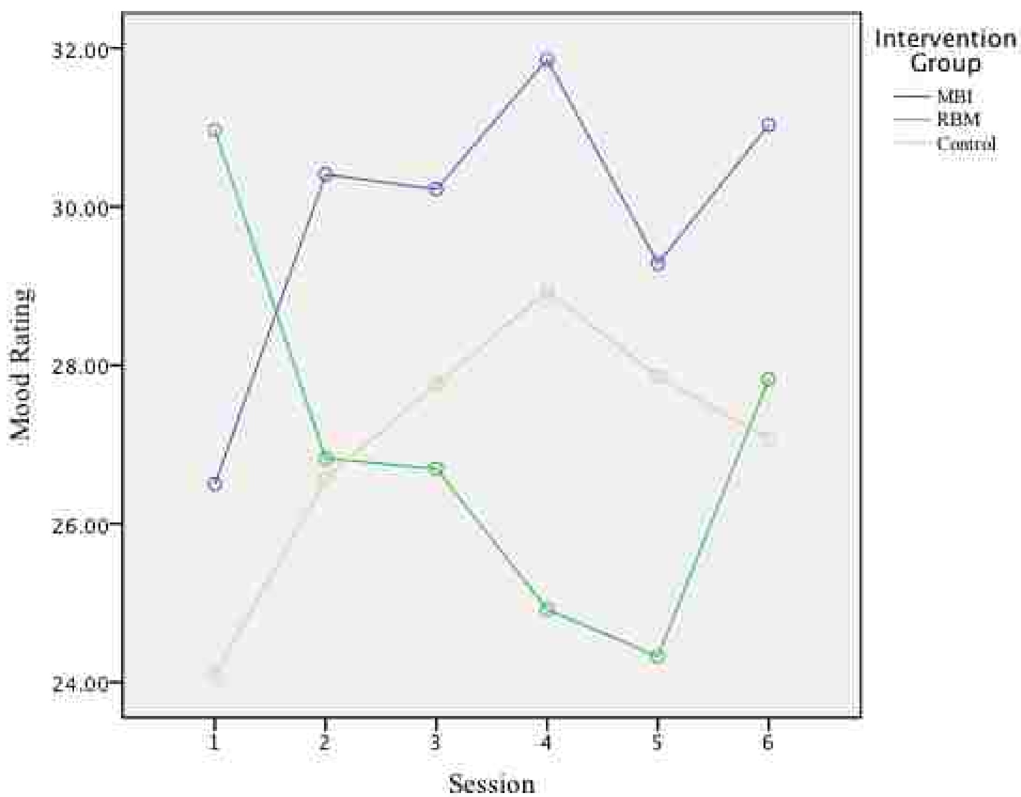


Figure 8. PANAS positive mood ratings across session, divided by intervention condition.

Higher scores denote higher positive mood.

Table 9.
Negative PANAS Scores: Means and Standard Deviations

	N	Session 1 M*(SD)*	Session 2 M*(SD)*	Session 3 M*(SD)*	Session 4 M*(SD)*	Session 5 M*(SD)*	Session 6 M*(SD)*	Total M*(SD)*
MBI	12	18.16*(8.03)*	16.66*(7.65)*	15.66*(4.69)*	15.25*(5.64)*	17.25*(6.31)*	13.00*(2.69)*	15.99*(5.84)*
RBM	15	19.06*(8.02)*	15.60*(8.21)*	14.66*(7.31)*	14.93*(4.01)*	12.60*(4.10)*	12.66*(1.95)*	14.92*(5.60)*
Control	15	15.60*(4.32)*	14.93*(5.29)*	14.20*(3.80)*	13.27*(3.47)*	14.00*(4.47)*	13.13*(4.22)*	14.18*(4.31)*

Figure 9.

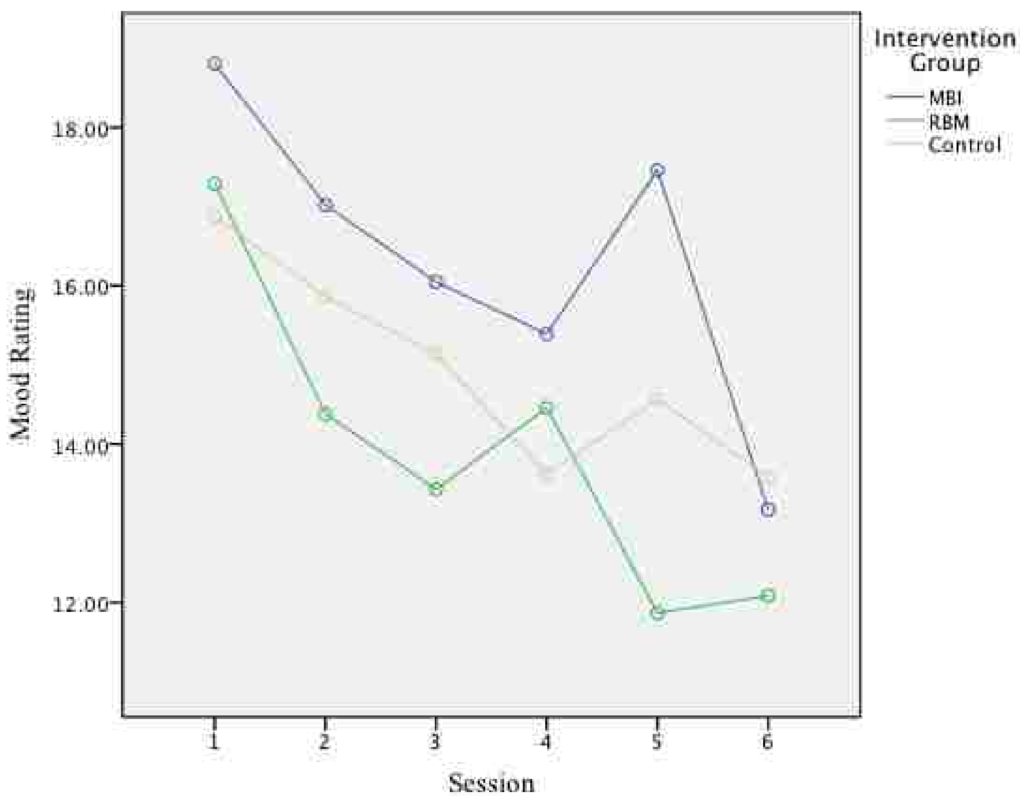


Figure 9. PANAS negative mood ratings across sessions. Higher scores denote higher negative mood.

Table 10.

Pairwise Comparisons: Changes in Negative Mood by Intervention Group

(I)Intervention Group	(J) Intervention Group	Mean Difference (I-J)	Std. Error	Sig.
MBI	RBM	2.40	1.25	.06
	Control	1.37	1.19	.25
RBM	MBI	-2.40	1.25	.06
	Control	-1.02	1.23	.41
Control	MBI	-1.37	1.19	.25
	RBM	1.02	1.23	.41

Table 11.
Pairwise Comparisons of Negative Mood Change Across Sessions

(I) Session Number	(J) Session Number	Mean Difference (I-J)	Std. Error	Sig.[b]
1	2	1.89	.970	.06
	3	2.78*	1.03	.010*
	4	3.16*	1.10	.007*
	5	3.02*	1.17	.014*
	6	4.71*	1.10	.000*
2	1	-1.89	.97	.058
	3	.88	1.07	.41
	4	1.26	1.21	.30
	5	1.13	1.27	.38
	6	2.81*	1.17	.022*
3	1	-2.78*	1.03	.010*
	2	-.88	1.07	.41
	4	.38	.83	.65
	5	.24	1.06	.82
	6	1.93*	.94	.047*
4	1	-3.16*	1.10	.007*
	2	-1.26	1.21	.30
	3	-.37	.83	.65
	5	-.14	.81	.87
	6	1.55	.80	.06
5	1	-3.02*	1.17	.014*
	2	-1.13	1.27	.38
	3	-.24	1.06	.82
	4	.14	.81	.87
	6	1.69*	.60	.008*
6	1	-4.71*	1.10	.000*
	2	-2.82*	1.17	.022*
	3	-1.93*	.94	.047*
	4	-1.55	.80	.06
	5	-1.69*	.60	.008*

However, there was a significant main effect of the covariate intelligence (WTAR scores) between subjects, $F(1, 55) = 10.28$, $p < .02$, $\eta 2_p = .10$, indicating that higher intelligence level better predicted TMT B scores than did the intervention group. Pairwise comparisons (see Table 15) indicated no significant differences in TMT B scores between intervention conditions, but significant reductions in time taken to complete the TMT B at each session. This difference can be explained by practice effects (See Figure 11).

Table 12.

Means and Standard Deviation of the TMT A Completion Time (in seconds)

	N	Session 1 M*(SD)*	Session 4 M*(SD)*	Session 6 M*(SD)*	Total M*(SD)*
MBI	18	21.50*(7.12)*	16.33*(5.63)*	16.00*(4.74)*	17.94*(5.83)*
RBM	18	20.56*(5.69)*	18.06*(5.13)*	16.61*(6.66)*	18.41*(5.83)*
Control	24	23.89*(11.29)*	19.70*(8.74)*	16.68*(5.32)*	22.19*(8.45)*

Table 13.

Pairwise Comparisons for TMT A Across Sessions

(I) TMTA	(J) TMTA	Mean Difference (I-J)	Std. Error	Sig.
1	4	3.96*	.86	.000*
	6	5.60*	1.03	.000*
4	1	-3.96*	.86	.000*
	6	1.64*	.78	.041*
6	1	-5.60*	1.03	.000*
	4	-1.64*	.78	.041*

*Significant at $p < .05$

Figure 10.

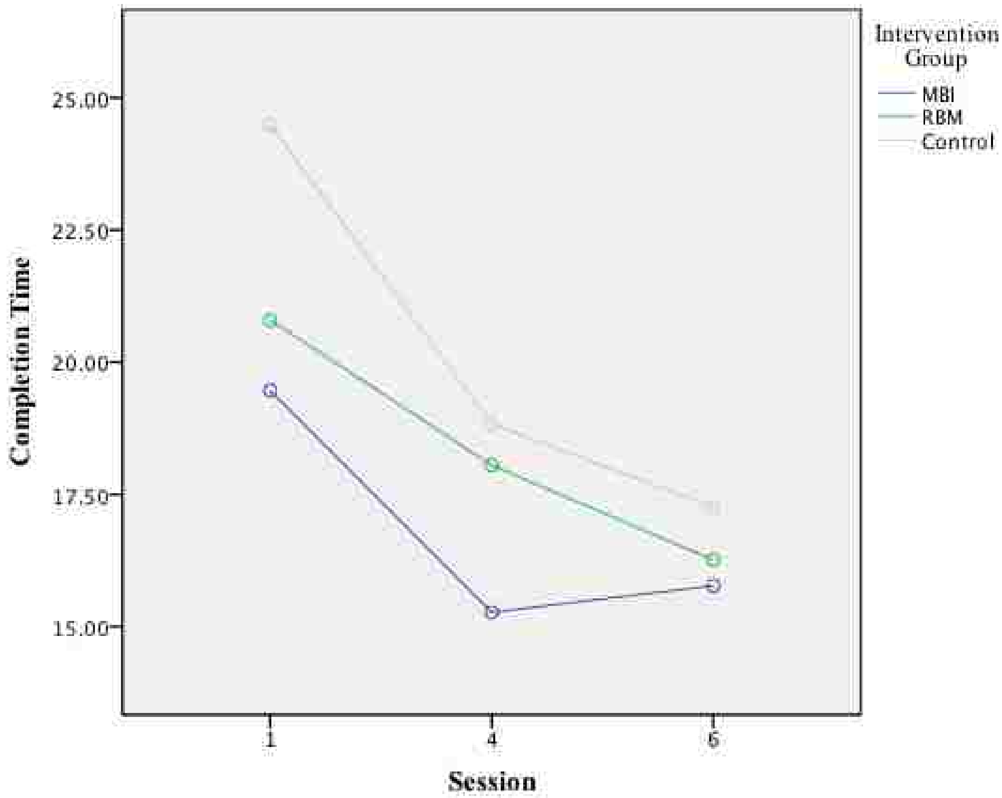


Figure 10. Trail Making Test Form A completion time, in seconds. All three intervention conditions became faster at completing the task.

Table 14.

Means and Standard Deviations of Completion Time on TMT B (in seconds)

	N	Session 1 M*(SD)*	Session 4 M*(SD)*	Session 6 M*(SD)*	Total M*(SD)*
MBI	18	41.06*(14.09)*	41.22*(14.00)*	37.33*(19.42)*	39.87*(15.83)*
RBM	18	41.17*(15.24)*	36.06*(12.15)*	35.94*(20.52)*	37.72*(15.97)*
Control	24	48.35*(13.31)*	42.50*(18.36)*	37.17*(15.34)*	42.67*(15.67)*

Table 15.

Pairwise Comparisons of TMT B scores across sessions

(I) TMTB	(J) TMTB	Mean Difference (I-J)	Std. Error	Sig.
1	4	3.59	1.91	.07
	6	6.74*	2.14	.003*
4	1	-3.59	1.91	.07
	6	3.14	2.05	.132
6	1	-6.74*	2.14	.003*
	4	-3.14	2.05	.13

*. The mean difference is significant at the $p < .05$ level

Figure 11.

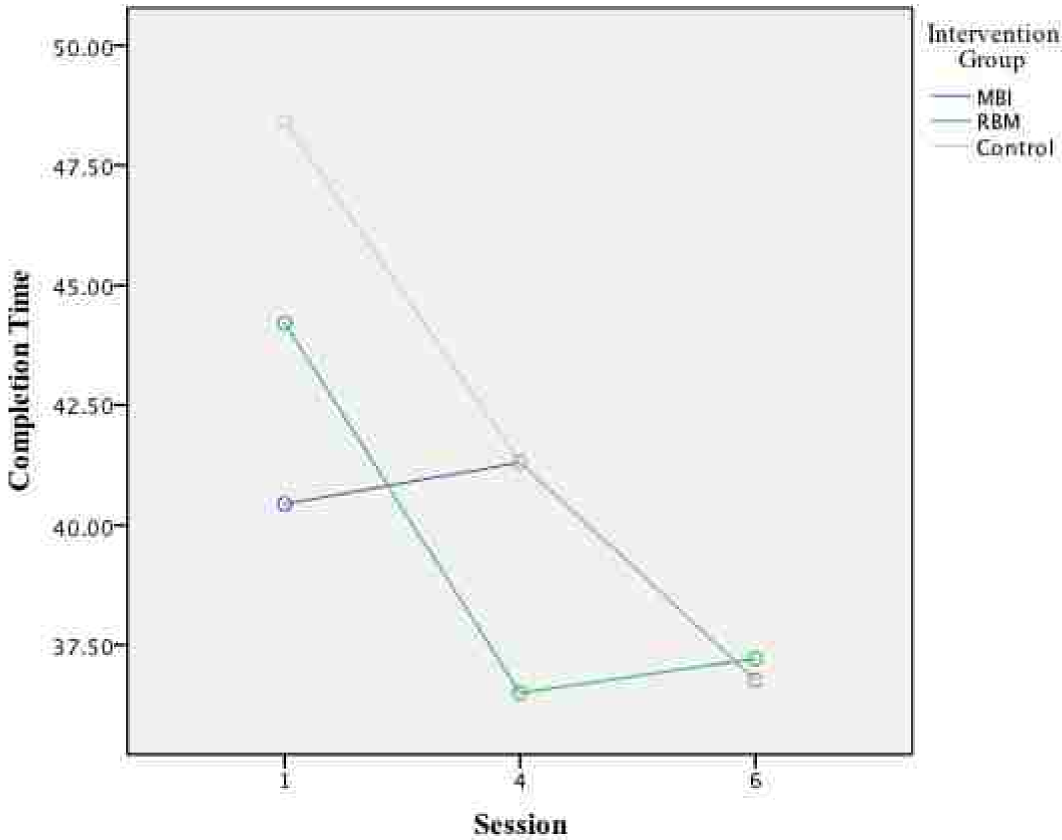


Figure 10. Trail Making Test Form B completion time, in seconds. All intervention conditions got faster over time.

Change in Inhibition (Stroop) Across Sessions

Three different outcome scores of the Stroop Test were of interest: a) change in reaction time for congruent trials, b) change in reaction time for incongruent trials, and c) overall accuracy over time. Means and standard deviations for congruent Stroop reaction times are included in Table 17.

Congruent reaction times. Congruent reaction time scores violated the assumptions of Sphericity ($\chi^2(2) = 6.18$, $p = .046$) and were adjusted using the Huynh- Feldt correction ($\varepsilon = .88$). Results showed that there was a main effect of congruent reaction times across session, $F(2, 96) = 5.37$, $p = .006$ $\eta 2_p = .101$, but not between intervention conditions $F(2, 96) = .088$, $p = .969$. Further, the interaction was non-significant, $F(4, 96) = 1.13$, $p = .35$. Pairwise comparisons (see Table 18) showed no significant differences in congruent trial reactions times between conditions, but reaction times across session were significantly different across sessions, with RT decreasing each session, indicating practice effects (See Figure 12).

Incongruent reaction time. Change in scores for incongruent trials (i.e., color and word differ) violated the assumption of Sphericity. Mauchley's Test of Sphericity was significant ($\chi^2(2) = 41.17$, $p < .000$), which indicated that the variance of the differences in scores across sessions were not equal. F-ratios were adjusted using the Greenhouse-Geisser correction ($\varepsilon = .42$). Means and standard deviations for incongruent Stroop results are included in Table 19. There was no main effect between intervention conditions, $F(2, 48) = .36$, $p = .70$ or between sessions, $F(1.26, 60.62) = 1.18$, $p = .31$. However, the interaction across sessions and between intervention group was approaching significance, $F(2.77, 60.62) = 2.47$, $p = .08$, $\eta 2_p = .09$.

Table 16.

Means and Standard Deviations for Congruent Reaction Times

	N	Session 1 M*(SD)*	Session 4 M*(SD)*	Session 6 M*(SD)*	Total M*(SD)*
MBI	18	793.23*(217.03)*	682.98*(193.07)*	618.37*(141.10)*	698.20*(183.73)*
RBM	16	837.87*(282.94)*	650.41*(113.91)*	635.34*(142.96)*	707.87*(179.93)*
Control	19	800.52*(151.57)*	711.09*(225.82)*	589.98*(134.71)*	700.53*(170.70)*

Table 17.

Pairwise Comparisons of Stroop Congruent Reaction Time Across Sessions

(I) congruent	(J) congruent	Mean Difference (I-J)	Std. Error	Sig.
1	4	129.99*	32.70	.000*
	6	196.59*	26.26	.000*
4	1	-129.99*	32.70	.000*
	6	66.61*	24.96	.010*
6	1	-196.59*	26.26	.000*
	4	-66.61*	24.96	.010*

*. The mean difference is significant at the $p < .01$

Figure 12.

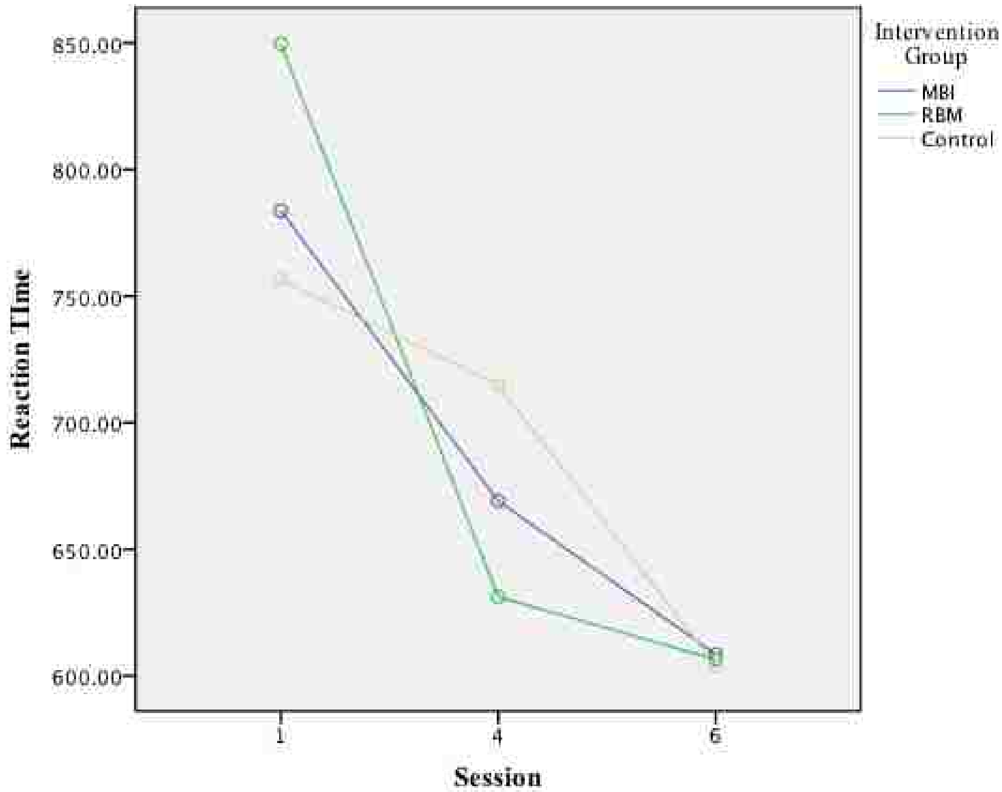


Figure 12. Reaction time (in milliseconds) for congruent trials (where color matched word).

All intervention conditions got markedly faster in responding over time.

Table 18.

Means and Standard Deviations of Stroop Incongruent Reaction Times

	N	Session 1 M*(SD)*	Session 4 M*(SD)*	Session 6 M*(SD)*	Total M*(SD)*
MBI	18	905.07*(192.62)*	830.69*(289.99)*	758.39*(197.50)*	831.38*(226.7)*
RBM	18	983.35*(380.71)*	817.99*(221.29)*	788.03*(213.73)*	863.09*(271.91)*
Control	24	1165.22*(683.56)*	751.83*(186.30)*	674.50*(191.86)*	863.85*(353.9)*

Table 19.

Pairwise Comparisons of Change in Incongruent RT across sessions

(I) Session	(J) Session	Mean Difference (I-J)	Std. Error	Sig.
1	4	218.40*	65.72	.002*
	6	278.31*	64.52	.000*
4	1	-218.40*	65.72	.002*
	6	59.91*	26.95	.031*
6	1	-278.31*	64.52	.000*
	4	-59.91*	26.95	.031*

*. The mean difference is significant at the $p < .05$

Figure 13.

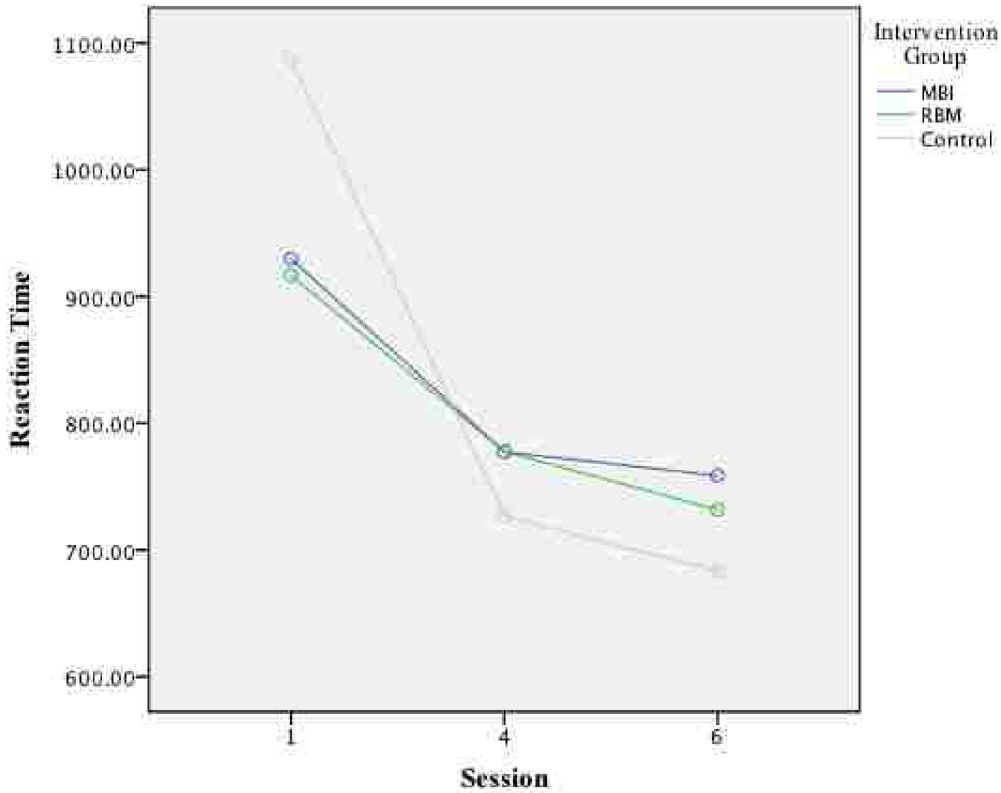


Figure 13. Reaction time (in milliseconds) of Stroop incongruent trials (color and word do not match). All groups got faster at the activity over time.

Pairwise comparisons (see Table 20) showed no significant differences in incongruent trial reactions times between conditions, but reaction times across session were significantly different across sessions, with RT decreasing each session, indicating practice effects (See Figure 12).

Total accuracy. Total accuracy scores on the Stroop task over time were also analyzed. Means and standard deviations for total Stroop results are included in Table 21. Mauchley's Test of Sphericity was significant ($\chi^2(2) = 7.11$, $p < .03$), which indicated that the variance of the differences in scores across sessions were not equal. F-ratios were adjusted using the Hyunh-Feldt correction ($\varepsilon = .86$). There was no main effect of intervention group $F(2, 48) = .36$; $p = .70$, or session $F(1.96, 94.41) = 1.98$, $p = .14$; however, the interaction between intervention group and session time was significant, $F(3.93, 94.41) = 2.65$, $p = .04$, $\eta 2_p = .099$, which indicated that the intervention that participants received may have impacted their inhibition skills, specifically maintaining the directions and blocking out competing thoughts or distractions when completing the Stroop activity. Namely, participants in the MBI condition showed more accurate Stroop scores across sessions. Pairwise comparisons (see Table 22) showed no significant differences in total accuracy between conditions, but accuracy across sessions were significantly different, indicating practice effects (See Figure 13).

Table 20.

Means and Standard Deviations of Stroop Total Accuracy Scores

	N	Session 1 M*(SD)*	Session 4 M*(SD)*	Session 6 M*(SD)*	Total M*(SD)*
MBI	18	.87*(.08)*	.91*(.07)*	.94*(.05)*	.91*(.07)*
RBM	16	.83*(.14)*	.96*(.07)*	.92*(.07)*	.90*(.10)*
Control	19	.87*(.09)*	.90*(.10)*	.92*(.05)*	.90*(.08)*

Table 21.
Pairwise Comparisons of Stroop Total Accuracy Scores Across Session

(I) Session	(J) Session	Mean Difference (I-J)	Std. Error	Sig.
1	4	-.07*	.02	.000*
	6	-.07*	.02	.000*
4	1	.07*	.02	.000*
	6	-.01	.02	.67
6	1	.07*	.02	.000*
	4	.01	.02	.67

*. The mean difference is significant at the $p < .01$

Figure 14.

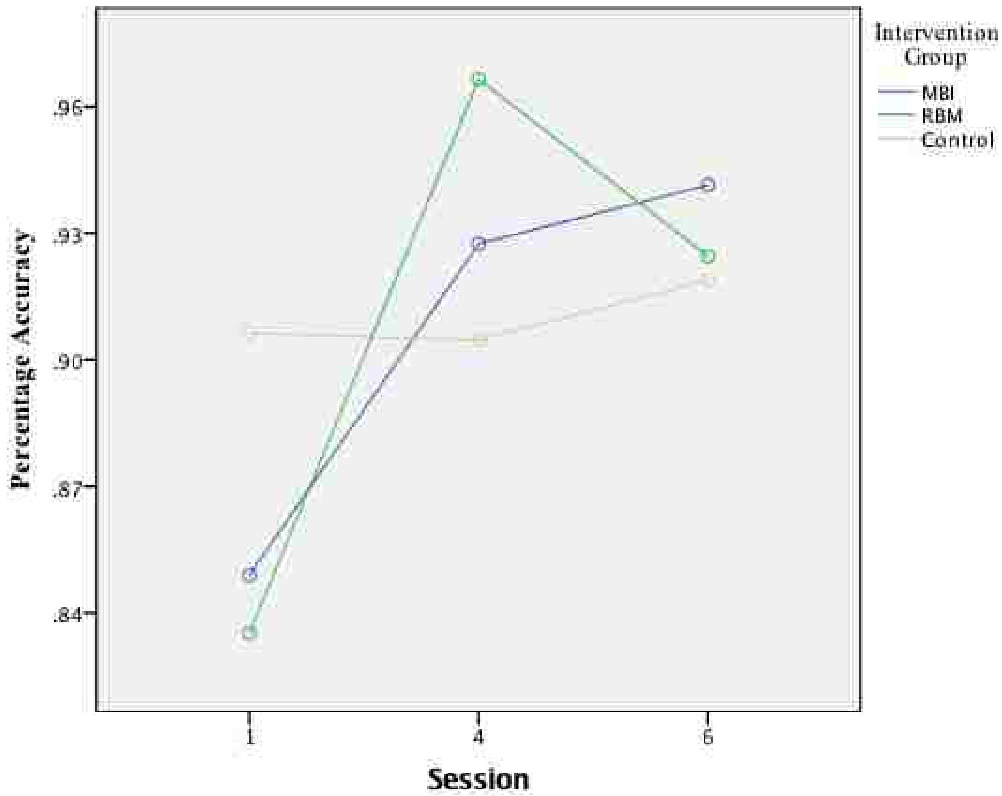


Figure 14. Percentage accuracy of responding on both incongruent and congruent Stroop trials.

Multivariate Analysis of the Interactions between Working Memory, Inhibition, Task-Switching, Mind-wandering and Mood Across Sessions

Repeated-measures MANCOVA examined WTAR and MAAS scores as covariates, the Stroop task, TMT, OSPAN, PANAS, and mind-wandering probes as dependent variables (DVs), and treatment condition (MBI, RBM, Control) as independent variables (IVs). The second mind-wandering question, which probed the nature of the participants' thoughts was excluded from this analysis due to the categorical nature of the variable and were analyzed with a chi-square analysis and contingency table contrasting (Grace- Martin, 2017). All dependent and control variables were centered around the group mean for each variable to combat multicollinearity between the dependent variables (Field, 2009). The total number of participants in analysis (N= 35) included only participants who completed *all* measures across the six intervention sessions. Since list-wise deletion reduced the sample size so greatly the power, reliability, and validity of the study must be fully considered. However, the data provide valuable information for examining trends that may exist in fully-completed data and for refining and detailing future research collection questions and methods.

Means and standard deviations for the repeated-measures MANCOVA are listed in Table 23. Mauchley's tests of Sphericity were significant for the OSPAN ($\chi^2(2) = 6.581$ $p <$ .037), TMT version A scores ($\chi^2(2) = 6.89$ $p < .032$) and PANAS negative mood ratings ($\chi^2(2) = 11.54$, $p < .002$). Thus, the F tests on these variables were adjusted using the Huynh-Feldt calculation.

Within – subjects effects. There were significant interactions between session and the covariate of intelligence. Intelligence significantly interacted with OSPAN scores $F(1.98, 59.88) = 3.18$, $p = .026$, $\eta 2_p = .115$, with higher intelligence associated with higher

OSPAN scores. Stroop Congruent Reaction Time Scores also interacted with intelligence $F(2, 60) = 3.81$, $p=.028$, $\eta 2_p = .04$, as did PANAS negative total scores $F(1.76, 53.28) = 5.20$, $p=.011$, $\eta 2_p = .14$ indicating those with higher WTAR scores were faster in responding in trials where colors were congruent to words, and ultimately reported lower negative mood states. No other dependent variables were affected by this interaction. No dependent variables were significantly affected by the covariate of trait mindfulness.

There was a significant main effect of session number on OSPAN scores $F(2, 56) = 3.18$, $p =.049$, $\eta 2_p = .10$. There was also a main effect of session on Stroop Congruent Reaction Times $F(2, 56) = 3.81$, $p=.028$, $\eta 2_p = .11$. Negative mood ratings on the PANAS also showed a main effect across sessions $F(1.78, 56) = 3.71$, $p =.036$, $\eta 2_p = .11$. These significant effects suggest that OSPAN, Stroop Congruency trials, and negative mood effects were significantly affected by the session in which the data was collected, but not necessarily by the intervention group the participant was in. There were no significant main effects of session on Stroop congruent RT $F(2, 56)= .91$, $p =.410$, Stroop Incongruent Reaction times $F(2, 56)= 1.07$, $p =.35$, TMT A scores $F(2, 56)= .020$, $p =.98$, TMT B scores $F(2, 56)= 1.83$, $p =.27$, or either of the mind-wandering probes: Q1) $F(2, 56)= .17$, $p =.90$; Q3) F(2, 56)= 1.81, $p =.174$. The main effect of session number on PANAS positive scores was approaching significance, $F(2, 56) = 2.97$, $p =.059$.

There was a significant interaction of session number by condition on Stroop Accuracy Scores $F(4, 60) = 2.53$, $p=.05$, $\eta 2_p = .14$, indicating participants who received MBI increased their accuracy in the inhibition task more so than the other intervention conditions. Further, there was a significant session by condition interaction on PANAS positive scores $F(4, 60) = 2.75$, $p=.036$, $\eta 2_p = .16$, displaying a significant difference in mood ratings across session dependent on intervention received, with individuals who received MBI ultimately reporting the most positive changes in mood. There was also a significant session by condition interaction on reported mind-wandering question one, probing where the participant's attention was directed during the task $F(2, 56) = 2.86$, $p=.031$, $\eta 2_p = .160$, indicating that participants who received either the MBI or RBM intervention reported decreased mind-wandering across sessions more than those in the Control condition. There were no other significant interactions between session and condition on any of the dependent variables, including OSPAN $F(4, 60)= 1.38$, $p=.25$, Stroop Incongruent $F(4, 60)= 2.26$, $p=.073$, and Congruent $F(4, 60)= 1.07$, $p=.380$ reaction times, TMT A $F(4, 60)= .47$, $p=.76$ or B $F(4, 60)= .58$, $p=.67$ scores, negative mood $F(4, 60)= 1.18$, $p=.329$, or three $F(4, 60)= .72$, $p=.581$. Table 24 displays the pairwise comparisons between each group.

Between-subjects effects. There was also a significant effect of intelligence scores between conditions on Incongruent Stroop Trials, $F(1,28) = 5.26$, $p = .029$, $\eta 2_p = .194$, and Stroop Total Accuracy: $F(1,28) =5.07$, $p = .032$, $\eta 2_p = .144$. This result suggests that intelligence may have predicted Stroop scores more so than which intervention was implemented. No dependent variables were significantly affected by the interaction of condition by the covariate of trait mindfulness. There was a main effect of condition on self-reported mind-wandering question one $F(2,30) =4.52$, $p = .019$, $\eta 2_p = .232$, indicating that the intervention received affected the reported rate of mind-wandering across sessions. Table 25 shows the comparisons across sessions. Overall, many dependent variables were significantly affected by session more so than assigned condition. Figures 14- 24 show change in each of the dependent variables across session.

Power analyses. Before starting the experiment, a power analysis was conducted using G*Power software (Faul, Erdfelder, Lang, & Buchner, 2007) to determine the number of participants needed to demonstrate experimental results. An effect size of 0.3 (d = 0.3), which indicates a small to moderate effect of the intervention was chosen for the analyses because it was found to be consistent with the effect sizes of research across a recent meta-analysis (Zenner et al, 2014). An alpha of .05 (α = .05) was used to calculate the sample size. As a result, it was determined that a minimum of 111 participants will be needed for this study.

A post-hoc power analyses was conducted on the MANCOVA data to determine how much the participant attrition had affected the strength of the data. (N=35). Suitable power is usually considered to be a .08 in statistical results (Field, 2009). None of the dependent variable results from the MANCOVA showed this level of power, supporting the notion the experiment was underpowered and must be interpreted with this consideration at the forefront. (see Table 25).

Table 22.

Means and Standard Deviations of Dependent Variables Across Intervention Groups

	Intervention Group							
	MBI		RBM		Control		Total	
	Mean (SD)	*N*	Mean(SD)	*N*	Mean (SD)	*N*	Mean(SD)	*N*
OSPAN 1	55.41 (17.06)	12	56.25 (13.64)	12	61.90 (11.55)	11	57.74 (14.21)	35
OSPAN 4	59.25 (14.67)	12	60.42(12.38)	12	56.45 (18.62)	11	58.77(14.97)	35
OSPAN 6	61.66 (8.42)	12	61.83 (13.28)	12	58.65 (17.47)	11	60.77(13.11)	35
Stroop Acc 1	.85(.09)	12	.83 (.12)	12	.91(.08)	11	.86 (.10)	35
Stroop Acc 4	.93(.06)	12	.96 (.08)	12	.91(.13)	11	.93(.09)	35
Stroop Acc 6	.94(.05)	12	.91(.08)	12	.92(.05)	11	.93(.06)	35
Stroop Inc. RT 1	915.19 (117.42)	12	951.40(295.94)	12	1065.09(345.21)	11	974.72(268.19)	35
Stroop Inc. RT 4	793.73(252.12)	12	777.03(175.69)	12	709.52(157.32)	11	761.54(197.88)	35
Stroop Inc. RT 6	767.71 (204.41)	12	728.31(143.88)	12	676.88(230.59)	11	725.66(193.00)	35
Stroop Con. RT 1	799.55(205.92)	12	839.78(262.09)	12	749.91(146.18)	11	797.75(208.78)	35
Stroop Con. RT 4	656.30(131.95)	12	642.94(117.28)	12	715.72(233.15)	11	670.40(164.53)	35
Stroop Con. RT 6	605.91(145.78)	12	608.80(116.86)	12	604.31(161.29)	11	606.39(137.66)	35
TMT A 1	20.41(6.15)	12	19.42(6.08)	12	24.95(14.51)	11	21.50(9.59)	35
TMT A 4	15.66(6.21)	12	17.50(5.45)	12	19.00(6.79)	11	17.34 6.13	35
TMT A 6	15.66(5.01)	12	16.50(7.90)	12	17.13(5.19)	11	16.41(6.05)	35
TMT B 1	40.91(11.01)	12	43.92(16.69)	12	48.21(14.79)	11	44.24(14.24)	35
TMT B 4	42.00(15.60)	12	36.58(10.47)	12	40.45(20.72)	11	39.66(15.67)	35
TMT B 6	37.8(21.97)	12	37.67(23.84)	12	35.09(11.76)	11	36.91(19.55)	35

PANAS Positive 1	27.08(5.99)	12	29.33(7.81)	12	24.54(7.88)	11	27.06(7.32)	35
PANAS Positive 4	30.08(9.46)	12	25.42(7.96)	12	29.27(9.18)	11	28.23(8.86)	35
PANAS Positive 6	30.41(8.13)	12	30.00(9.93)	12	28.90(9.77)	11	29.80(9.04)	35
PANAS Negative 1	17.91(8.06)	12	17.92(6.45)	12	16.18(4.87)	11	17.37(6.49)	35
PANAS Negative 4	13.75(3.30)	12	15.50(3.77)	12	13.09(4.04)	11	14.14(3.74)	35
PANAS Negative 6	13.16(2.75)	12	12.83(1.99)	12	14.18(4.47)	11	13.37(3.15)	35
MW Question 1: 2	2.67(.88)	12	2.17(.83)	12	1.82(.603)	11	2.23(.84)	35
MW Question 1:4	2.83(1.03)	12	2.08(.79)	12	1.45(.52)	11	2.14(.97)	35
MW Question 1:6	2.17(.94)	12	1.67(.49)	12	2.00(.63)	11	1.94(.73)	35
MW 3:2	2.43(.32)	12	2.48(.68)	12	2.42(.249)	11	2.44(.45)	35
MW 3:4	2.58(.99)	12	2.33(.89)	12	2.63(.924)	11	2.51(.92)	35
MW 3:6	2.25(.96)	12	2.08(.67)	12	2.27(.467)	11	2.20(.72)	35

Table 23.

Pairwise comparisons of each dependent variable across sessions

Measure	(I) Session	(J) Session	Mean Difference (I-J)	Std. Error	Sig.
OSPAN	1	4	-.86	1.381	.54
		6	-2.89	2.07	.17
	4	1	.86	1.38	.54
		6	-2.03	2.05	.33
	6	1	2.89	2.07	.17
		4	2.03	2.05	.33
Stroop Total Accuracy	1	4	-.07*	.02	.001*
		6	-.07*	.02	.000*
	4	1	.07*	.02	.001*
		6	.01	.02	.79
	6	1	.07*	.02	.000*
		4	-.01	.02	.79
Stroop Incongruent RT	1	4	217.27*	44.13	.000*
		6	253.36*	41.36	.000*
	4	1	-217.27*	44.13	.000*
		6	36.09	30.26	.24
	6	1	-253.36*	41.36	.000*
		4	-36.09	30.26	.24
Stroop Congruent RT	1	4	124.97*	39.39	.003*
		6	190.27*	31.53	.000*
	4	1	-124.97*	39.39	.003*

		6	65.299*	28.32	.028*
	6	1	-190.27*	31.53	.000*
		4	-65.30*	28.32	.028*
TMT A	1	4	4.20*	1.12	.001*
		6	5.15*	1.52	.002*
	4	1	-4.20*	1.12	.001*
		6	.95	1.07	.38
	6	1	-5.15*	1.52	.002*
		4	-.95	1.07	.38
TMT B	1	4	4.65	2.68	.09
		6	7.44*	2.99	.019*
	4	1	-4.65	2.68	.09
		6	2.79	3.04	.37
	6	1	-7.44*	2.98	.019*
		4	-2.79	3.04	.37
PANAS positive	1	4	-1.28	1.23	.31
		6	-2.81	1.39	.054
	4	1	1.28	1.23	.31
		6	-1.53	1.51	.32
	6	1	2.81	1.40	.054
		4	1.53	1.51	.32
PANAS negative	1	4	3.25*	1.05	.004*
		6	3.96*	1.14	.002*
	4	1	-3.25*	1.05	.004*
		6	.71	.64	.28

	6	1	-3.96*	1.14	.002*
		4	-.71	.64	.28
Mind-wandering Q1	2	4	.09	.17	.58
		6	.27	.16	.10
	4	1	-.09	.17	.58
		6	.18	.13	.19
	6	1	-.27	.16	.09
		4	-.18	.13	.19
Mind-wandering Q3	2	4	-.08	.15	.61
		6	.24	.15	.11
	4	1	.08	.15	.61
		6	.32*	.14	.028*
	6	1	-.24	.15	.11
		4	-.38*	.14	.028*

*. The mean difference is significant at the $p < .05$

Table 24.

Pairwise Comparisons of Changes Between Intervention conditions

Measure	(I) Intervention Group	(I) Intervention Group	Mean Difference (I-J)	Std. Error	Sig.
OSPAN	MBI	RBM	-2.82	5.53	.61
		Control	.15	5.31	.98
	RBM	MBI	2.82	5.53	.61
		Control	2.97	5.45	.59
	Control	MBI	-.15	5.31	.98
		RBM	-2.97	5.45	.59
Stroop Total Accuracy	MBI	RBM	-.003	.03	.91
		Control	-.004	.03	.87
	RBM	MBI	.003	.03	.91
		Control	-.001	.03	.96
	Control	MBI	.004	.03	.87
		RBM	.001	.03	.96
Stroop Incongruent RT	MBI	RBM	13.25	75.04	.86
		Control	-10.40	72.12	.89
	RBM	MBI	-13.25	75.04	.86
		Control	-23.65	73.96	.75
	Control	MBI	10.40	72.12	.89
		RBM	23.65	73.96	.75

Stroop Congruent RT	MBI	RBM	-8.64	60.24	.89
		Control	-4.66	57.89	.94
	RBM	MBI	8.64	60.24	.89
		Control	3.97	59.37	.95
	Control	MBI	4.66	57.89	.95
		RBM	-3.97	59.37	.95
TMT A	MBI	RBM	-1.53	2.74	.58
		Control	-3.36	2.63	.21
	RBM	MBI	1.53	2.74	.58
		Control	-1.82	2.70	.51
	Control	MBI	3.36	2.63	.21
		RBM	1.82	2.70	.51
TMT B	MBI	RBM	.20	5.87	.97
		Control	-2.65	5.64	.64
	RBM	MBI	-.20	5.87	.97
		Control	-2.85	5.79	.63
	Control	MBI	2.65	5.64	.64
		RBM	2.85	5.79	.63
PANAS positive	MBI	RBM	.41	3.15	.90
		Control	1.34	3.03	.66
	RBM	MBI	-.41	3.15	.90
		Control	.93	3.10	.77
	Control	MBI	-1.34	3.03	.66
		RBM	-.93	3.10	.77
PANAS negative	MBI	RBM	.21	1.42	.88
		Control	.59	1.36	.67

	RBM	MBI	-.21	1.42	.88
		Control	.38	1.40	.80
	Control	MBI	-.59	1.36	.70
		RBM	-.38	1.40	.80
Mind-wandering Q1	MBI	RBM	.49	.26	.07
		Control	.74*	.25	.006*
	RBM	MBI	-.49	.26	.07
		Control	.25	.26	.34
	Control	MBI	-.74*	.25	.006*
		RBM	-.25	.26	.34
Mind-wandering Q3	MBI	RBM	.23	.24	.40
		Control	-.01	.23	.98
	RBM	MBI	-.23	.24	.35
		Control	-.24	.24	.33
	Control	MBI	.01	.23	.98
		RBM	.24	.24	.33

Based on estimated marginal means

*. The mean difference is significant at the $p < .05$

Table 25.

Effect Sizes and Observed Power of MANCOVA Analysis.

Main Effects and Interactions	*Dependent Variable*	*Sig. (p)*	*Partial Eta Squared (d)*	*Observed Power*
Session number	WMC	.049*	.096	.066
	Stroop Accuracy	.410	.029	.055
	Stroop Incongruent RT	.351	.003	.063
	Stroop Congruent RT	.092	.074	.481
	TMT A	.028*	.116	.705
	TMT B	.980	.001	.054
	PANAS positive mood	.059	.090	.771
	PANAS negative mood	.030*	.110	.171
	Mind-wandering question 1	.958	.001	.228
	Mind-wandering question 3	.995	.000	.173
*Interaction: session number * Trait Mindfulness*	WMC	.971	.001	.051
	Stroop Accuracy	.920	.003	.054
	Stroop Incongruent RT	.204	.052	.370
	Stroop Congruent RT	.187	.054	.358
	TMT A	.181	.055	.404
	TMT B	.922	.003	.068

	PANAS positive mood	.080	.081	.211
	PANAS negative mood	.241	.043	.223
	Mind-wandering question 1	.593	.017	.127
	Mind-wandering question 3	.253	.084	.101
*Interaction: Session number * Intelligence*	WMC	.026*	.115	.104
	Stroop Accuracy	.377	.032	.326
	Stroop Incongruent RT	.298	.040	.370
	Stroop Congruent RT	.349	.035	.416
	TMT A	.253	.045	.459
	TMT B	.094	.076	.423
	PANAS positive mood	.073	.084	.098
	PANAS negative mood	.008*	.148	.065
	Mind-wandering question 1	.678	.013	.053
	Mind-wandering question 3	.327	.037	.403
*Interaction: Session number * Intervention group*	WMC	.253	.084	.441
	Stroop Accuracy	.05*	.144	.625
	Stroop Incongruent RT	.073	.131	.638
	Stroop Congruent RT	.380	.067	.433
	TMT A	.758	.030	.185
	TMT B	.676	.037	.239

PANAS positive mood	.036*	.155	.240
PANAS negative mood	.073	.131	.288
Mind-wandering question 1	.031*	.160	.769
Mind-wandering question 3	.581	.046	.428

* denotes significance at $p < .05$

Figure 15.

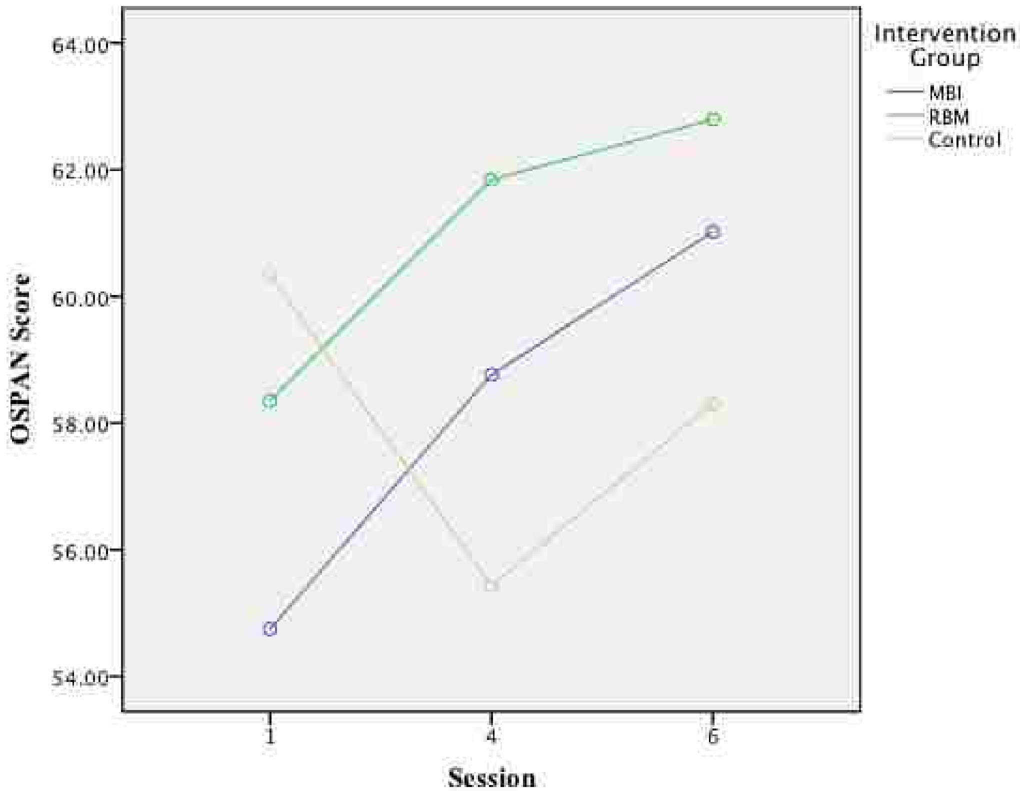


Figure 15. Mean OSPAN scores by intervention condition. Higher scores indicated better working memory capacity.

Figure 16.

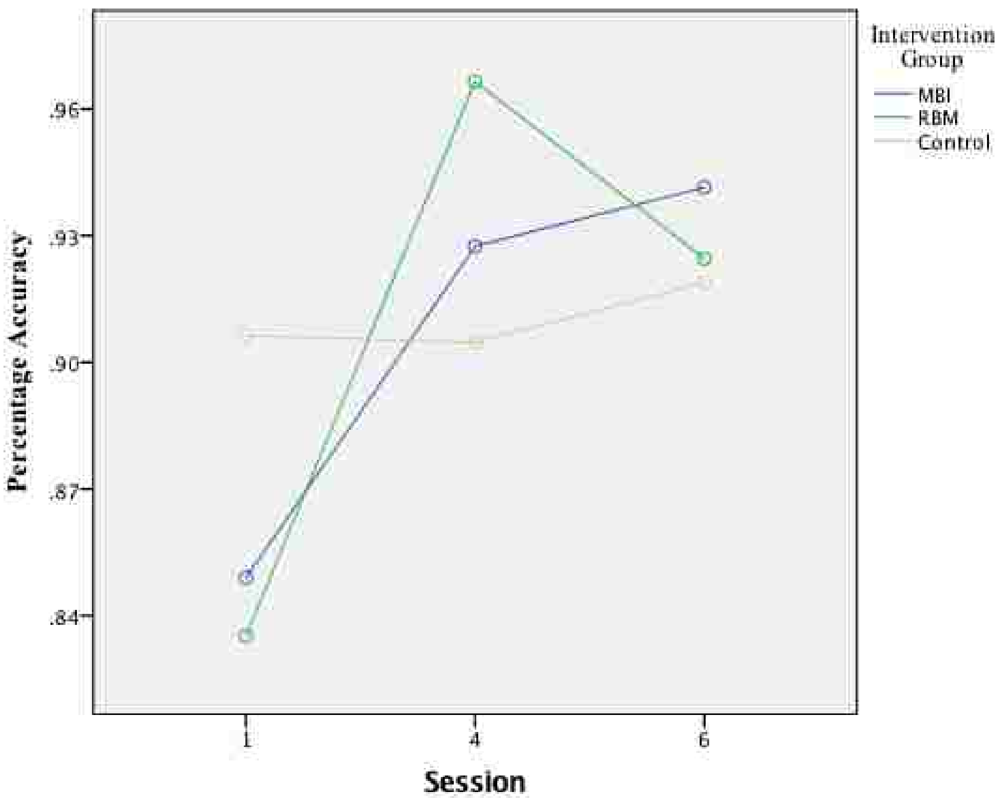


Figure 16. Total percentage accuracy of incongruent and congruent trials on the Stroop task.

Figure 17.

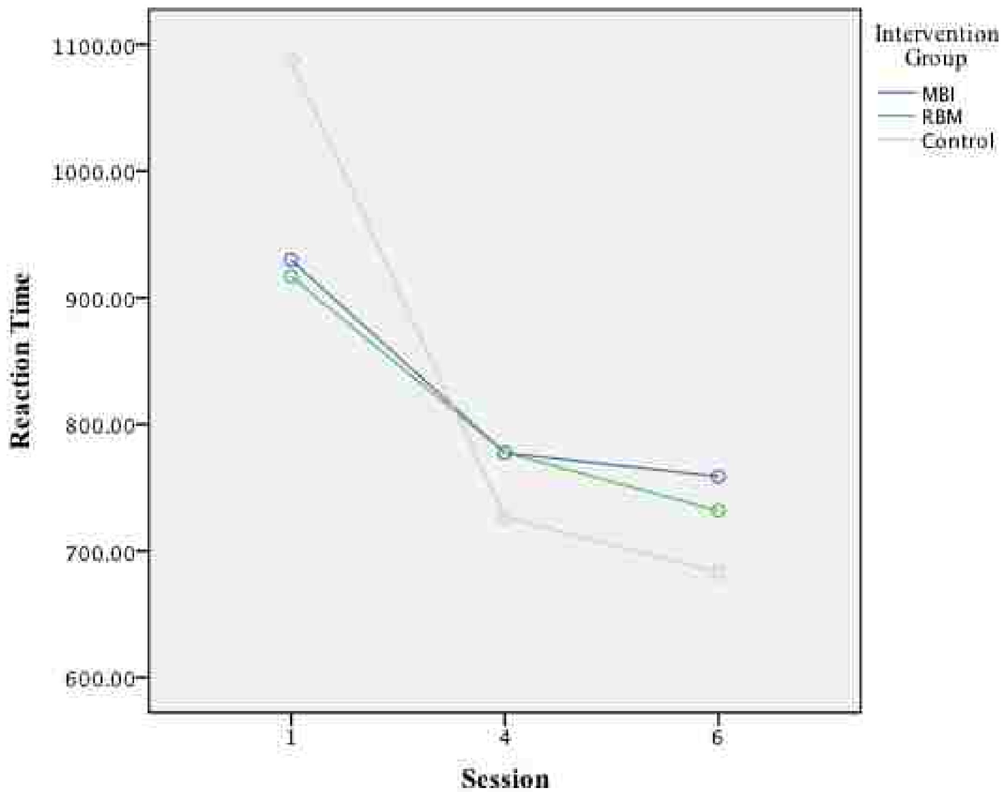


Figure 17. Reaction time (in milliseconds) for the Stroop incongruent (color and word do not match) trials.

Figure 18.

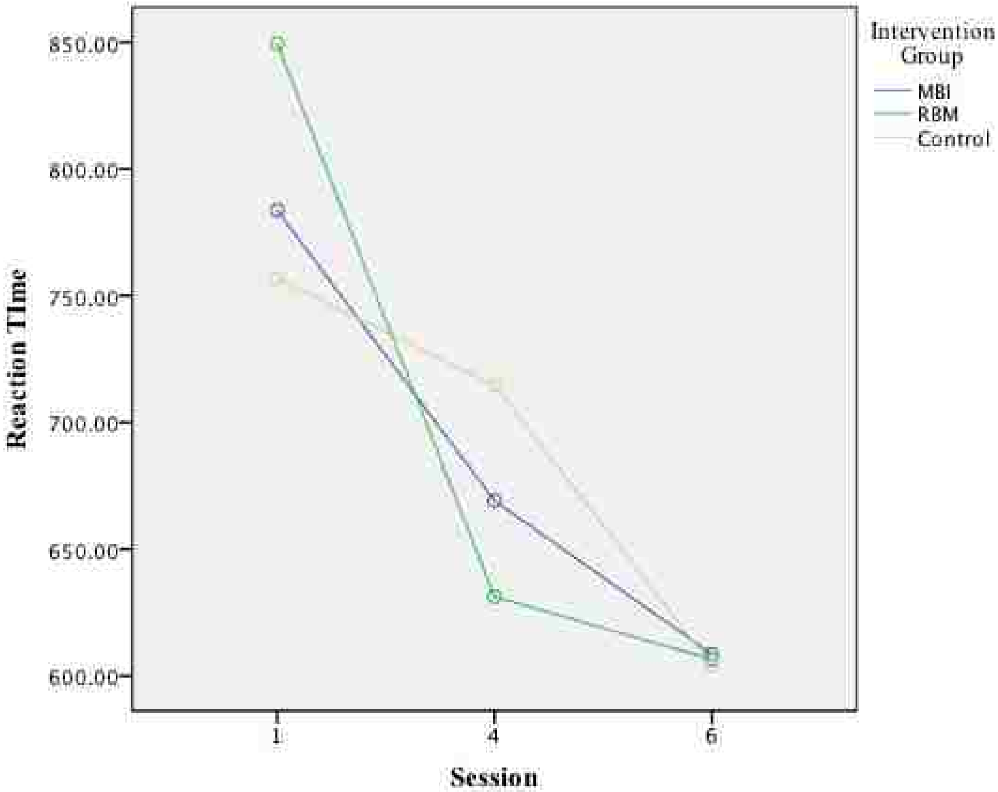


Figure 18. Mean reaction time (in milliseconds) for congruent word trials (word and color are the same).

Figure 19.

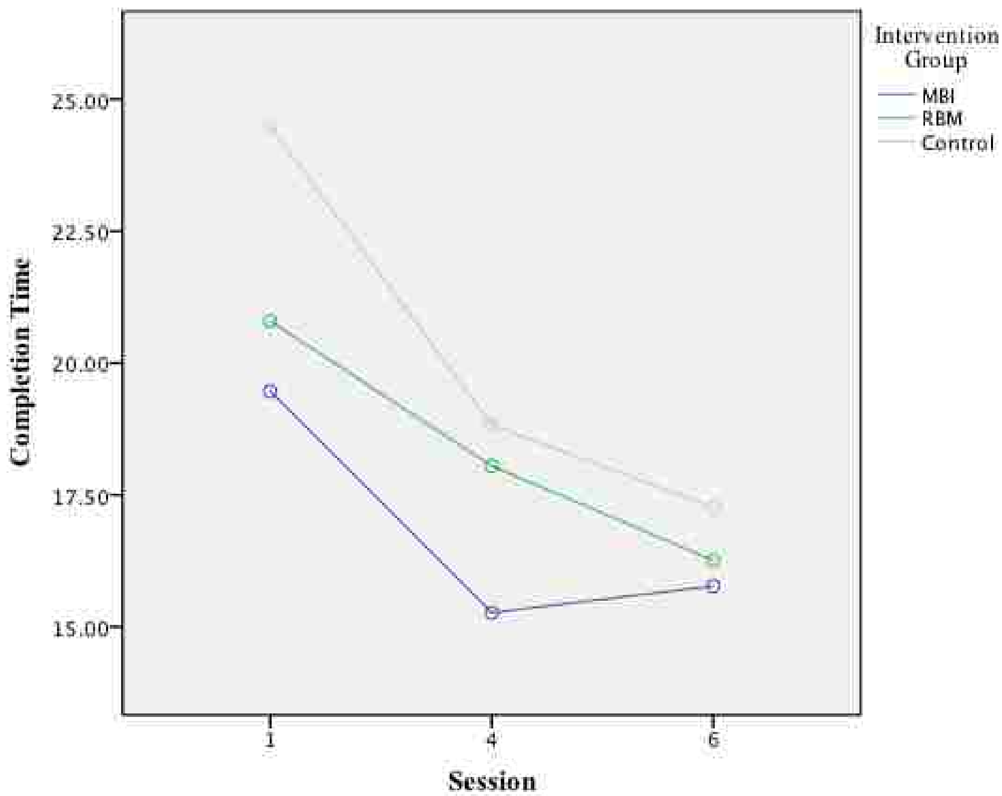


Figure 19. TMT A completion time (in seconds) across intervention groups and sessions.

Figure 20.

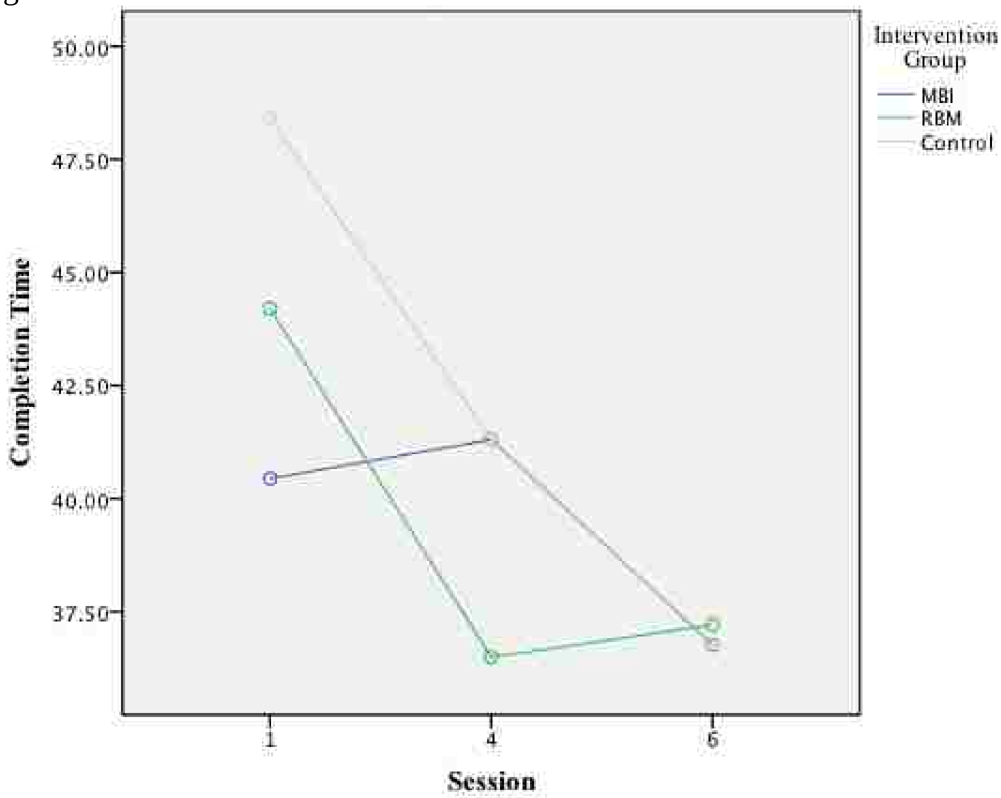


Figure 20. Completion time (in seconds) for the Trail Making Test, Part B.

Figure 21.

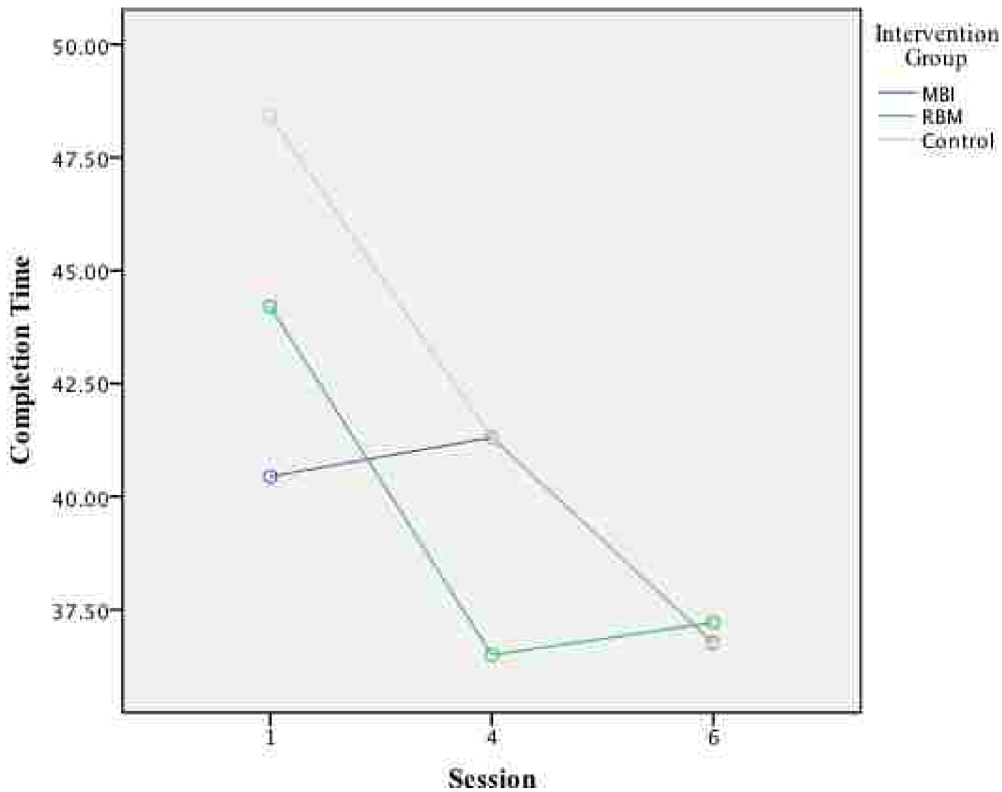


Figure 21. PANAS positive mood ratings. Higher ratings signify more positive mood.

Figure 22.

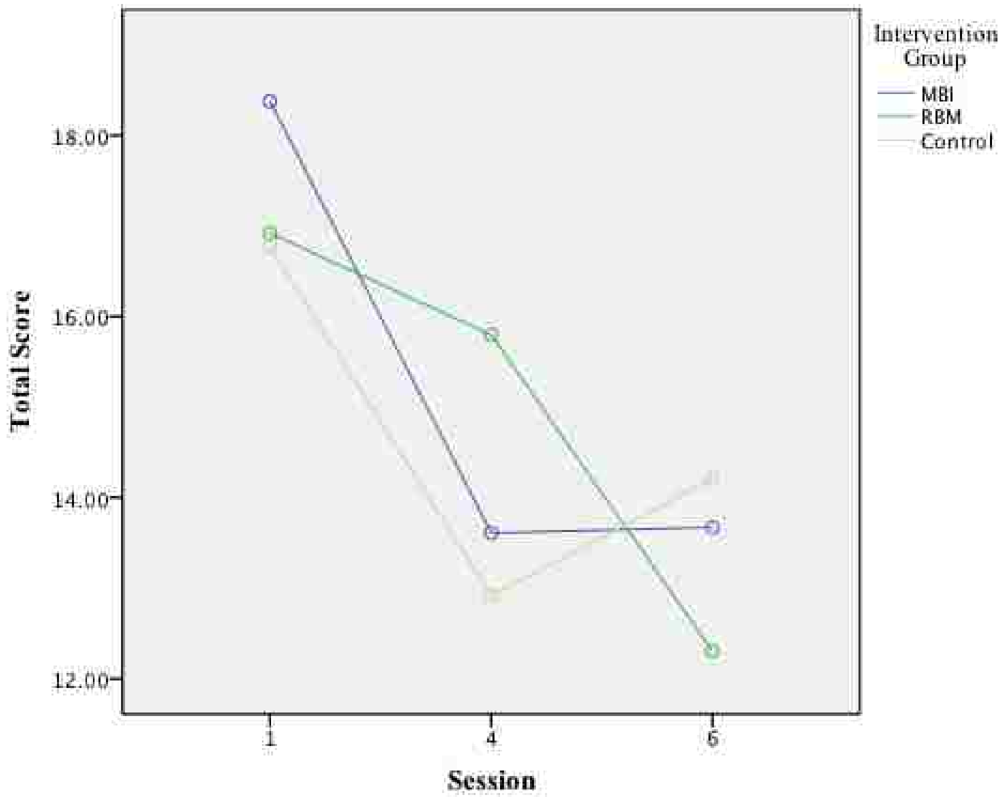


Figure 22. Negative mood ratings on the PANAS. Higher score signifies more negative mood.

Figure 23.

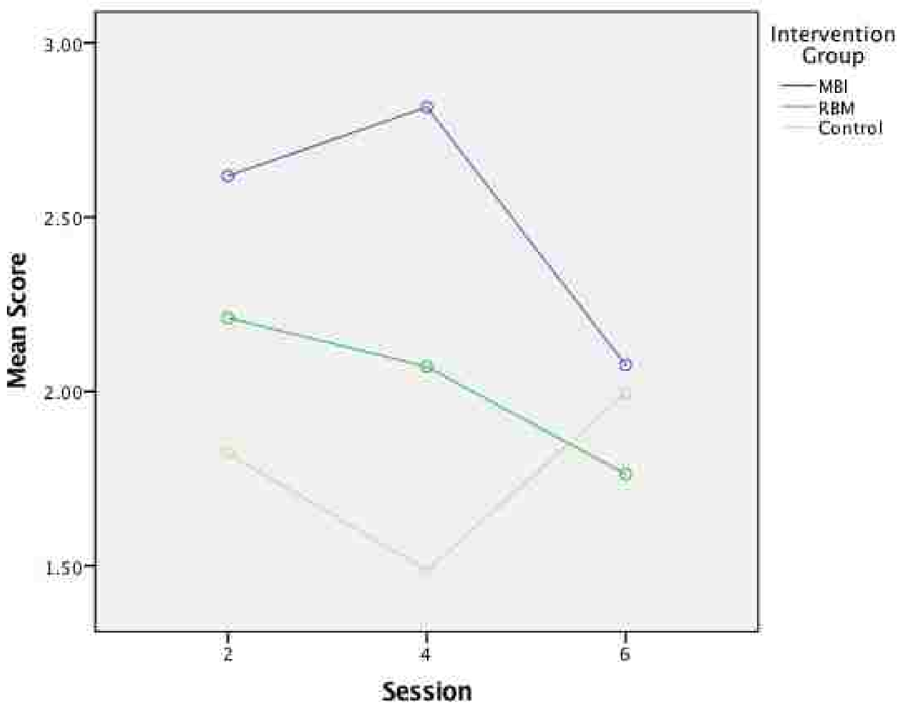


Figure 23. Mean responses to the question, "In the moments prior to this probe, your attention was focused on…"

Figure 24.

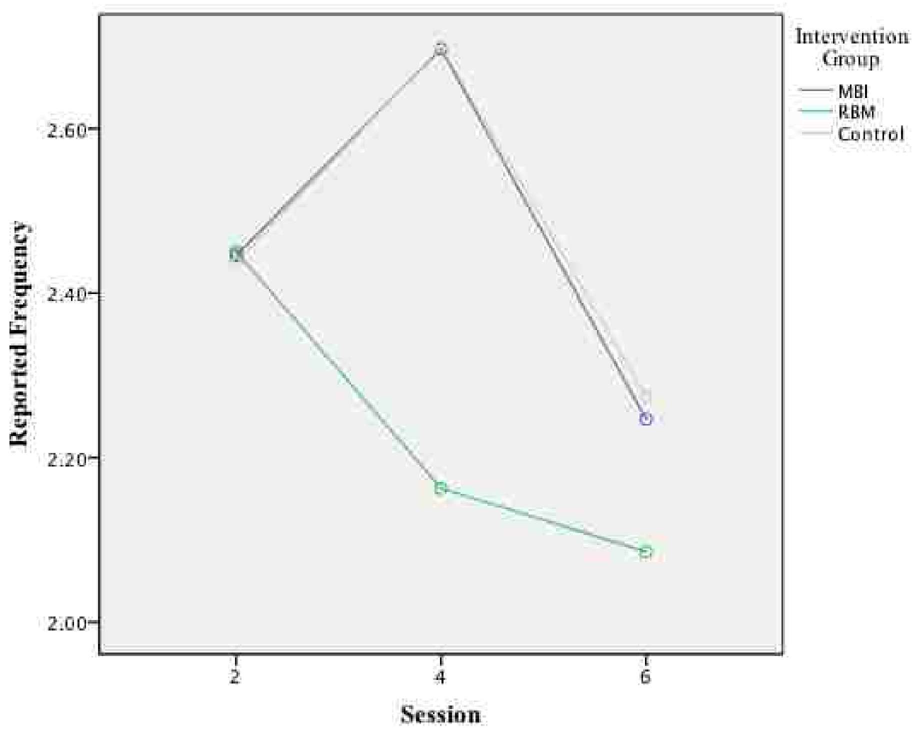


Figure 24. Mean responses to the question, "How Frequently Did You Mind-wander During this Task?"

Chapter V

Discussion, Limitations, and Future Directions

Discussion

The purpose of this experimental study was to further understand how brief MBIs lead to improvement in executive processing; particularly mind-wandering, attentional control, inhibition and task switching over time. Specifically, this study aimed to establish further evidence that MBIs improved attentional control processes such as working memory, inhibition, and task switching, as well as decreasing mind-wandering and negative mood through repetitive practice of focus attention and awareness on the present moment. This randomized control experiment provided further insight into the underlying attentional processes benefitted by MBI. Specifically, I hypothesized that participants in the MBI group would demonstrate a greater increase in working memory, inhibition, task switching and positive mood ratings; as well as decreased mind-wandering scores, compared to individuals in the RBM and control conditions.

Effect of MBI on Working Memory Capacity

The first goal of this study was to examine how repeated exposure to MBI impacted individual WMC over time. The current research study showed no significant effect of intervention condition on improvement in WMC, which differs from previous research studies. For example, Mrazek and colleagues (2012) found that exposure to a short MBI was connected to participants' WMC and GRE test scores. Further, Mrazek and colleagues (2013) determined brief MBIs had effects on WMC and performance on GRE test questions. In these studies, participants who received the brief MBI exhibited an increase in scores of WM and a reduction in self-reported mind-wandering. The current experiment's sample size, which was less robust than prior research, showed trends that supported the previous research, but called for stronger power and a larger sample to definitively draw conclusions about the success of MBI on individual WMC.

Similarly, using ANCOVA analysis to singularly measure WMC scores over time, MBI did not significantly improve working memory capacity compared to RBM and Control conditions. However, trends suggested that individuals who received an intervention (e.g., MBI or RBM) consistently improved their scores over time as compared to the control group. Further, participants in the control condition, who started with the highest working memory, produced more variable scores across sessions, suggesting that the interventions in which participants were guided through may have been advantageous to the participants, and improvement may not have been a result of pure practice effects. These trends are not significant, but are encouraging for future research with larger sample size and greater power.

Although the results of the working memory capacity were non-significant, when examining the trends of WMC scores across time, participants in the control condition began the experiment with the highest average WMC, yet completed the experiment with the lowest average WMC. Conversely, participants in the MBI condition initially scored lowest, but showed the highest gains compared to the control and RBM conditions, a six-point gain between session 1 and session 6. Interestingly, the RBM group ended with the highest OSPAN scores of the three conditions, showing a five-point gain on scores by the end of the experiment. Mixed-model regression analysis will help to further understand the significance of the current experiment's results by incorporating missing data into analysis.

Notably, the covariate intelligence significantly interacted with working memory capacity, providing further evidence of the positive correlation between general intelligence and working memory capacity (Kane & Engle, 2002). Previous research has shown that the connection between WMC and intelligence reveals an individual's ability to keep information active, particularly in the face of distractions and interference, and is indicative of higher-order processing abilities (Engle et al., 1999; McVay & Kane, 2009; Redick, et al., 2012). In this experiment, the interaction between intelligence and WMC indicated an individual's performance on the OSPAN measure may have been better explained by their overall fluid intelligence rather than the intervention they received. As such, it is unclear if brief MBIs could help individuals to strengthen their WMC, or if their improvement was more reliant on their own intelligence.

It is also worth considering that the results that showed higher WMC scores for the RBM condition may in part be affected by the initially significantly different ratings of trait mindfulness. Trait mindfulness has been shown to correlate to individual WMC, meaning those who are more mindful often perform significantly better on tasks of WMC (Brown & Ryan, 2003; Schooler et al., 2014). That is, the RBM group may have scored higher on tests of WMC because they were naturally at an advantage (e.g. higher mindfulness) over the other two groups. If, as reported, RBM participants were more mindful during the task, they would better be able to focus on the rapidly presented stimuli. Consequently, their reportedly greater ability to focus on the present and block internal and external distractions may have skewed the outcome of the intervention results to the RBM condition's favor. Another possible reason for this difference in WMC scores between conditions is that participants in the RBM condition were simply able to perform better on the OSPAN after their intervention; they were better able to focus attention on working memory capacity performance after allowing their mind to relax and wander to a preferred, safe location in their mind. If this possibility is true, one must begin to question if including mindfulness interventions in academic settings is truly helpful, or perhaps, if simply allowing students to take a "brain break" and let their mind wander before returning to complicated tasks is the key to higher performance. This notion, although possible, is not probable due to the existing research base indicating the detrimental effects of mind-wandering on difficult cognitive tasks and mood (Schooler et al., 2014).

Effect of MBIs on Task-Switching

Novel to this study was the inclusion of a task-switching measure, to better parse out the specific attentional processes targeted by MBI. The current results showed no significant differences in task-switching abilities because of MBI. Although there were no prior research studies that used the TMT A and B to measure task-switching after exposure to MBI, Anderson and colleagues (2007) found no significant differences in pre-and-posttest measures of their task switching measure in participants exposed to mindful interventions. Also, the sensitivity of the measure in a relatively homogenous population should be considered before use in future studies (Giovagnoli et al., 1996).

Results of the repeated-measures MANOVA showed no significant interactions or main effects related to task-switching across the three conditions. Nonetheless, pairwise comparisons showed significant differences in completion time from Session 1 to Session 4, as well as Session 1 to Session 6 for all participants regardless of condition. That is, all participants became faster at completing the task. This suggests the measure may have not been sensitive enough to register changes in task-switching abilities, that the interventions did not change these abilities, and/or the data may a product of practice effects over time (Anderson, et al., 2007; Giovagnoli et al., 1996).

In the ANCOVA analysis solely examining TMT A and B scores, pairwise comparisons indicated no significant differences in TMT A scores between intervention conditions, but significant reductions in time taken to complete the TMT A at each session. Further, pairwise comparisons indicated no significant differences in TMT B scores between intervention conditions, but significant reductions in time taken to complete the TMT B at each session. These differences are again best explained by practice effects.

Overall, the results of the two separate analyses indicate marked improvement in task-switching performance across sessions. Such improvement most likely resulted from familiarity with the task. However, previous research investigating change in task-switching also showed no significant change in measured task-switching in participants, and as such, researchers proposed that the development of attentional awareness through MBI may be more important than specific attentional processes in mindfulness interventions (Anderson et al., 2007).

Notably, there was a significant main effect of the covariate intelligence (WTAR scores) between subjects, indicating higher intelligence level better predicted TMT B scores than did intervention group. This result relates to evidence people with higher intelligence have greater ability in managing complex directions and switching their attention (e.g. Kane & Engle, 2000, Schooler et al., 2014). Thus, their ability to quickly execute 'mental switches' and better maintain the directions of the task (i.e., alternately connect letters and numbers in sequential order) may have influenced the findings of this experiment. Additionally, the sample in which the data was collected may have affected the findings. This sample of participants was a relatively normative sample of high functioning students (e.g. individuals able to succeed in college level courses). Although the measure used is sensitive to detecting neurological deficits and dementia, it is less sensitive to minute differences in functioning due to age or education level (Giovagnoli, et al., 1996). Thus, the measure may have not been sensitive enough to detect changes in a sample of considerably higher-functioning adults who were all in the same range and of the same educational status.

Effect of MBIs on Inhibition

Although WMC and task-switching improvements were not significant, participants who received MBI did exhibit significantly improved accuracy with inhibitory processes. There were three different scores of interest when analyzing change in inhibition across sessions. The first examined the participant's reaction times when responding to color congruent trials (e.g., the word 'red' was show in red ink), the second score looked at reaction time on incongruent trials (e.g., the word 'red' was shown in green ink), and the third looked at total percentage of correct responding during the whole activity.

When examining congruent and incongruent reaction times, participants in each condition significantly increased their reaction time in each session. It is likely this increase across time and conditions is due to practice effects after participants became more familiar with the task. These results align with prior research demonstrating practice effects on computerized Stroop tasks (Edwards, Brice, Craig, & Penri-Jones, 1996).

Results of MANCOVA analysis showed a significant interaction of condition by session on inhibition accuracy scores, indicating participants who participated in the MBI increased their accuracy in inhibition tasks over time more so than the other intervention conditions. Overall, participants in the RBM condition increased their accuracy scores, but these scores fluctuated throughout the sessions, while participants in the MBI condition demonstrated a steady increase, ending the experimental process with the highest scores. Similarly, participants in the control condition also increased their scores, but incrementally. These results contrast previous research by Anderson and colleagues (2007) that found no significant differences in pre-and-posttest measures of Stroop performance after exposure to a mindfulness – based stress reduction intervention.

The current data lend important evidence towards improvement in attentional processing because of MBI. Oberle and colleagues (2012) found that trait mindfulness was positively correlated with individuals' cognitive inhibition. That is, individuals who scored higher on trait mindfulness measures showed greater accuracy on a task of inhibitory control, which indicates that they are better able to inhibit external distractions while completing the task at hand. Although these researchers did not directly measure the impact of MBI on inhibition, their results show that people who are inherently more mindful are more successful with inhibition. The current experiment lends credence to that theory. As theorized (Figure 4), MBI a person's ability to inhibit internal and external stimuli that may distract them from the task at hand to become more accurate at a difficult task. The results of the current experiment supported prior findings that individuals who have received mindfulness interventions can better inhibit distraction during complex tasks; lending credence to the theory that improved mindfulness builds executive skills and the ability to block distractions and maintain instructions during complex tasks (Schooler et al., 2014; Zelazo & Lyons, 2012).

Of note, results of the experiment showed a significant effect of intelligence on participant's inhibition. This result is similar to previous research that has found slight correlations between intelligence and Stroop performance (Kane & Engle, 2003). However, many Stroop tasks have been conducted in restricted sampling populations, completed by college-aged students, which is hypothesized to be the reason that the correlation is not stronger (Dempster, 1991). Further research has found a significant association between intelligence and inhibitory skills among school-aged children, and that children with learning or intellectual disabilities (who display less ability to sustain their attention, are more distractible, and are more likely to be unable to control their behavior) perform significantly worse on Stroop Tasks (Tamm et al., 2004). It is thought inhibitory skills may incorporate with processing speed abilities, and directly affect efficiency of processing information and providing output (Dempster, 1991). These findings in tandem with research asserting that executive functions are trainable and most malleable in children ages 3-5 and continues to be malleable through young adulthood (Zelazo & Calrson, 2012), provide a convincing argument in implementation of MBI at a school-age level.

When exclusively examining the Stroop data in a repeated-measures ANCOVA, there were no significant differences in congruent trial reactions times between conditions, but reaction times were significantly different across sessions. This marked decrease over time can be attributed to faster participant responding as they became more familiar with the task, indicating practice effects. The reactions times for incongruent responses also decreased over time for all three sessions, indicating practice effects. These results match prior research demonstrating practice effects on computerized Stroop tasks (Edwards, et al., 1996). However, the interaction between intervention group and session time was again significant, which indicated that the intervention that participants received may have impacted their accuracy in building the ability to block out competing thoughts or distractions when completing the inhibition task. Namely, participants in the MBI condition showed more accurate Stroop scores across session. The MBI conditions accuracy scores increased across each session, indicating a stronger ability to inhibit distraction to accurately follow directions. The RBM condition scores ranged from the lowest scores, to the highest, and then to the middle. This trend may support the notion the when participants were given the direction to let their mind wander, their ability to block out distraction to be accurate became more variable (Schooler et al., 2014). The Control condition showed barely any increase in accuracy, lending credence to the improvement in the MBI group as being more than practice effects. Again, these results support the growing research base that implementation of MBIs improves inhibitory skills, or the ability to maintain attention in the present moment in the face of distraction (e.g., Oberle et al., 2012; Schooler et al., 2014).

Effect of MBIs on Self-Reported Mind-wandering

The fourth goal of this research study was to understand the effect of MBI on self-reported mind-wandering. Mind-wandering (as illustrated in Figure 1) is the opposite construct of mindfulness (Schooler et al., 2014). I hypothesized the participants in the MBI condition would report decreased mind-wandering throughout the course of the experiment. Results of the current study did not directly support my hypothesis.

Results of the current study found that the MANCOVA analyses of mind-wandering during sessions two, four, and six, there was a significant session by condition interaction on the first question of the mind-wandering probe (i.e., *Where was your attention focused?)*. This result indicated participants in both the MBI and RBM condition were better able to keep their mind on the task at hand across sessions compared to participants in the control condition. This finding supports previous studies demonstrating the relationship between mind-wandering, deficits of working memory, and tasks that require attentional processing (Mrazek et al., 2012).

Further, research has found that individuals with lower working memory capacity reported more mind-wandering during difficult tasks than individuals with high working memory capacity (Kane & McVay, 2012). Higher mind-wandering was associated with poorer scores on the automated OSPAN and self-reported mind-wandering predicted 49% of the variance in many tests of cognitive performance like SAT scores, the OSPAN, and the Ravens Progressive Matrices test. (Mrazek et al, 2012; Unsworth, et al., 2005). This finding is significant because it implicates mind-wandering as a main culprit in problems of attention. As such, finding MBI can reduce reported mind-wandering after brief intervention has exciting implications for students who struggle to regulate their attention and are susceptible to mind-wandering at inappropriate times.

The finding the RBM condition also reported less mind-wandering was unexpected. Although this experiment is the first of its kind to incorporate a relaxation-based meditation condition, previous research has shown that this result is contrary to the hypothesis that engaging the mind in a relaxing task that allows the mind to wander has costs for sustained attention and working memory task performance (see Schooler et al., 2014). It is worth recalling, however, that participants in the RBM condition reported they were significantly more mindful (i.e., had more Trait Mindfulness) than the MBI and Control conditions. As such, their ability to engage in mindful concentration on difficult tasks may have skewed the present data. More complete data would help to further understand how these trends may change or become more significant.

The repeated measures ANCOVA included all five MW scores in analyses, thus differing from the combined MANCOVA that only included data from session two, four, and six. Especially interesting was the trending decrease in reported mind-wandering for the MBI group, while the control and RBM group were more variable in reporting how on task they were. This again supports research asserting MBI and mind-wandering as opposite constructs in which one cannot exist while the other is engaged (Schooler et al., 2014). Conversely, the RBM and Control conditions reported mind-wandering scores more randomly, and the control group reported final mind-wandering scores slightly higher than other conditions, perhaps lending strength to the argument that MBI specifically reduces mind-wandering over time, when compared to relaxation or silent reading techniques (Schooler et al., 2014).

On the second question, the only significant difference in these reports of mind-wandering content occurred between the reported content of mind-wandering in the control condition and the RBM condition. This difference occurred following the session in which they received the initial intervention; that is, when they first engaged in either MBI, RBM, or the control task. The difference in reported mind-wandering may indicate that the first time the directions about the RBM intervention were administered, there was an induction of mind-wandering in the participants that guided their thoughts away from focused task completion. Further data collection would make this finding clearer. Question three probed about the estimated frequency of mind-wandering. The data did not show a significant decrease in reported frequency of mind-wandering. However, the frequency measure probed amounts in ranges of four (i.e., *one to four times)*, so the sensitivity of the probe should be considered and adjusted in future research.

There was a significant effect of the trait mindfulness covariate between intervention conditions, indicating that the frequency of reported mind-wandering may have been more affected by the trait mindfulness of the participant rather than the intervention they received. This directly supports research that mindfulness is the opposite construct of mind-wandering; in which those who reported they were more mindful reported less mind-wandering (Schooler et al., 2014). More powerful data would help further understand if this is a significant trend.

Effect of MBIs on Positive and Negative Mood

Ancillary to the examination of attentional processes was the exploration of change in positive and negative mood ratings over time and how reported mood was affected by exposure to MBI. MBIs have been shown to improve affect, and recent research asserts inducing a negative mood increases mind-wandering, and people are generally less happy when mind-wandering compared to when they are not (e.g., Liehr & Diaz, 2010; Schooler et al., 2014). I hypothesized that individuals who participated in MBIs would report higher positive affect as measured by the Positive and Negative PANAS compared to individuals in the RBM and control conditions. Results supported this hypothesis.

Positive mood ratings. Another disadvantage of mind-wandering is that it is associated with negative change in mood and affect (Schooler et al., 2014). Results of the repeated-measures MANOVA indicated a significant session by intervention interaction on PANAS positive scores, demonstrating participants in the MBI condition reported the most significant increase in positive mood. Previous research suggested increased mind-wandering is correlated with dips in mood, if the mind-wandering is about something undesired, predicting future events, or when ruminating on past mistakes (Smallwood et al., 2009). This finding lends evidence to prior research that MBI is advantageous for many individuals' mood by training individuals to enhance their capacity to self-regulate their attention and emotion (Meiklejohn et al., 2012).

Although pairwise comparison showed no significant differences between intervention group across sessions, participants in the RBM condition initially reported the highest positive mood ratings, but the scores fluctuated across sessions, with their final mood ratings matching those in the MBI condition. The participants did not receive their assigned intervention in the first session, and only completed their measures as "pre-intervention" data, so it is interesting that the RBM group's positive mood ratings decreased so significantly after being exposed to an intervention that encouraged them to let their mind-wander to a preferred location or safe place. Killingsworth and Gilbert (2010) found a significant association between negative mood and mind-wandering; with mind-wandering accounting for more than twice as much variance in happiness ratings than did the actual content or nature of the activities in which individuals were engaging. Further, results suggested mind-wandering preceded negative mood, and not vice versa. Thus, when an individual engaged mind-wandering about pleasant topics, the mind-wandering had no effect on subsequent mood ratings. Thus, it could be this positive mood fluctuation may be accounted for by the induction of mind-wandering in the RBM condition and dependent on the individuals' content of the thoughts during the intervention.

Outcomes of reported mind-wandering may have also been affected by the initial significant differences between intervention conditions in reported trait mindfulness and intelligence scores, both of which have been implicated as affecting mood (Killingsworth & Gilbert, Schooler et al., 2014). Deng, Li, and Teng (2014) found that individuals who reported higher mind-wandering reported less dispositional mindfulness (as measured by the MAAS), and exhibited a positive relationship with depression symptoms. Thus, individuals who are more mindful are more likely to demonstrate less negative or depressive mood states. Furthermore, previous research has shown people with high trait mindfulness scores reported less mind-wandering while completing a complex attention task, and subsequently performed better (Mrazek et al., 2012). Greater control over executive functions like inhibition and working memory have long been linked to intellectual abilities, and failure to control executive function while trying to block distracting (e.g., wandering) thoughts is dependent on level of executive function. Thus, low cognitive or intellectual resources results in higher mind-wandering (Randall, Oswald, & Beier, 2014).

Separate ANCOVA analysis of positive mood ratings was also executed for all six session scores. The interaction between intervention conditions and session was significant, again indicating the type of intervention received effected positive mood ratings across sessions. The significant interaction between the covariate of Intelligence (WTAR score) on positive mood ratings across session number was also significantly affected the participants' positive mood ratings, again demonstrating the connection between cognitive functioning and mind-wandering (Randall et al., 2014). Although non-significant, the change in mood ratings over time indicated interesting trends for each intervention group. It appears the MBI group did not report the highest positive mood score in the first session, but rated themselves much more positively across the remaining sessions than did the RBM and control conditions. Additionally, the RBM's positive mood reports declined across all sessions, save the final session, which may be indicative that once they were told to let their mind wander, their mood decreased.

Negative mood ratings. The current data showed MBI not only enhanced positive mood ratings, but significantly reduced negative mood ratings as well. This finding is important to consider moving forward, as mental health becomes a more prevalent prevention and treatment issue within the school systems (NASP, 2012). Although there was not a significant interaction between session and intervention condition, the condition in which the participants were assigned did significantly affect mood ratings across the sessions. Interestingly, negative mood significantly decreased between the first and fourth session, but not the fourth and final session. This finding suggests that the implementation of the intervention did indeed affect the mood ratings, since participants did not receive intervention in the first session and only completed session one mood measure as pre-intervention data.

Trends indicated participants in the MBI condition reported negative mood during the first session (before receiving MBI), but that their negative mood decreased drastically by the fourth session, and remained lower for the final session. This finding suggests MBI not only enhanced positive mood ratings, but significantly reduced negative mood ratings as well. In that same vein, RBM participants consistently reported less negative mood across sessions which may be accounted for by the individual content of their intervention – induced mind-wandering, or their significantly higher trait mindfulness ratings (Killingsworth & Gilbert, 2010; Mrazek et al., 2013; Schooler et al., 2014). There was a significant interaction between the covariate intelligence and negative ratings. That is, these results supported previous research showing that level of intellectual functioning is tied to the amount of time spent mind-wandering (Randall, et al., 2014), and that mind-wandering tends to induce more negative mood states (Schooler et al., 2014).

The ANCOVA analyses of negative mood ratings across all 6 sessions showed no significant interactions, but the difference in mood ratings between the MBI and RBM group was approaching significance. This initial finding indicates that MBI may have a significant effect on reducing negative mood, or conversely, boosting attention which disengages negative mind-wandering and mood states. Additionally, there were significant differences in negative mood ratings across sessions. Overall, negative mood ratings in the first session were significantly higher than in subsequent sessions, and final sessions ratings were significantly different than every other session's ratings. The covariate *Trait Mindfulness (*MAAS scores) highlighted a between-subjects interaction, indicating that self-rated trait mindfulness better predicted negative mood ratings than did the intervention received or session probed. This supports the prior hypothesis from the prior MANCOVA analyses that higher trait mindfulness affected the mood ratings, especially in the RBM group that was reportedly more mindful.

Summary

The purpose of this experiment was to better understand which attentional processes may be impacted by exposure to MBIs. Overall, the results of this experiment suggest that some mechanisms of attention (i.e. inhibition) are improved by MBI, as is mood and self-reported focus. Specifically, contrary to prior studies (e.g. Anderson et al., 2007) this experiment presented evidence that brief MBI contributed to a significant increase in inhibitory accuracy. Further, this experiment supported prior research that ties mindfulness to reduced mind-wandering and positive changes in mood (Liehr & Diaz,2009; Mrazek et al., 2013).

Conclusions and Implications for School Psychology

Overall, the evidence that brief MBIs can improve an individual’s ability to control their attention and inhibit external and internal distractions has implications for multiple tiers of service delivery in school psychology. This experiment contributed to this evidence base, demonstrating individuals exposed to brief MBIs showed greater accuracy in inhibition tasks, more self-reported attentional focus, and increased positive (and decreased negative) mood. These contributions to the research lend more understanding to the relationship between MBI, mind-wandering, attentional control, and mood. It seems as if, as illustrated by Figure 4, brief MBIs provided “repetitions” for an individual’s attentional control abilities, and inhibitory skills, mind-wandering, and mood were all effected. These components have many implications for the practice of school psychology.

Attentional control and executive function are linked to student outcomes. For example, individuals with specific learning disorders often have lower executive functioning skills and are more likely to allow distraction or undesired responses to emerge during task performance (e.g., testing, group work, or instruction; Alloway et al., 2009; Barrett et al., 2008). Further, students who achieve a higher score on tests of WMC are better able to focus their attention, and are more successful at enacting controlled, goal-directed processing (e.g., following complex and multi-step directions), blocking interference, and suppressing anxious and depressed thoughts relative to those with low WMC (Barrett, et al., 2008 Conway & Engle, 1994; Kane & Engle, 2003; Macrae & Bodenhausen, 2000; Macrae et al., 1999; Tuholski, et al., 2001; von Hippel, et al., 2000). Finally, WMC and attentional control predict higher individual success in multiple academic subjects such as reading comprehension, language comprehension, listening comprehension, problem solving, complex reasoning, strategy adaption, vocabulary, and spelling (Alloway et al., 2005). Accordingly, success with difficult tasks like following directions, note-taking, logic learning, story-telling, and emotional processing are also affected by individual levels of WMC (see Barrett et al., 2008). As such, brief MBIs incorporated at all tiers of intervention (i.e., universal, secondary, tertiary) may strengthen student inhibitory skills, which results in a multitude of positive outcomes.

Brief MBIs at all tiers of intervention may increase cooperation in the classroom and facilitate better classroom management and learning readiness. When considering how mindfulness training may benefit students, Meiklejohn and colleagues (2012) suggest that MBIs with students would enhance their capacity to self-regulate their attention and emotion. As such, it is theorized that MBIs increase a student’s capacity to regulate their attention through practicing the skills of focusing, sustaining, and redirecting attention (Oberle et al., 2012; Napoli et al., 2005). If MBI is indeed able to train the skill of inhibition, or redirecting attention, this has important implications for enhancing success for students in the classroom, as students' ability to regulate mood and attention has been shown to be associated with increased academic performance and behavioral outcomes, as well as decreased incidences of special education referrals at various tiers of school instruction (Alloway et al., 2005; Holmes & Gathercole, 2013). Many students do not develop learning readiness skills at the developmentally appropriate age, and their academic, social, and behavioral life is hindered by the skills needed to be successful in the classroom (Alloway, 2006). Consequently, brief MBIs may enhance learning readiness and classroom management through training the ability to focus, listen, absorb information, do seatwork, regulate social-emotional well-being, and learn in a formal setting from direct instruction (Blaustein, 2005). At secondary and tertiary levels, using brief MBIs is appropriate for students with a number of presenting difficulties in a small-group or individual setting. Research shows that individuals with autism (Andersen, et al., 2013), Attention-deficit Hyperactivity Disorder (Alloway et al., 2009; Martinussen & Tannock, 2006), anxiety (e.g., Owens, et al.,2012), and various other developmental and learning disorders all exhibit decreased executive functioning skills which could be improved through brief MBI.

At a systems level, implementation of brief MBIs in classrooms may have broad benefits like improving relationships with classmates, teacher-student relationships, and improving and promoting equitable and supportive school climates (Bottiani, Bradshaw, & Mendolsen, 2014). There also may be systemic implications of MBI implementations in school regarding crisis management. During moments of crisis (e.g., fire, lockdown) in schools, there may be a flurry of activity to ensure the safety of students and staff. If students and teachers can remain more mindful in these moments (i.e., controlling attention, inhibiting unnecessary distractions), they may be more able to follow complex or multi-step instructions from teachers, administration, or emergency professionals to ensure their safety and the safety of their classmates. Finally, staying mindful may help staff and students focus on the current situation without being overcome by internal or external fears or distractions, which may enable them to regulate their emotional arousal and more readily act at appropriate times.

All in all, the implementation of brief MBIs into school settings has many beneficial effects for staff and students spanning from individual to systems-levels. Namely, training and building attentional control skills can help facilitate student success at all levels of ability. Social-emotional benefits such as increased positive mood also facilitate learning readiness, social-emotional management, and classroom climate. Given that MBIs have increased in popularity for use in school settings, the current study aided in understanding how MBIs improve cognitive performance in students, and targets the process of inhibition as the attentional process that may influence student gains in attentional control and cognitive performance.

Limitations and Future Directions

Limitations

Overall, the results of the current study showed some components of attentional control and mood changed due to intervention condition. However, the current study had several limitations that must be considered. The primary issue with this experiment is the power of the results. Due to attrition, missing data, and Sphericity, the power of the experiment is extremely low. Suitable power is usually considered to be a .08 in statistical results (Field, 2009). None of the dependent variable results from the MANCOVA showed this level of power, indicating that the current experiment requires more complete data or regression analysis in order to better understand the effects of brief interventions on attentional processes.

Secondly, although participants were randomly assigned conditions, there were significant differences between conditions at the outset of the experiment. Participants in the RBM condition were significantly younger and initially rated themselves as more mindful compared to participants in the other condition. Thus, higher trait mindfulness may have affected the RBMs subsequent scores on all dependent measures, and affected potential main effects and interactions that may be present in data with normally distributed intervention conditions. Consequently, some of the results must be interpreted with those considerations in mind.

This was a mostly homogenous, non-diverse sample that consisted mostly of females aged 18 to 20. Further, almost three-quarters of the sample had been exposed to some form of mindfulness or knew of mindfulness before signing up for the experiment. This may have created an expectation bias about the intervention they would receive or what experience they should have, and could have attributed to inflated ratings. Future research aims to implement similar experiments with younger children, which may reduce expectation bias and homogeneity of sampling.

Another concern was the interventions implemented may have been too similar. Although the purpose of the experiment was to differentiate between relaxation-based meditation and mindfulness-based intervention, there may not have been sufficient differentiation. For instance, each intervention was recorded using a guided script and the same voice. Although the RBM intervention encouraged participants to let their mind-wander to a preferred location, the intervention still guided them through a process of grounding and relaxation. Although not an active meditation with a specific goal (i.e., 'bring your attention back'), the intervention may have included enough guidance to discourage more active mind-wandering that might be akin to daydreaming or 'zoning out.' In the future, providing less guided instruction during the relaxation-based meditation to fully induce the participant's ability to let their mind wander wherever it wants to go may result in clearer data.

A significant concern regarding this data set was attrition rate and missing data. The missing data was random and could have been accounted for by several factors. Participants could have experienced burnout by the responsibility of attending 6 weeks of sessions for only experimental credits. Thus, participants may have dropped out or not extended their full effort - because they simply wanted to be finished. The reward for completion was class credit, and the participants received all their required class credit if they attended all sessions of the experiment. However, the participants were granted partial credit after each session, leaving them the option of completing other open experiments to complete their credits sooner. Many of the participants admitted to the research assistants they would not be returning to finish the experiment because they had all the credits they needed. Participants also would skip questions on the experiment screen, which subsequently would eliminate that scale for later analysis. Experimenter and technological error also attributed to missing data. There were four different research assistants who helped to administer the experiment. Although they were trained on a protocol and provided a script, each had their own personality, subtle style of experiment implementation, and may have elicited different unconscious reactions in each of the participants. Finally, there were inevitable computer glitches and malfunctions that may have hindered the collection of information, which in turn, later applied to random missing data that was excluded from analysis. Consequently, in analyzing the data with the proposed ANCOVA and MANCOVA analyses, list-wise deletion had to be used, because pair-wise data and multiply imputed data sets are not to be used in repeated-measures analysis (Boyko, 2013). Also, post-hoc tests are not able to be calculated on repeated-measures factors, which limits the conclusions drawn from the data.

In the MANCOVA analyses, the covariate of intelligence (WTAR score) also significantly interacted across sessions with OSPAN scores, Stroop Congruent Reaction Time Scores and PANAS negative total scores. There was also a significant interaction of Intelligence scores between intervention conditions on Incongruent Stroop Trials. This interaction supports research about correlations between intelligence, working memory, and negative mood (see Schooler et al., 2014). Further, both congruent and incongruent reaction times on the Stroop significantly interacted with WTAR scores. This finding also supports previous research that found individuals who lack inhibition typically display less ability to sustain their attention, which is also correlated with working memory and intelligence (Tamm et al., 2004). After further research, future analyses will include a mixed model linear regression analysis that numerical and categorical data to be analyzed within a singular analysis. Also, in mixed model linear regression missing data is approached differently, with only the specific data being excluded (e.g. question 1 mind-wandering probe), instead of the entirety of the participant's submitted data (e.g., all of participant's scores over time). In additions time is treated as a continuous variable, post-hoc tests are allowed, and covariates can be conceptualized as mediators (Grace-Martin, 2017).

Overall, the experiment provided data that supported previous research trends regarding improvement of cognitive function and mood after exposure to MBI. The data collection process and subsequent data analysis led to knowledge regarding future data analysis, experiment design, and research implementation.

Future Directions

The present research focused on understanding the different attentional processes that may be affected by brief MBIs in college-aged students. Overall, the current research showed that inhibition skills, or the ability to block internal and external distractions, improved after exposure to brief MBIs. Previous research including inhibition has shown mixed effects, with one study reporting decreased Stroop interference (Moore & Malinowski, 2009), but others showing no results of MBI on inhibition in adult samples (Anderson et al., 2007; Semple, 2010). This ability to control and direct attention in the face of distraction is an important component to students' academic success and social-emotional well-being (Alloway, 2006; Brown & Ryan, 2003; Zelazo & Lyons, 2012). Future research should further explore this finding in primary and secondary aged students.

In considering future research projects, there are several adjustments that may need to be made to ensure adequate power and validity. First, research designs and recruitment that ensure more complete data are necessary for fully understanding how MBI affects students' attentional control and learning readiness in the classroom. This can be done through increased incentivizing of participation or through recruiting specific conditions or classrooms in schools to participate in the research process. Additionally, mixed-method designs that incorporate quantitative and qualitative data (e.g., student or teacher interviews) would result in richer understanding of the effects of brief MBI in school settings.

Second, one must consider the student populations with whom they will be working. MBI is a flexible tool that can be implemented at all three levels of instruction (i.e. general, secondary, tertiary). As such, research should make sure that the distribution of student ability matches the level instruction that they are targeting. It is my goal to understand how

MBI can be used as a preventative intervention at the general level. As such, future research will focus on whole-classroom improvement regardless of the preliminary diversity in attentional, intellectual, and emotional ability. Consequently, it will be important to ensure that conditions are equally distributed regarding the number of students who are considered typically developing versus those who may require accommodations or IEPs.

Third, considering the consistency or standardization of measures used in MBI is essential moving forward. Central to this study was the meta-analysis by Zenner and colleagues (2014) that found large gains in cognitive performance. However, the measures of cognition were variable, and the most commonly used measure of cognitive performance was grade reports. As such, I recommend that moving forward, researchers use the Stroop Color and Word Test: Children's Version (Golden, Freshwater, & Golden, 2012) when conducting MBI research in children ages 5-14. Further, incorporating a measure like the Automated Working Memory Assessment (AMWA; Alloway, 2007) that is sold by Pearson for children ages 4-22 to screen for deficits in working memory could be a useful standardized measure to create reliability across research studies. Additionally, a standard, sensitive way to probe for mind-wandering should be developed and implemented for school-aged children.

Lastly, future studies should investigate various modalities of mindfulness in youth, and the subsequent effects on attentional abilities. As MBI becomes a more commonly accepted and implemented intervention in the school, it would be helpful to realize all the modalities in which mindfulness and attentional control can be nurtured. There are many activities in the school day, including band, orchestra, choir, theatre, P.E., and after-school sports that encourage concentration to the task at hand. Music therapists have begun to recognize music as a modality of mindfulness (e.g. Roberts, 2009), as sports psychologists have implemented mindfulness techniques for use in college and professional athletes (Birrer, Röthlen, & Morgan, 2012). Thus, it’s important to understand how implementing “specials” like music education in the developmental years of a students’ life may affect student outcomes inside and outside of the classroom develop and maintains mindful attention.

References

Allen, M., Dietz, M., Blair, K. S., van Beek, M., Rees, G., Vestergaard-Poulsen, P., ... Roepstorff, A. (2012). Cognitive-affective neural plasticity following active-controlled mindfulness intervention. *The Journal of Neuroscience, 32,* 15601–15610. http://dx.doi.org/10.1523/jneurosci.2957-12.2012.

Alloway, T. P. (2006). Working memory and children with developmental coordination disorders. In T. P. Alloway & S. E. Gathercole (Eds.), Working memory and neurodevelopmental conditions *Psychology Press,* 161–187.

Alloway, T. P., Gathercole, S.E., Kirkwood, H., Elliot, J. (2009). The cognitive and behavioral characteristics of children with low working memory. *Child Development, 80,* 606-621. doi: 10.1111/j.1467-8624.2009.01282.x.

Alloway, T. P., Gathercole, S. E., Willis, C., & Adams, A. M. (2005). Working memory and special educational needs. *Educational and Child Psychology, 22,* 56-67. *http://shop.bps.org.uk/publications/publication-by-series/educational-and-child-psychology.html*

Alloway, T. P., Rajendran, G., & Archibald, L. M. (2009). Working memory in children with developmental disorders. *Journal of learning disabilities, 42,* 372-382. doi: 10.1177/0022219409335214.

Andersen, P. N., Hovik, K. T., Skogli, E. W., Egeland, J., and Oie, M. (2013). Symptoms of ADHD in children with high-functioning autism are related to impaired verbal working memory and verbal delayed recall. *PLOS ONE: A Peer-reviewed Open Access Journal* doi:10.1371/journal.pone.0064842

Anderson, N., Lau, M., Segal, Z., & Bishop, S. (2007). Miindfulness-based stress reduction and attentional control. *Clinical Psychology and Psychotherapy, 14,* 449-463. doi: 10.1002/cpp.544

Baer, R. (2003). Mindfulness training as a clinical intervention: A conceptual and empirical review. *Clinical Psychology: Science and Practice, 10*, 125–143. doi: 10.1093/clipsy/bpg015.

Baddeley, A (2000) The episodic buffer: a new component of working memory? *Trends in cognitive Sciences,* 4 (11), 417-423. DOI: http://dx.doi.org/10.1016/S1364-6613(00)01538-2

Baddeley, A. D., Hitch, G. J. (1994). Developments in the concept of working memory. *Neuropsychology, 8*, 485–493. http://www.apa.org/pubs/journals/neu/.

Baird, B., Smallwood, J., Mrazek, M. D., Kam, J. W. Y., Franklin, M. S., & Schooler, J. W. (2012). Inspired by Distraction Mind Wandering Facilitates Creative Incubation. *Psychological Science, 23*, 1117-1122. doi:10.1177/0956797612446024

Barrett, L. F., Tugade, M. M., Engle, R. W. (2004). Individual Differences in Working Memory Capacity and Dual-Process Theories of the Mind. *Psychological Bulletin, 4, 553-573.* Doi: 10.1037/0033-2909.130.4.553.

Beauchemin, J., Hutchins, T. L., & Patterson, F. (2008). Mindfulness meditation may lessen anxiety, promote social skills, and improve academic performance among adolescents with learning difficulties. *Complementary Health Practice Review*, *13*, 34– 45. doi:10.1161/01.HYP.26.5.820.

Birrer, D., Röthlin, P., & Morgan, G. (2012). Mindfulness to enhance athletic performance: Theoretical considerations and possible impact mechanisms. *Mindfulness*, *3*(3), 235-246.

Bishop, S., Lau, M., Shapiro, S., Carlson, L., Anderson, N., Carmody, J., Segal, Z., Abbey, S., Speca, M., Velting, D., & Devins, G. (2004) Mindfulness: a proposed operational definition. *Clinical Psychology: Science and Practice*, 11 (3), 230-242

Blakemore, S. J., & Choudhury, S. (2006). Development of the adolescent brain: implications for executive function and social cognition. *Journal of child psychology and psychiatry*, *47*, 296-312. doi: 10.1111/j.1469-7610.2006.01611.x.

Blaustein, M. (2005) See, hear, touch: The basics of learning readiness. *Young Children on the Web*, 1- 10. Accessed from: http://www.naeyc.org/ on May 5th, 2015.

Bottiani, J. H., Bradshaw, C. P., & Mendelson, T. (2014). Promoting an equitable and supportive school climate in high schools: The role of school organizational health and staff burnout. *Journal of school psychology*, *52*(6), 567-582.

Boyko, Jennifer, "Handling Data with Three Types of Missing Values" (2013). Doctoral Dissertations. Paper 141. Accessed from: Digital Commons @UConn: http://digitalcommons.uconn.edu/cgi/viewcontent.cgi?article=6359&context=dissertations.

Braver, T. S., Gray, J. R., & Burgess, G. C. (2007). Explaining the many varieties of working memory variation: Dual mechanisms of cognitive control. Variation in Working Memory, 76-106.

Brefczynzki-Lewis, J. A., Lutz, A, Schaefer, H. S., Levinson, D. B., & Davidson, R. J. (2006). Neural correlates of attentional expertise in long-tern meditation practitioners. *PNAS, 104(27), 11483-11488.* Retrieved from: www.pnas.org/cgi/doi/101.1073/pnas.0606552104

Broderick, P. C. & Jennings, P. A. (2012). Mindfulness for adolescents: A promising approach to supporting emotion regulation and preventing risky behavior. *New Directions for Youth Development, 136*, 111-126. doi: 10.1002/yd.20042.

Brown, K. W., & Ryan, R. M. (2003). The benefits of being present: Mindfulness and its role in psychological well-being. *Journal of Personality and Social Psychology, 84,* 822–848. DOI:10.1037/0022-3514.84.4.822.

Brown, K. W., Ryan, R. M., Creswell, J. D. (2007) Mindfulness: theoretical foundations and evidence for its salutary effects. *Psychology Inquiry, 18,* 211-237. http://www.tandfonline.com/toc/hpli20/current.

Burke, C. A. (2009). Mindfulness-Based Approaches with Children and Adolescent: A Preliminary Review of Current Research in an Emergent Field. *Journal Child Family Studies, 19,* 133-144. doi: 10.1007/s10826-009-9282-x

Case, R., Kurland, M., & Goldberg, J. (1982). Operational efficiency and the growth of short-term memory. *Journal of Experimental Child Psychology, 33,* 386-404. http://www.sciencedirect.com/science/journal/00220965.

Cantor, J., & Engle, R. W. (1993). Working-memory capacity as long-term memory activation: An individual-differences approach. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 19,* 1101– 1114. http://www.apa.org/pubs/journals/xlm/.

Carretti, B., Borella, E., & De Beni, R. (2007). Does strategic memory training improve the working memory performance of younger and older adults*? Experimental Psychology, 54*, 311–320. doi:10.1027/1618- 3169.54.4.311

Cheema, J. R. (2014). Some general guidelines for choosing missing data handling methods in educational research. *Journal of Modern Applied Statistical Methods*, *13*(2), 3.

Cheyene, J. A., Solman, G. J. F., Carriere, J. S. A., & Smilek, D. (2009). Age trends for failures of sustained attention. *Psychology of Aging, 25*, 569-574. doi: 10.1037/a0019363.

Chiesa, A., & Serretti, A. (2009). Mindfulness-based stress reduction for stress management in healthy people: A review and meta-analysis. *Journal of Alternative & Complementary Medicine, 15,* 593–600. doi: 10.1089/acm.2008.0495.

Coholic, D. (2011). Exploring the feasibility and benefits of arts-based mindfulness-based practices with young people in need: Aiming to improve aspects of self-awareness and resilience. *Child Youth Care Forum, 40,* 303-3-17. doi: 10.1007/s10566-010-9139-x.

Comblain, A. (1994). Working memory in Down's syndrome: Training the rehearsal strategy. *Down's Syndrome: Research and Practice, 2*, 123-126. doi:10.3104/reports.42

Conway, A. R. A., & Engle, R. W. (1994). Working memory and retrieval: A resource-dependent inhibition model. *Journal of Experimental Psychology: General, 123,* 354-373. http://www.apa.org/pubs/journals/xge/.

Conway, A. R. A., Tuholski, S. W., Shisler, R. J., & Engle, R. W. (1999). The effect of memory load on negative priming: An individual differences investigation. *Memory & Cognition, 27*, 1042–1050. http://link.springer.com/journal/13421.

Cullen M. (2011). Mindfulness-based interventions: an emerging phenomenon. *Mindfulness, 2*, 186–193. doi:10.1007/s12671-011-0058-1.

Daneman, M., & Carpenter, P. A. (1980). Individual differences in working memory and reading. *Journal of Verbal Learning & Verbal Behavior, 19,* 450-466. doi:10.1037/0033-2909.130.4.553.

Davidson, M. C., Amso, D., Anderson, L. C., & Diamond, A. (2006). Development of cognitive control and executive functions from 4 to 13 years: Evidence from manipulations of memory, inhibition, and task switching. *Neuropsychologia*, *44*(11), 2037–2078. doi:10.1016/j.neuropsychologia.2006.02.006

Dempster, F. N. (1991). Inhibitory processes: a negleted dimension of intelligence. *Intelligence*, *15*(2), 157-173.

Deng, Y. Q., Li, S., & Tang, Y. Y. (2014). The relationship between wandering mind, depression and mindfulness. *Mindfulness*, *5*(2), 124-128.

Desrosiers, A., Klemanski, D. H. & Nolen-Hoeksema, S. (2013). Mapping Mindfulness Facets onto Dimensions of Anxiety and Depression, *Behavior Therapy*, *44*, 373-384. doi: 10.1016/j.beth.2013.02.001

Dijksterhuis, A., & Meurs, T. (2006). Where creativity resides: The generative power of unconscious thought. *Consciousness and Cognition*, *15*, 135–146. doi:10.1016/j.concog.2005.04.007

Donnell, A. J., Pliskin, N., Holdnack, J., Axelrod, B., & Randolph, C. (2007) Rapidly Administered Short Forms of the Wechsler Adult Intelligence Scale—3rd Edition. *Archives of Clinical Neuropsychology*, 22, 917-924. doi:10.1016/j.acn.2007.06.007.

Dunning, D. L., Holmes, J. (2014). Does working memory training promote the use of strategies on untrained working memory tasks? *Memory & Cognition, 42,* 854-862.doi: 10.3758/s13421-014-0410-5

Edwards, S., Brice, C., Craig, C., & Penri-Jones, R. (1996). Effects of caffeine, practice, and mode of presentation on Stroop task performance. *Pharmacology Biochemistry and Behavior*, *54*(2), 309-315.

Engle, R.W. (2002). Working memory capacity as executive attention. *Current Directions in Psychological Science, 11*, 19-23. doi: 10.1111/1467-8721.00160.

Engle, R. W., & Kane, M. J. (2004). Executive attention, working memory capacity, and a two-factor theory of cognitive control. *The Psychology of Learning and Motivation, 44*, 145–199. http://www.sciencedirect.com/science/bookseries/00797421.

Engle, R. W., Tuholski, S. W., Laughlin, J. E., & Conway, A. R. A. (1999). Working memory, short-term memory, and general fluid intelligence: A latent variable approach. *Journal of Experimental Psychology. General,* 125, (309–331).

Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. Behavior Research Methods, 39, 175-191.

Flook, L., Golberg, S. B., Pinger, L., Davidson, R. J. (2015). Promoting prosocial behavior and self-regulatory skills in preschool children through a mindfulness-based kindness curriculum. *Developmental Psychology, 1,* 44-51. doi: 10.1037/a0038256.

Flook, L., Smalley, S. L., Kitil, M. J., Galla, B. M., Kaiser-Greenland, S., Locke, J., Ishijima, E., Kasari, C. (2010). Effects on mindful awareness practices on executive functions in elementary school children. *Journal of Applied School Psychology, 26,* 70-95. doi: 10.1080/15377900903379125

Forster, S. & Lavie N. (2013). Distracted by your mind? Individual differences in distractibility predict mind wandering. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 40,* 251–260. doi: 10.1037/a0034108.

Franklin, M. S., Mooneyham, B. M., Baird, B., & Schooler, J. W. (2013). Thinking one thing, saying another: The behavioral correlates of mind-wandering while reading aloud. *Psychonomic Bulletin & Review, 21*(1), 205-210. doi:10.3758/s13423-013-0468-2.

Franklin, M. S., Smallwood, J., & Schooler, J. W. (2011). Catching the mind in flight: Using behavioral indices to detect mindless reading in real time. *Psychonomic Bulletin & Review, 18,* 992–997. doi:10.3758/ s13423-011-0109-6

Gallant, S. (2016) Mindfulness meditation practice and executive functioning: Breaking down the benefit. *Consciousness and Cognition, 40,* 116-130. http://dx.doi.org/10.1016/j.concog.2016.01.005

Gathercole, S.E., Alloway, T. P., Kirkwood, H. J., Elliot, J. G., Holmes, J., & Hilton, K. A. (2008) Attentional and executive behavioral profiles of children with poor working memory. *Learning and Individual Differences, 18*, 214-223. doi:10.1016/j.lindif.2007.10.003.

Gathercole, S.E., Alloway, T.P., Willis, C., Adams, A.M. (2006). Working memory in children with reading disabilities. *Journal Experimental Child Psychology, 93,* 265-281. doi:10.1016/j.jecp.2005.08.003.

Gathercole, S. E., Brown, L., & Pickering, S. J. (2003). Working memory assessments at school entry as longitudinal predictors of National Curriculum attainment levels. *Educational and Child Psychology, 20*, 109-122. http://shop.bps.org.uk/publications/publication-by-series/educational-and-child-psychology.html.

Genevieve, S. (2015). Safe Place Guided Meditation. Retrieved April 13, 2015. Accessed from: http://www.envisionintegrativetherapies.com

Giovagnoli, A. R., Del Pesce, M., Mascheroni, S., Simoncelli, M., Laiacona, M., & Capitani, E. (1996). Trail making test: normative values from 287 normal adult controls. *The Italian Journal of Neurological Sciences*, *17*(4), 305-309.

Greenberg, Mark T. & Harris, Alexis R. (2011). Nurturing Mindfulness in Children and Youth: Current State of Research. *Child Development Perspectives, 6, 161-166*. doi: 10.1111/j.1750-8606.2011.00215.x

Green, R. E. A., Melo, B., Christensen, B., Ngo, L., Monette, G. & Bradbury, C. (2008). Measuring premorbid IQ in traumatic brain injury: An examination of the validity of the Wechsler Test of Adult Reading (WTAR). *Journal of Clinical and Experimental Neuropsychology, 30,* 163-172. doi:10.1080/13803390701300524.

Grace-Martin, Karen (2017) *The Analysis Factor Website:* Repeated-measures Design and Mixed-model regression analysis. Accessed from www.theanalysisfactor.com on January 22nd, 2017.

Hanania, R., & Smith, L. B. (2010). Selective Attention and Attention Switching: Toward a Unified Developmental Approach. *Developmental Science*, *13*(4), 622–635. doi:10.1111/j.1467-7687.2009.00921.x

Harnett, P. & Dawe, S. (2012). Review: The contribution of mindfulness-based therapies for children and families and proposed conceptual integration. *Child and Adolescent Mental Health, 17,* 195-208. doi:10.1111/J.1475-3588.2011.00643.X.

Heeren, A., Van Broeck, N., & Philippot, P. (2009). The effects of mindfulness on executive processes and autobiographical memory specificity. *Behaviour Research and Therapy*, *47*, 403–409. http://dx.doi.org/10.1016/j.brat.2009.01.017.

Holmes, J., Gathercole, S. E., & Dunning, D. L. (2009). Adaptive training leads to sustained enhancement of poor working memory in children. *Developmental Science, 12*, F9–F15. doi: 10.1111/j.1467-7687.2009.00848.x.

Holmes J., Gathercole S. E. (2013). Taking working memory training from the laboratory into schools. *Educational Psychology, 34,* 440-450. doi: 10.1080/01443410.2013.797338

Hutchison, K. A., Smith, J.L., & Ferris, A. (2013). Goals can be threatened to extinction: Using the Stroop task to clarify working memory depletion under stereotype threat. *Social Psychological and Personality Science*, *4,* 75-82. doi: 10.1177/1948550612440734.

Jensen, C. G., Vangkilde S., Frokjaer, V., Hasselbalch, S. G. (2011) Mindfulness training affects attention—or is it attentional effort? *Journal of Experimental Psychology, 141,* 106–123. doi: 10.1037/a0024931.

Jensen, A.R. (1965). Scoring the Stroop test. *Acta Psychologica, 24,* 398-408.

Jha, A. P., Kiyonaga, A., Wong, L., Gelfand, L. & Stanley, E. A. (2010). Examining the Protective Effects of Mindfulness Training on Working Memory Capacity and Affective Experience. *Emotion, 10, 54-64.* doi: 10.1037/a0018438

Jonides, J., Lacey, S. C., & Nee, D. E. (2005). Processes of working memory in mind and brains. *Current Directions in Psychological Science*, *14,* 2-5. http://cdp.sagepub.com/.

Kabat-Zinn, J. (1990). Full catastrophe living: Using the wisdom of your body and mind to face stress, pain and illness. New York, NY: Delacorte.

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

Kabat-Zinn, J. (2003). Mindfulness-based interventions in context: Past, present, and future. *Clinical Psychology: Science and Practice, 10*, 144–156. doi:10.1093/clipsy.bpg016

Kane, M. J., Bleckley, M. K., Conway, A. R., & Engle, R. W. (2001). A controlled-attention view of working-memory capacity. *Journal of Experimental Psychology: General, 130*(2), 169. http://dx.doi.org/10.1037/0096-3445.130.2.169

Kane, M. J., Brown, L. H., McVay, J. C., Silvi, P. J., Myin-Germeys, I., Kwapil, T. R. (2007). For whom the mind wander, and when: An experience-sampling study of working memory and executive control in daily life. *Psychological Science, 18,* 614-621. http://pss.sagepub.com/.

Kane, M. J., & Engle, R. W. (2000). Working memory capacity, proactive interference, and divided attention: Limits on long-term memory retrieval. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 26,* 333-358. http://www.apa.org/pubs/journals/xlm/.

Kane, M. J., & Engle, R. W. (2002). The role of prefrontal cortex in working-memory capacity, executive attention, and general fluid intelligence: An individual differences perspective. *Psychonomic Bulletin & Review, 9,* 637-671. http://www.springer.com/psychology/cognitive+psychology/journal/13423.

Kane, M. J., & Engle, R. W. (2003). Working memory capacity and the control of attention: The contributions of goal neglect, response competition, and task set to Stroop interference. *Journal of Experimental Psychology: General, 130,* 169-183. http://www.apa.org/pubs/journals/xge/.

Killingsworth, M. A., and Gilbert, D. T. (2010). A wandering mind is an unhappy mind. *Science, 330,* 932–932. doi: 10.1126/science.1192439

Koch, I., Gade, M., Schuch, S., & Philipp, A. M. (2010). The role of inhibition in task switching: A review. *Psychonomic bulletin & review*, *17*(1), 1-14. Doi: 10.3758/PBR.17.1.1

Kozasa, E. H., Sato, J. R., Lacerda, S. S., Barreiros, M. A., Radvany, J., Russell, T. A., ... & Amaro, E. (2012). Meditation training increases brain efficiency in an attention task. *Neuroimage*, *59*(1), 745-749.

Kozhevnikov M., Louchakova O., Josipovic Z., Motes M.A. (2009). The Enhancement of Visuospatial Processing Efficiency Through Buddhist Deity Meditation. *Psychological Science*, *20*, 645 – 653. doi: 10.1111/j.1467-9280.2009.02345.x.

Kyllonen, P. C., & Christal, R. E. (1990). Reasoning ability is (little more than) working-memory capacity?! *Intelligence*, *14*, 389-433. http://www.journals.elsevier.com/intelligence/.

Langer E., & Piper, A. (1987). The Prevention of Mindlessness. *Journal of Personality and Social Psychology, 53,* 280-287. http://www.apa.org/pubs/journals/psp/index.aspx.

Langer, E. J., & Moldoveanu, M. (2000). The construct of mindfulness. *Journal of Social Issues, 56*, 1-10. doi: 10.1111/0022-4537.00148.

Lamers, M.J. (2010). Selective Attention And Response Set In The Stroop Task. *Memory & Cognition 38 (7): 893–904.* doi:10.3758/mc.38.7.893.

Lehr, P. & Diaz, N. (2010). A pilot study examining the effect of mindfulness on depression and anxiety for minority children. *Archives of Psychiatric Nursing*, *24*, 69-71. doi: 10.1016/j.apnu.2009.10.001.

Loomes, C., Rasmussen, C., Pei, .J, Manji, S., Andrew, G. (2008). The effect of rehearsal training on working memory span of children with fetal alcohol spectrum disorder.

Research in Developmental Disabilities, *29*, 113-124. doi:10.1016/j.ridd.2007.01.001.

Lustig, C., **Hasher, L**., & Zacks, R. T. (2007). Inhibitory deficit theory: Recent developments in a "new view". In D. S. Gorfein & C. M. MacLeod (Eds.), The place of inhibition in cognition. Pp. 145-162. Washington, DC: American Psychological Association.

Macrae, C. N., & Bodenhausen, G. V. (2000). Social cognition: Thinking categorically about others. *Annual Review of Psychology, 51*, 93–120. http://www.annualreviews.org/journal/psych.

Macrae, C. N., Bodenhausen, G. V., Schloerscheidt, A. M., & Milne, A. B. (1999). Tales of the unexpected: Executive function and person perception. *Journal of Personality and Social Psychology*, *76*, 200-213. http://www.apa.org/pubs/journals/psp/index.aspx.

Martinussen, R., Tannock, R. (2006). Working memory impairments in children with attention-deficit hyperactivity disorder with and without comorbid language learning disorders. *Journal of Clinical Experimental Neuropsychology, 7,* 1073-1094. doi: 10.1080/13803390500205700.

McNamara, D. S., & Scott, J. L. (2001). Working memory capacity and strategy use. *Memory & Cognition*, *29,* 10-17. http://www.springer.com/psychology/cognitive+psychology/journal/13421.

National Center for Learning Disabilities: Attention Issues. (2014). Retrieved on January 7th, 2015 from https://www.understood.org/en/learning-attention-issues/child-learning-disabilities/executive-functioning-issues.

McVay, J. C., Kane, M. J. (2009). Conducting the train of thought: Working memory capacity, goal neglect, and mind-wandering in an executive-control task. *Journal of Experimental Psychology: Learning, Memory, & Cognition, 35,* 196–204. doi: 10.1037/a0014104.

McVay, J. C., & Kane, M. J. (2010). Does mind wandering reflect executive function or executive failure? Comment on Smallwood and Schooler (2006) and Watkins (2008). *Psychological Bulletin, 136,* 188 – 197. doi: 10.1037/a0018298.

McVay, J. C., & Kane, M. J. (2012). Why does working memory capacity predict variation in reading comprehension? On the influence of mind wandering and executive attention. *Journal of Experimental Psychology: General, 141,* 302– 320. doi: 10.1037/a0025250

Meiklejohn, J., Phillips, C., Freedman, M., Griffin, M., Biegel, G., Roach, A… Saltzman, A. (2010). Integrating mindfulness training into K-12 education: fostering the resilience of teachers and students. *Mindfulness, 1,* 1-17. doi: 10.1007/s12671-012-0094-5.

Meiklejohn, J., Phillips, C., Freedman, M.L., Griffin, M.L., Biegel, G., Roach, A., Frank, J., Burke, C., Pinger, L., Soloway, G., Isberg, R., Sibinga, E. Grossman, L., & Saltzman, A. (2012). Integrating Mindfulness Training into K-12 education: Fostering the resilience of teachers and students. *Mindfulness: an Online Journal*. doi: 10.1007/s12671-012-0094-5

Mezzacappa, E., & Buckner, J.C. (2010). Working memory training for children with attention problems or hyperactivity: a school-based pilot study. *School Mental Health, 2*, 202-208. doi:10.1007/s12310-010-9030-9.

Miller, G. A. (1956). The magical number seven, plus or minus two : some limits on our capacity for processing information. *Psychology Review, 63*, 81–87. http://www.apa.org/pubs/journals/rev/index.aspx.

Miller, E.K. and Cohen, J.D. (2001) An integrative theory of prefrontal cortex function. *Annual Review of Neuroscience*, *24*,167-202. doi: 10.1146/annurev.neuro.24.1.167.

Monsell, S. (2003). Task switching. Trends in cognitive sciences, 7(3), 134-140. doi:10.1016/S1364-6613(03)00028-7

Mooneyham, B. W., and Schooler, J. W. (2013). The costs and benefits of mind-wandering: a review. *Canadian Journal of Experimental Psychol*ogy, *67*, 11–18. doi: 10.1037/a0031569

Moore, A., & Malinowski, P. (2009). Meditation, mindfulness and cognitive flexibility. *Consciousness and Cognition*, 18, 176–186. http://dx.doi.org/10.1016/ j.concog.2008.12.008.

Morrison, A. B. & Chein, J. M. (2011). Does working memory training work? The promise and challenges of enhancing cognition by training working memory. *Psychon Bull Rev*, *18,* 46-60. doi: 10.3758/s13423-010-0034-0

Moynihan, J. A., Chapman, B. P., Klorman, R., Krasner, M. S., Duberstein, P. R., Brown, K. W., & Talbot, N. L. (2013). Mindfulness-based stress reduction for older adults: Effects on executive function, frontal alpha asymmetry and immune function. *Neuropsychobiology*, *68*, 34–43. http://dx.doi.org/10.1159/ 000350949.

Mrazek, M. D., Franklin, M. S., Tarchin, P., Baird, B. & Schooler, J. W. (2013). Mindfulness Training Improves Working Memory Capacity and GRE Performance

While Reducing Mind Wandering. *Association for Psychology Science, 24, 1-6.* doi: 10.1177/0956797612459659

Mrazek, M. D., Smallwood, J., Franklin, M. S., Chin, J. M., Baird, B., & Schooler, J. W. (2012). The role of mind-wandering in measurements of general aptitude. *Journal of Experimental Psychology. General*, *141*(4), 788-798. Doi: 10.1037/a0027968.

Mrazek, M. D., Smallwood, J., & Schooler, J. W. (2012). Mindfulness and Mind-Wandering: Finding Convergence Through Opposing Constructs. *Emotion*. Advance online publication. doi: 10.1037/a0026678

Napoli, M., Krech, P. R., & Holley, L. C. (2005). Mindfulness training for elementary school students: The attention academy. *Journal of Applied School Psychology, 21,* 99–125. doi: 10.1300/J008v21n01_05.

Oberle, E., Schonert-Reichl, K., Lawlor, M., & Thomson, K. (2012). Mindfulness and Inhibitory Control in Early Adolescence. *The Journal of Early Adolescence, 32,* 565-588. doi:10.1177/0272431611403741.

Owens, M., Stevenson, J., Hadwin, J.A., Norgate, R. (2012) Anxiety and depression in academic performance: An exploration of the mediating factors of worry and working memory. *School Psychology International, 33,* 433-449. doi: 10.1177/0143034311427433.

Posner, M. I., Rothbart, M. K., Tang, Y. (2015). Enhancing attention through training. *Current Opinion in Behavioral Sciences, 4,* 1-5. doi: 10.1016/j.cobeha.2014.12.008

Radvansky, G.A., & Copeland, D.E. (2001). Phonological Similarity in working memory. *Memory and Cognition, 25,* 774-776. http://www.springer.com/psychology/cognitive+psychology/journal/13421.

Randall, J. G., Oswald, F. L., & Beier, M. E. (2014, August 4). Mind-Wandering, Cognition, and Performance: A Theory-Driven Meta-Analysis of Attention Regulation. *Psychological Bulletin*. http://dx.doi.org/10.1037/a0037428

Redick, T. S., Broadway, J. M., Meier, M. E., Kuriakose, P. S., Unsworth, N., Kane, M. J. (2012). Measuring working memory capacity with automated complex span tasks. European Journal of Psychological Assessment, 28, 164–171. Doi: http://dx.doi.org/10.1027/ 1015-5759/a000123.

Reichle, E. D., Reineberg, A. E., & Schooler, J. W. (2010). Eye movements during mindless reading. *Psychological Science, 21*, 1300-1310. doi: 10.1177/0956797610378686

Reitan, R. M. (1958). Validity of the Trail Making Test as an indicator of organic brain damage. *Perceptual and motor skills, 8*(3), 271-276. doi: 10.2466/pms.1958.8.3.271

Renshaw, T. L. (2013, February). *Mindfulness-based interventions for enhancing the well-being of youth.* Training conducted at the meeting of the National Association of School Psychologists, Seattle, WA.

Renshaw, T. (2012). Mindfulness-based practices for crisis prevention and intervention. In S. Brock., P. Lazarus, & S. Jimerson, (Eds.), *Best Pactices in School Crisis Prevention* (pp. 1-22). Bethesda, MD: National Association of School Psychologists. Chapter retrieved from: goog.gl/iRcx2

Robarts, J. (2009). Supporting the development of mindfulness and meaning: Clinical pathways in music therapy with a sexually abused child. *Communicative musicality: Exploring the basis of human companionship*, 377-400.

Rosen, V. M., & Engle, R. W. (1997). The role of working memory capacity in retrieval. *Journal of Experimental Psychology: General, 126*, 211–227. http://www.apa.org/pubs/journals/xge/.

Ryan, R & Deci, E. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist, 55*, 68-78. doi: 10.1037110003-066X.55.1.68.

Salthouse, T A., & Babcock, R. L. (1991). Decomposing adult age differences in working memory. Dev*elopmental Psychology, 27,* 763- 776. http://www.apa.org/pubs/journals/dev/.

Sanchez-Cubillo, I., Perianez, J. A., Adrover-Roig, D., Rodriguez-Sanchez, J. M., Rios-Lago, M., Tirapu, J., & Barcelo, F. (2009). Construct validity of the Trail Making Test: role of task-switching, working memory, inhibition/interference control, and visuomotor abilities. *Journal of the International Neuropsychological Society, 15*(03), 438-450.

Santangelo-White, L. (2012). Reducing stress in school-age girls through mindful yoga. *Journal of Pediatric Healthcare, 28, 45-56.* doi:10.1016/j.pedhc.2011.01.002

Schafer, J. L., & Graham, J. W. (2002). Missing data: our view of the state of the art. *Psychological methods, 7*(2), 147. DOI: 10.1037//1082-989X.7.2.147

Schmiedek, F., Lövdén, M., & Lindenberger, U. (2010). Hundred days of cognitive workout enhance cognitive abilities broad in adulthood. *Frontiers in Aging Neuroscience, 2,* 1-10. doi: 10.3389/fnagi.2010.00027.

Schonert-Reichl, K. A., Lawlor, M. S. (2010). The effects of a mindfulness-based education program on pre- and early adolescents' well-being and social and emotional competence. *Mindfulness,* 1-15. doi: 10.1007/s12671-010-0011-8.

Schonert-Reichl, K. A., Oberle, E., Lawlor, M. S., Abbott, D. , Thomson, K., Oberlander, T. F., Diamond. A. (2015). Enhancing cognitive and social–emotional development through a simple-to-administer mindfulness-based school program for elementary school children: A randomized controlled trial. *Developmental Psychology, 51*, 52-66. doi: 10.1037/a0038454

Schooler, J. W., Mrazek, M. D., Franklin, M. S., Baird, B., Mooneyham, B. W., Zedelius, C., & Broadway, J. M. (2014). The Middle Way: Finding the Balance between Mindfulness and Mind-Wandering. *The Psychology of Learning and Motivation, 60,* 1-33. http://www.sciencedirect.com/science/bookseries/00797421.

Schooler, J. W., Reichle, E. D., & Halpern, D. V. (2004). Zoning out during reading: Evidence for dissociations between experience and metaconsciousness. In D. T. Levin (Ed.), Thinking and seeing: Visual metacognition in adults and children (pp. 204-226). Cambridge, MA: MIT Press

Semple, R.J. (2010). Does mindfulness meditation enhance attention? A randomized controlled trial. *Mindfulness, 1,* 121-130. Doi: 10.1007/s12671-010-0017-1.

Semple, Randye J., Reid, Elizabeth F. G, & Miller, Lisa. (2005) Treating Anxiety With Mindfulness: An Open Trial of Mindfulness Training for Anxious Children. *Journal of Cognitive Psychotherapy: An International Quarterly, 19,* 379-392. doi: 10.1891/088983905780907702.

Semple, R. J., Lee, J., Rosa, D., & Miller, L. F. (2010). A randomized trial of mindfulness-based cognitive therapy for students: Promoting mindful attention to enhance social-emotional resiliency in children. *Journal of Child and Family Studies, 19*, 218–229. doi:10.1007/s10826-009-9301-y.

Shah, P., & Miyake, A. (1996). The separability of working memory resources for spatial thinking and language processing: An individual differences approach. *Journal of Experimental Psychology: General, 125,* 4-27. http://www.apa.org/pubs/journals/xge/.

Shapiro, S., Brown, K.W., & Biege,l G. (2007). Teaching self-care to caregivers: Effects of mindfulness-based stress reduction on the mental health of therapists in training. *Training and Education in Professional Psychology, 1,* 105-115. doi: 10.1037/1931-3918.1.2.105.

Shipstead, Z., Redick, T. S. & Engle, R. W. (2012).Is Working Memory Training Effective. *American Psychological Association, 138,* 628-654. doi: 10.1037/a0027473

Sibinga, E., Perry-Parrish, C., Chung, S., Johnson, S., Smith, M., & Ellen, J. (2013). School-based mindfulness instruction for urban male youth: A small randomized controlled trial. *Preventive Medicine, 57*, 799-801. doi: 10.1016/j.ypmed.2013.08.027.

Siegel, D. J. (2007). The mindful brain: Reflection and attunement in the cultivation of wellbeing. New York, NY: Norton.

Singh, N. N., Lancioni, G. E., Winton, A. S. W., Singh, A. N., Adkins, A. D., & Singh, J. (2009). Mindful staff can reduce the use of physical restraints when providing care to individuals with intellectual disabilities. *Journal of Applied Research in Intellectual Disabilities, 22,* 194-202. doi: 10.1111/j.1468-3148.2008.00488.x

Smalley, S. L., & Winston, D. (2010). *Fully present: The science, art, and practice of mindfulness.* Philadelphia, PA: De Capo Press.

Smallwood, J., & Schooler, J. W. (2006). The Restless Mind. *Psychological Bulletin, 132,* 946-958. doi: 10.1037/0033-2909.132.6.946.

Smallwood, J., O’Connor, R. C., Sudbery, M. V., & Obonsawin, M. (2007). Mindwandering and dysphoria. *Cognition & Emotion, 21,* 816–842. doi: 10.1080/02699930600911531

Smallwood, J., McSpadden, M., & Schooler, J. W. (2008). When attention matters: The curious incident of the wandering mind. *Memory & Cognition, 36*, 1144 –1150. doi:10.3758/MC.36.6.1144

Smallwood, J., McSpadden, M., Luus, B., & Schooler, J. (2008). Segmenting the stream of consciousness: The psychological correlates of temporal structures in the time series data of a continuous performance task. *Brain and Cognition, 66,* 50–56. doi:10.1016/j.bandc.2007.05.004.

Smallwood, J., Nind, L., & O’Connor, R. C. (2009). When is your head at? An exploration of the factors associated with the temporal focus of the wandering mind. *Consciousness and Cognition, 18,* 118–125. doi:10.1016/j.concog.2008.11.004.

Smallwood, J. (2011). Mind-wandering While Reading: Attentional Decoupling, Mindless Reading and the Cascade Model of Inattention. *Language and Linguistic Compass, 5,* 63-77. doi: 10.1111/j.1749-818X.2010.00263.x.

Spreen, O., & Strauss, E. (1998). A compendium of neuropsychological tests: Administration, norms, and commentary (2nd ed.). New York, NY: Oxford.

St. Clair-Thompson, H. L., Stevens, R., Hunt, A., & Bolder, E. (2010). Improving children’s working memory and classroom performance. *Educational Psychology, 30*, 203–220. http://www.apa.org/pubs/journals/edu/.

Stahl, B., & Goldstein, E. (2010). A mindfulness-based stress reduction workbook. Oakland, CA: New Harbinger Publications.

Steele, C. M. (1997). A threat in the air: How stereotypes shape intellectual identity and performance. *American Psychologist, 52*, 613–629. http://www.apa.org/pubs/journals/amp/.

Stroop, J.R. (1935). Studies of interference in serial verbal reactions. *Journal of Experimental Psychology 18 (6):* 643–662. doi:10.1037/h0054651.

Swanson, H. L., Beebe-Frankenberger, M. (2004). The relationship between working memory and mathematical problem solving in children at risk and not at risk for math disabilities. *Journal Education Psychology, 96*, 471–491. doi: 10.1037/0022-0663.96.3.471.

Tamm, L., Menon, V., Ringel, J., & Reiss, A. L. (2004). Event-related FMRI evidence of frontotemporal involvement in aberrant response inhibition and task switching in attention-deficit/hyperactivity disorder. *Journal of the American Academy of Child & Adolescent Psychiatry*, *43*(11), 1430-1440. doi:10.1097/01.chi.0000140452.51205.8d

Teper, R., & Inzlicht, M. (2013). Meditation, mindfulness and executive control: The importance of emotional acceptance and brain-based performance monitoring. *Social, Cognitive, and Affective Neuroscience, 8,* 85–92. http://dx.doi.org/10.1093/scan/nss045.

Tombaugh, T. N. (2004). Trail Making Test A and B: normative data stratified by age and education. *Archives of clinical neuropsychology*, *19*(2), 203-214.

Tuholski, S. W., Engle, R. W., & Baylis, G. C. (2001). Individual differences in working memory capacity and enumeration. *Memory & Cognition*, *29*, 484 – 492. http://www.springer.com/psychology/cognitive+psychology/journal/13421.

Turley-Ames, K. J., & Whitfield, M. M. (2003). Strategy training and working memory task performance. *Journal of Memory & Language, 49*, 446-468. http://www.journals.elsevier.com/journal-of-memory-and-language/.

Turner, M. L. & Engle, R. W. (1989). Is working memory capacity task dependent? *Journal of Memory and Language, 28*, 127-154. doi:10.1016/0749-596X(89)90040-5.

Unsworth, N., Heitz, R.P., Schrock, J.C., & Engle, R. W. (2005). An automated version of the operation span task. *Behavior Research Methods, 37,* 498-505. doi: 10.3758/BF03192720.

Unsworth, N., & Engle, R.W. (2007). The nature of individual differences in working memory capacity: Active maintenance in primary memory and controlled search from secondary memory. *Psychological Review, 114*, 104-132. doi: 10.1037/0033-295X.114.1.104.

Van de Weijer-Bergsma, E., Formsma, A. R., de Bruin, E. I., & Bögels, S. M. (2012). The effectiveness of mindfulness training on behavioral problems and attentional functioning in adolescents with ADHD. Journal of child and family studies, 21(5), 775-787.

von Hippel, W., Silver, L. A., & Lynch, M. E. (2000). Stereotyping against your will: The role of inhibitory ability in stereotyping and prejudice among the elderly. *Personality and Social Psychology Bulletin, 26,* 523–532. doi: 10.1177/0146167200267001.

Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology, 54,* 1063-1070. http://www.apa.org/pubs/journals/psp/index.aspx.

White, H. A., & Shah, P. (2006). Uninhibited imaginations: Creativity in adults with attention-deficit/hyperactivity disorder. *Personality and Individual Differences, 40*, 1121–1131. doi:10.1016/j.paid.2005.11.007.

Wisner, B.L. (2014) An exploratory study of mindfulness meditation for alternative school students: perceived benefits for improving school climate and student functioning. *Mindfulness* 5: 626. doi:10.1007/ s12671-013-0215-9

Wisner, B. L., Jones, B. L. & Gwin, D. (2010). School-based meditation practices for adolescents: A resource for strengthening self-regulation, emotional coping, and self-esteem. *Children & Schools (Special Issue), 32,* 150-159. doi: 10.1093/cs/32.3.150.

Zelazo, P. D., & Carlson, S. M. (2012). Hot and cool executive function in childhood and adolescence: Development and plasticity. *Child Development Perspectives, 6*(4), 354-360.

Zelazo, P. & Lyons, K. (2012), The Potential Benefits of Mindfulness Training in Early Childhood: A Developmental Social Cognitive Neuroscience Perspective. *Child Development Perspectives, 6,* 154–160. doi: 10.1111/j.1750-8606.2012.00241.x

Zenner, C., Hermleben-Kurz, S., & Walach, H. (2014). Mindfulness-based interventions in schools- a systematic review and meta-analysis. *Frontier Psychology 5:603.* doi: 10.3389/fpsyg.2014.00603.

APPENDICES

Appendix A

Fifteen-Minute Mindful Breathing (Stahl & Goldstein, 2010)

Take a few minutes to be still. Congratulate yourself for taking some time for meditation practice. Bring your awareness to your breath wherever you feel it most prominently in your body. It may be at the nose, neck, chest, belly, or somewhere else. As you breath in normally ad natural, be aware of breathing in, and as you breath out, be aware of breathing out. Simply maintain this awareness of the breath, breathing in and breathing out.

There is no need to visualize, count, or figure out the breath; just be mindful of breathing, in and out. Without judgment, just watch the breath ebb and flow like waves in the sea. There's no place to go and nothing else to do, just be in the here and now, noticing the breath – just living life one inhalation and one exhalation at a time.

As you breathe in and out, be mindful of the breath rising on the inhalation and falling on the exhalation. Just riding the waves of the breath, moment by moment, breathing in and breathing out.

From time to time, attention may wander from the breath. When you notice this, simply acknowledge where you went and then gently bring your attention back to the breath.

Breathing normally and naturally, without manipulating the breath in any way, just be aware of the breath as it comes and goes.

As you come to the end of this meditation, congratulate yourself for taking the time to be present; realizing that this is an act of love. May we be at peace, May all beings be at peace.

Appendix B

Safe Place Guided Imagery Meditation (Genevieve, 2014)

Safe Place Guided Imagery

The following script should be read by someone or into a recording device using slow even, speech that is almost monotone in nature. Background music will enhance the experience.

To begin this guided meditation find a comfortable position and close your eyes. Once you settle in notice your body. How does it feel? Let your body begin to relax by releasing the areas of tension by breathing. Take slow deep breaths and as you exhale let the tension go. Where is your body feeling tense? Focus your attention on this area as you take another breath in. Feel this area relaxing as you breathe out. Allow your breathing to gradually slow down.

Breathe in and out

As you do this, allow yourself to picture in your mind's eye, a safe place. What is the first place that comes to mind? What type of place does your mind choose as a safe place? Maybe you are in a beautiful garden, or in the mountains, or in an open field or the beach. Picture a place that feels calm, safe, and serene. A place you feel safe and protected. Imagine the details of your surroundings. Notice the foliage and beautiful colors and hues. What season is it? Notice the ground. Is it earthy soil, rock, or sand? Are you barefooted? What does it feel like beneath your feet? What smells do you notice? Is it sweet, pungent, or refreshing? Are there birds overhead? Listen to their singing. What other sounds do you hear? Let these sounds lull you peacefully. Notice if there is any water. Is there a pond or a waterfall or waves? Can you hear the sound of the water? Let the water flow over your skin. Notice how it feels on your skin. Can you taste it? Notice if there is a breeze or wind. What does it feel like on your face? Is it warm or cool? Allow yourself to take in all the senses feeling calm, serene, and peaceful.

Breathe in and out

Now allow yourself to lie down in the safe place and feel the ground beneath your body. Notice the gentle earth below warming you. Imagine the earth cradling you allowing you to relax even more and feel safe during this meditation. Feel your body resting on the ground allowing any tension to be released into the ground letting it seep away. Can you hear the water lapping in the pond, tricking by, or splashing as it makes waves? Imagine the water washing over you and taking away any tension left in your body.

Breathe in and out

Now look above you and notice the color of the sky. Notice the sun. Feel the warm rays of the sun on you skin. What else do you see? Are there clouds? Are there any trees around? What kind of leaves do they have? Notice their beautiful colors.

Breathe in and out

Now look around, notice a bench, or rock or tree stump in this place, and go sit on it. Feel the sun warming you and further relaxing you. Breathe in the warmth and vibrancy of the sun allowing it to fill you with a sense of calm and peace from the top of your head to the tips of your toes. Notice as you become part of your safe place that you feel more rested, more relaxed, more at peace.

Breathe in and out

After you have thoroughly visualized this place and you are ready to leave, allow yourself to come back into the room and leave your safe place for now, knowing that you can return to your safe place anytime you like. Open your eyes but stay in a relaxed position taking a moment to reawaken completely. Continue to breathe smoothly and rhythmically.

Take a few moments to experience and enjoy your relaxing guided meditation. Your safe place is available to you whenever you need to go there.

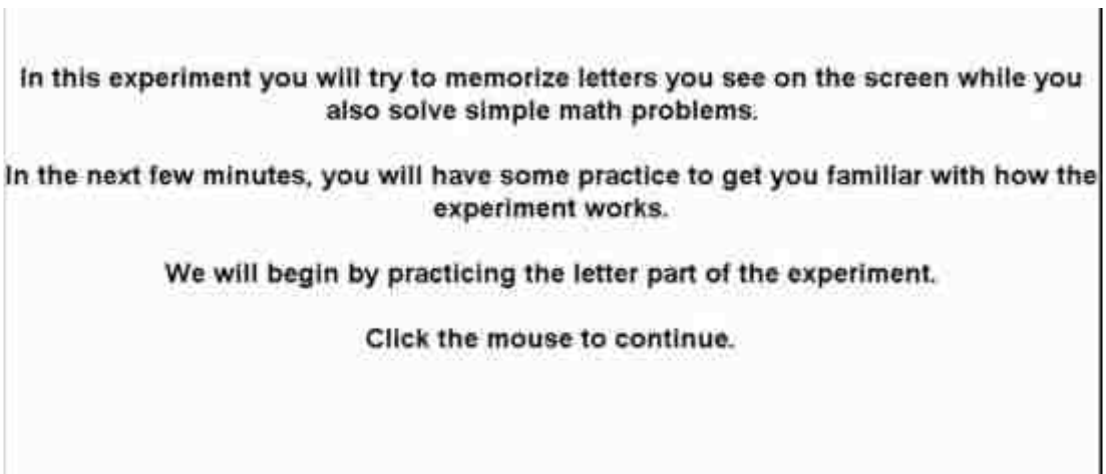
Accessed from: http://www.envisionintegrativetherapies.com/

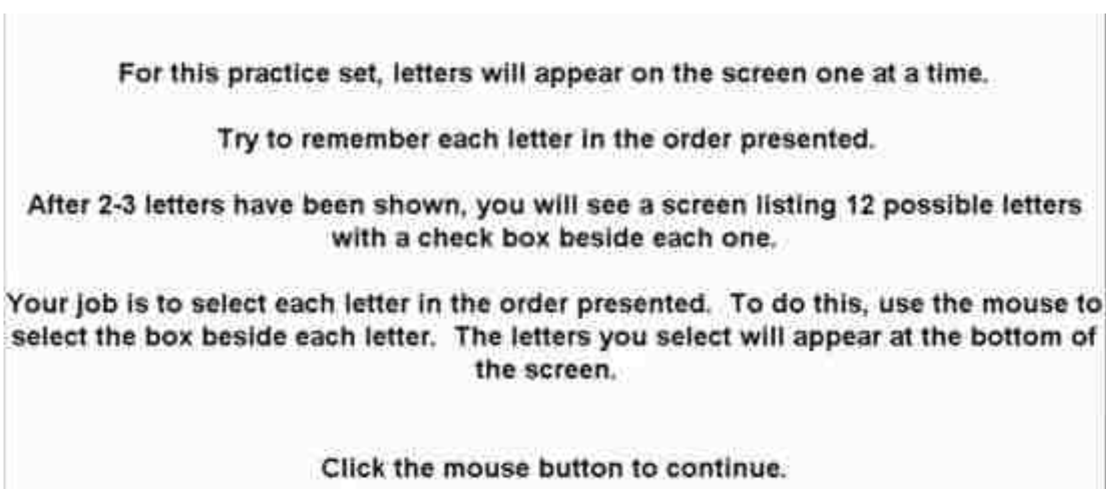
Appendix C

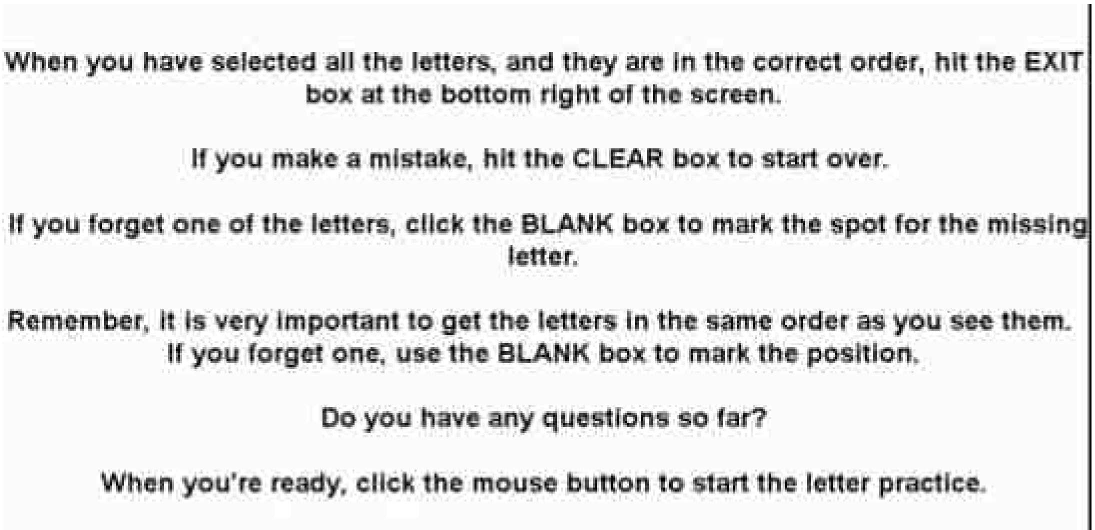
Images of the Automated Operations Span Practice Trials

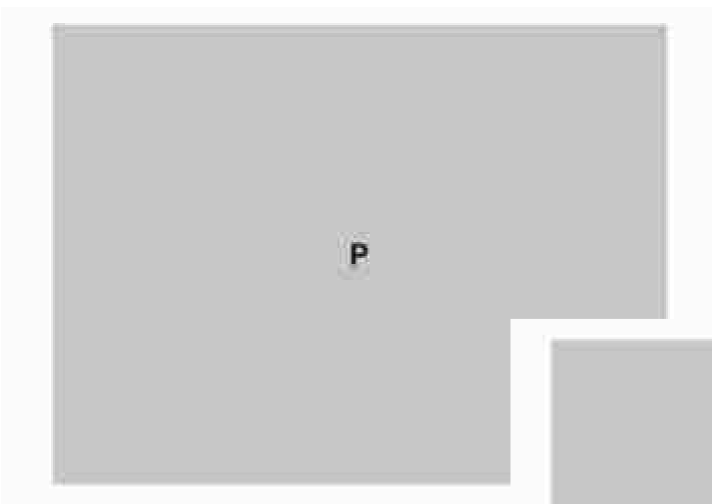
(OSPAN; Unsworth, Heitz, Schrock, & Engle, 2005)

The following images are taken from the practice trial portion of the Automated OSPAN. Participants will be seated at the computer station, and begin the trials after clicking the "Begin" button. The images below represent the progression of practice trials that will prepare the participants for the OSPAN task.

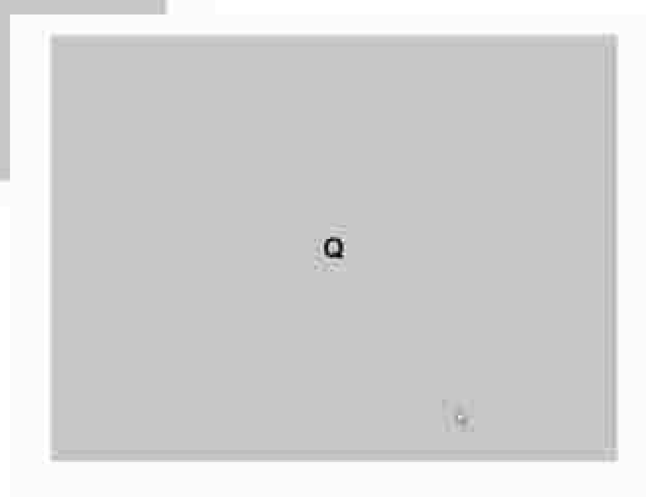






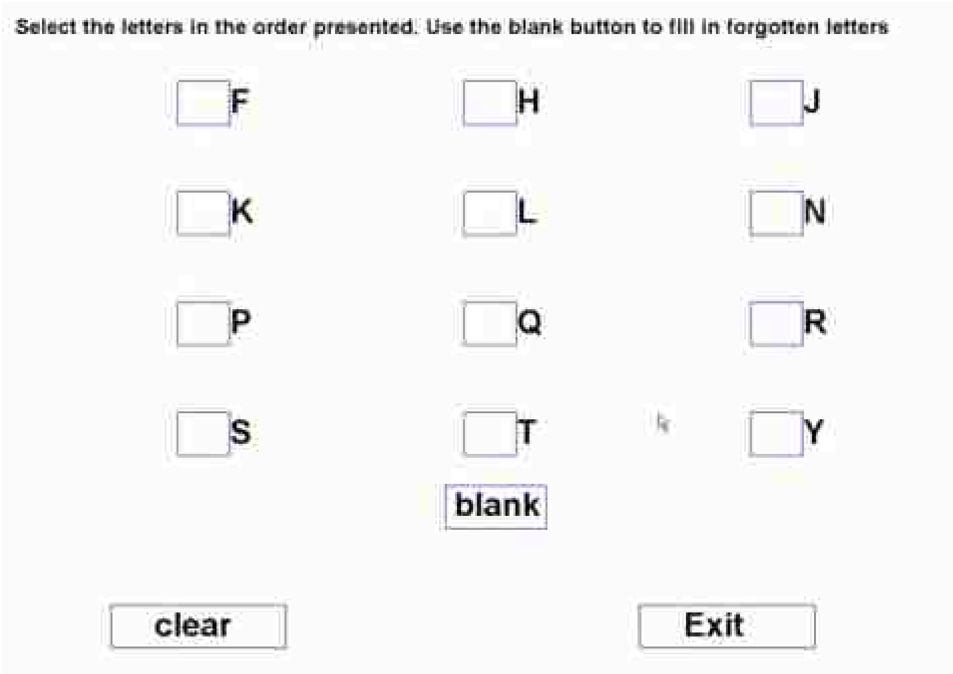


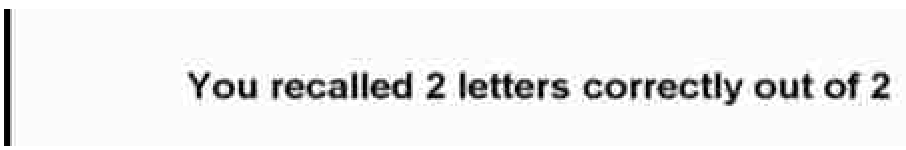
Screen 1



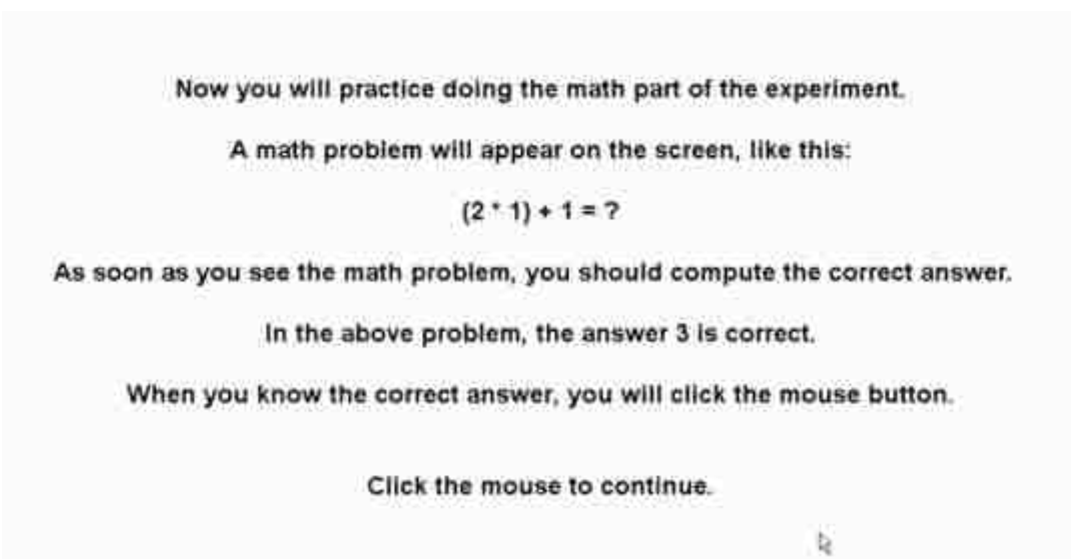
Screen 2

After the presentation of a string of numbers from 2-9, Participants will be asked to recall the letters in the order in which they were presented. They will then be shown their accuracy score.





After 25 practice trials, participants will be trained on the math portion of the task.



You will see a number displayed on the next screen, along with a box marked TRUE and a box marked FALSE.

If the number on the screen is the correct answer to the math problem, click on the TRUE box with the mouse.

If the number is not the correct answer, click on the FALSE box.

For example, if you see the problem
(2 * 2) + 1 = ?
and the number on the following screen is 5
click the TRUE box, because the answer is correct.

If you see the problem
(2 * 2) + 1 = ?
and the number on the next screen is 6
click the FALSE box, because the correct answer is 5, not 6.

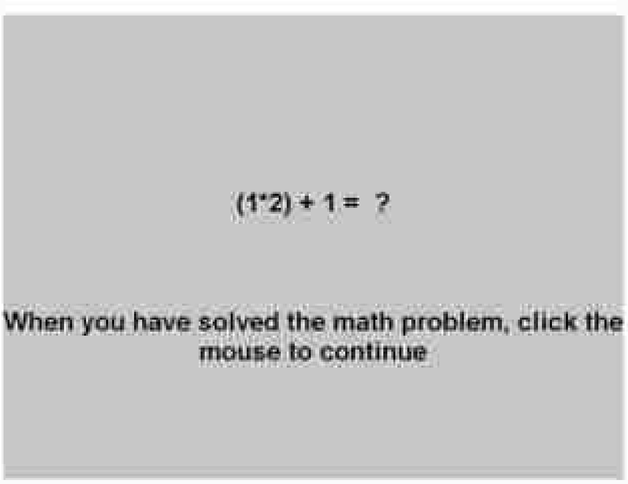
After you click on one of the boxes, the computer will tell you if you made the right choice.

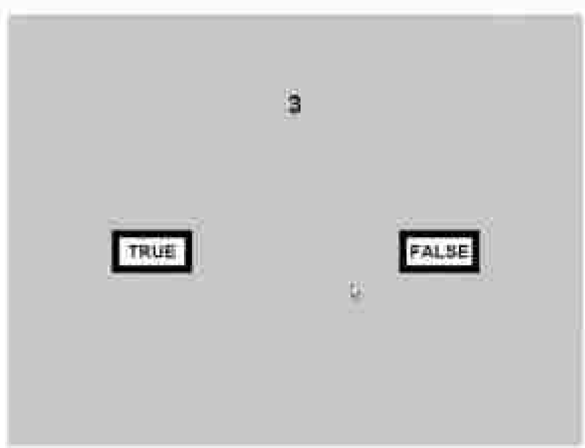
Click the mouse to continue.

It is VERY important that you get the math problems correct. It is also important that you try and solve the problem as quickly as you can.

Do you have any questions?

When you're ready, click the mouse to try some practice problems.





After 25 practice trials of math problems, participants will be asked to complete a test that combines the reading and math tasks.

Now you will practice doing both parts of the experiment at the same time.

In the next practice set, you will be given one of the math problems. Once you make your decision about the math problem, a letter will appear on the screen. Try and remember the letter.

In the previous section where you only solved math problems, the computer computed your average time to solve the problems. If you take longer than your average time, the computer will automatically move you onto the letter part, thus skipping the True or False part and will count that problem as a math error. Therefore it is VERY important to solve the problems as quickly and as accurately as possible

Click the mouse to continue.

After the letter goes away, another math problem will appear, and then another letter.

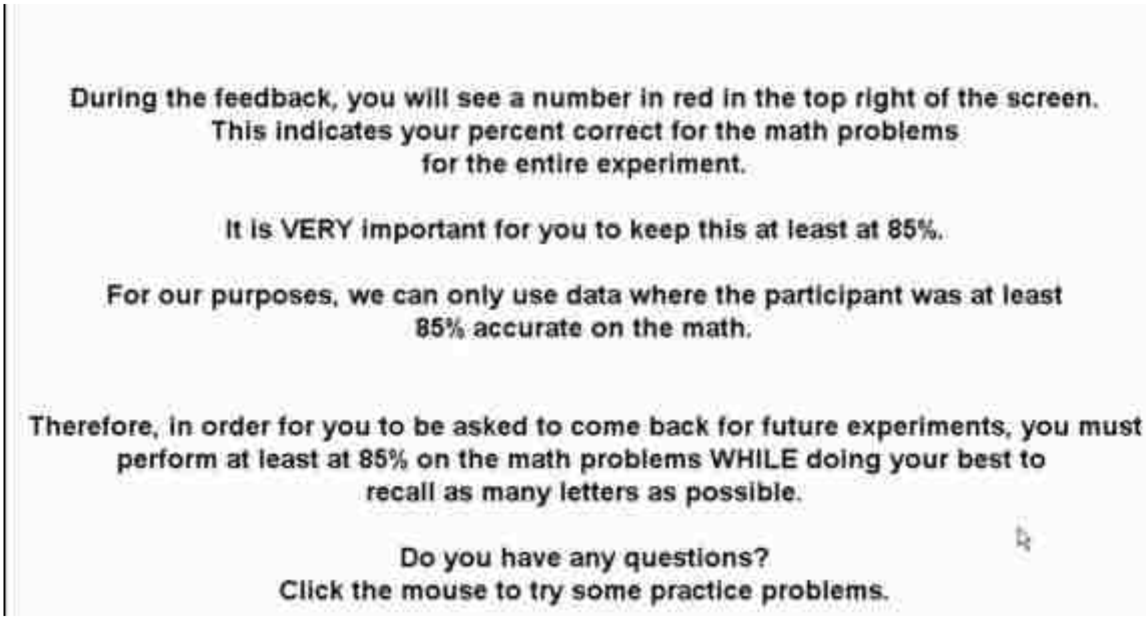
At the end of each set of letters and math problems, a recall screen will appear. Use the mouse to select the letters you just saw. Try your best to get the letters in the correct order.

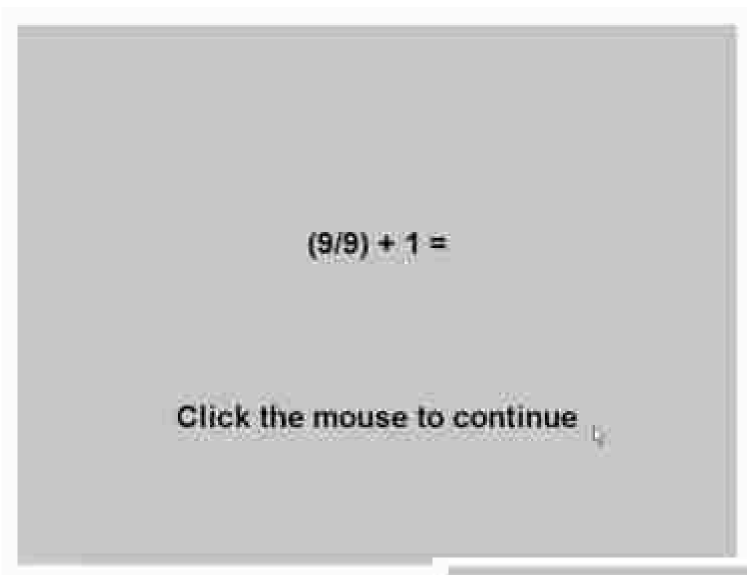
It is important to work QUICKLY and ACCURATELY on the math. Make sure you know the answer to the math problem before clicking to the next screen.

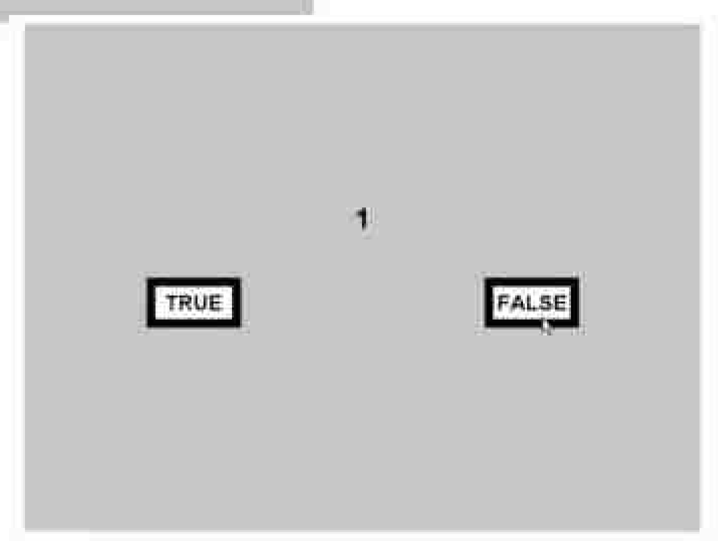
You will not be told if your answer to the math problem is correct.

After the recall screen, you will be given feedback about your performance regardng both the number of letters recalled and the percent correct on the math problems.

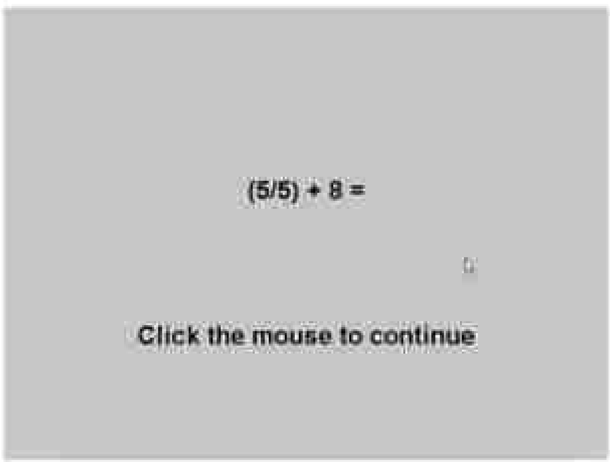
Do you have any questions?
Click the mouse to continue.

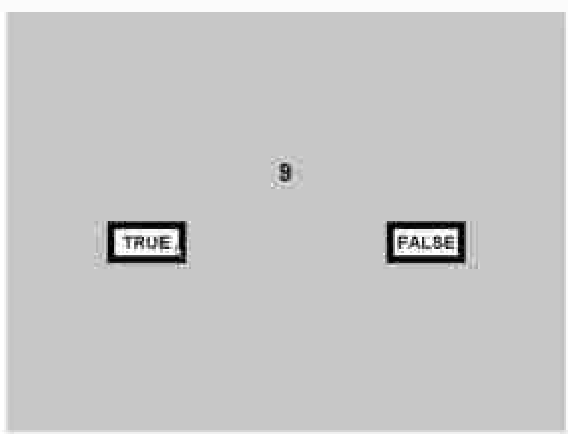

During the feedback, you will see a number in red in the top right of the screen.
This indicates your percent correct for the math problems
for the entire experiment.
It is VERY important for you to keep this at least at 85%.
For our purposes, we can only use data where the participant was at least
85% accurate on the math.
Therefore, in order for you to be asked to come back for future experiments, you must
perform at least at 85% on the math problems WHILE doing your best to
recall as many letters as possible.
Do you have any questions?
Click the mouse to try some practice problems.

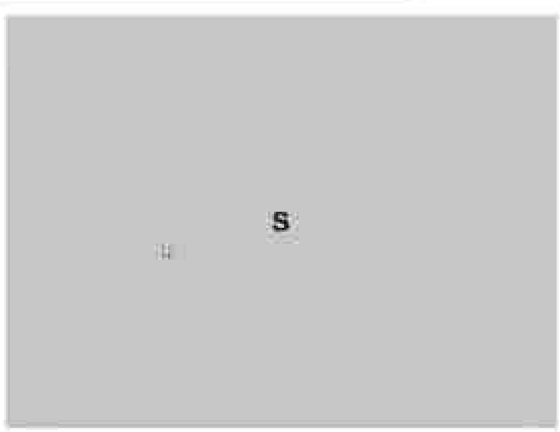

(9/9) + 1 =
Click the mouse to continue

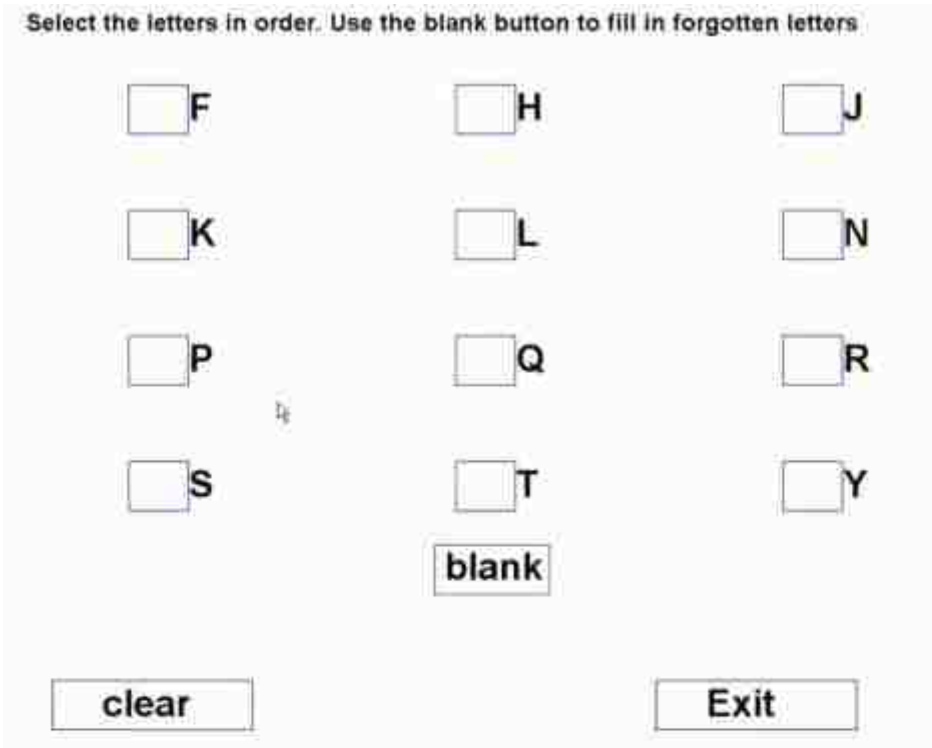

1
TRUE
FALSE

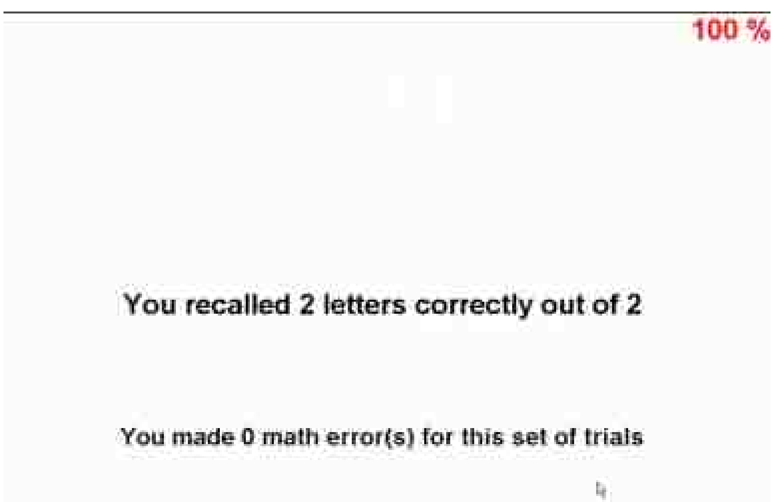

R


(5/5) + 8 =
Click the mouse to continue


9
TRUE
FALSE


S





After completing 75 math and 75 reading trials, participants will have completed the automated OSPAN task.

Appendix D

The Mindful Attention & Awareness Scale (Brown & Ryan, 2003)

Day-To-Day Experiences

Instructions: *Below is a collection of statements about your everyday experience. Using the1-6 scale below, please indicate how frequently or infrequently you currently have each experience. Please answer according to what really reflects your experience rather than what you think your experience should be. Please treat each item separately from every other item.*

1	2	3	4	5	6
Almost Always	Very Frequently	Somewhat Frequently	Somewhat Infrequently	Very Infrequently	Almost Never

1.	I could be experiencing some emotion and not be conscious of it until some time later.	1	2	3	4	5	6
2.	I break or spill things because of carelessness, not paying attention, or thinking of something else.	1	2	3	4	5	6
3.	I find it difficult to stay focused on what's happening in the present.	1	2	3	4	5	6
4.	I tend to walk quickly to get where I'm going without paying attention to what I experience along the way.	1	2	3	4	5	6
5.	I tend not to notice feelings of physical tension or discomfort until they really grab my attention.	1	2	3	4	5	6
6.	I forget a person's name almost as soon as I've been told it for the first time.	1	2	3	4	5	6
7.	It seems I am "running on automatic," without much awareness of what I'm doing.	1	2	3	4	5	6
8.	I rush through activities without being really attentive to them.	1	2	3	4	5	6
9.	I get so focused on the goal I want to achieve that I lose touch with what I'm doing right now to get there.	1	2	3	4	5	6

10. I do jobs or tasks automatically, without being aware of what I'm doing.	1	2	3	4	5	6
11. I find myself listening to someone with one ear, doing something else at the same time.	1	2	3	4	5	6
12. I drive places on ‘automatic pilot’ and then wonder why I went there.	1	2	3	4	5	6
13. I find myself preoccupied with the future or the past.	1	2	3	4	5	6
14. I find myself doing things without paying attention.	1	2	3	4	5	6
15. I snack without being aware that I’m eating.	1	2	3	4	5	6

Appendix E

Positive And Negative Affect Scales (PANAS; Watson, Clark, & Tellegen, 1988)

Instructions: *This scale consists of a number of words that describe different feelings and emotions. Read each item and then make the appropriate answer in the space next to that word. Indicate to what extent you have felt this way TODAY. Use the following scale to record your answers.*

1	2	3	4	5
Very Slightly or Not at all	A Little	Moderately	Quite a Bit	Extremely

____________	Interested	____________	Irritable
____________	Distressed	____________	Alert
____________	Excited	____________	Ashamed
____________	Upset	____________	Inspired
____________	Strong	____________	Nervous
____________	Guilty	____________	Determined
____________	Scared	____________	Attentive
____________	Hostile	____________	Jittery
____________	Enthusiastic	____________	Active
____________	Proud	____________	Afraid

Appendix F

Mind-wandering Probe

(adapted from McVay & Kane, 2009)

In the moments during the task and prior to this probe, was your attention focused on:

a) Completely on the task
b) Mostly on the task
c) On both the task and unrelated concerns
d) Mostly on unrelated concerns
e) Completely on unrelated concerns

Report what you were thinking about during the task and in the moments before the probe appeared:

a) *Task*: thinking about the task and the appropriate response
b) *Task performance*: thoughts evaluating one's own performance
c) *Everyday stuff*: thinking about recent or impending life events or tasks
d) *Current state of being*: thinking about states such as hunger or sleepiness
e) *Daydreams*: having fantasies disconnected from reality
f) *Other*: only for thoughts not fitting other categories.

How frequently do you think that your mind wandered during this task and in the moments before the probe appeared?

a) 0 times
b) 1-4 times
c) 5-9 times
d) 10-14 times
e) 15+ times

Appendix G
Participant Information

Age _______

*Please select the responses with which you best relate

Gender Male Female Transgender Other

Ethnicity
Non-Hispanic White
Black, Afro-Caribbean, or African American
Latino or Hispanic American
East Asian or Asian American
South Asian or Indian American
Middle Eastern or Arab American
Native American or Alaskan Native
Other

What was the size of the area in which you grew up?
Rural (Population less than 2,999 people)
Suburban (Population: 3,000 – 49,999 people)
Urban: (Population: over 50,000 people)

Educational Information

1. I am currently using University Disability Student Services	Yes	No	Prefer Not to Disclose
2. I have previously been diagnosed with a learning disability (e.g., reading disability, writing disability)	Yes	No	Prefer Not to Disclose
3. I have previously been diagnosed with attention problems (e.g., ADHD)	Yes	No	Prefer Not to Disclose
4. Sometimes I think that I should be diagnosed with an attention problem	Yes	No	Prefer Not to Disclose
5. I have previously been diagnosed with an emotional problem (e.g., anxiety; depression)	Yes	No	Prefer Not to Disclose
6. Sometimes I think that I should be diagnosed with an emotional problem	Yes	No	Prefer Not to Disclose

Appendix H

Informed Consent

Study Title: Attention and Relaxation Techniques (AaRT)

Sponsor: The University of Montana

Principal Investigator:

Erin Yosai, M.S.
Doctoral Candidate
Department of Psychology
The University of Montana-Missoula
Ph: 406-243-6089

Faculty Supervisor:
Anisa N. Goforth, Ph.D., NCSP
Assistant Professor
Department of Psychology
The University of Montana-Missoula
Phone: 406-243-2917

Purpose:
The Attention and Relaxation Techniques (AaRT) research study investigates how different techniques may affect your thoughts and attention.

Procedures:
If you agree to take part in this research study, you will be asked some questions about your personal and educational background. This research study takes place in three phases. During the first phase, you will be asked to complete a complex activity designed to measure some of your unique cognitive abilities. You will then be asked to ask to complete five surveys about your thoughts, feelings, and beliefs. During the second phase, you will be asked to attend 6, 30-40 minutes sessions of participation in a randomly assigned attentional technique. After participating in the attentional technique, you will be asked to again complete the complex activity that you learned in the first session, as well as measures of your thoughts, feelings, and beliefs. In the final phase, you will be asked to complete a final complex activity, and to share your final thoughts about your participation in the relaxation techniques. You will then be debriefed, and be given contact information regarding the study.

Payment for Participation:
We truly appreciate your participation in this research. You will be rewarded 8 research credits for your participation in this study.

Risks/Discomforts:
Answering the questions in this survey may cause you to have some mild uncomfortable feelings or thoughts. Should you become uncomfortable, you may stop completing in the study at any time.

Benefits:
By participating in this study, you will be assisting in advancing the field of school psychology in understanding how different relaxation techniques affect our ability to pay attention. You may find that you personally benefit from the relaxation techniques that you learn. Otherwise, there will not be a direct benefit to you.

Confidentiality:
Your responses to the survey will be kept confidential and will not be released without your consent except as required by law. Numeric identification numbers will be used to match your data across sessions for later analyses. Data will be stored on a password-protected computer using a password-protected document.

Voluntary Participation/Withdrawal:
Your decision to take part in this research study is entirely voluntary. You may refuse to take part in or you may withdraw from the study at any time. You will receive research credits based on the amount of sessions you have completed.

Questions:
You may wish to discuss this with others before you agree to take part in this study. If you have questions about the research now or during the study, contact Erin Yosai at 406-243-4521. If you have any questions regarding your rights as a research subject, you may contact the Chair of the IRB through The University of Montana Research Office at 406-243-6672.

Statement of Consent:
I have read the above description of this research study. I have been informed of the risks and benefits involved, and all my questions have been answered to my satisfaction. Submission of the survey will be interpreted as your informed consent to participate and that you affirm that you are at least 18 years of age. I voluntarily agree to take part in this study.

I have read the above information and agree to participate in this research project

______________________________	______________________________
Research Participant	Research Assistant (Witness)

Appendix I

AaRT Procedural Research Script

Phase One

1. Arrive to set-up the computers and paperwork no later than 15 minutes before the participants arrive for their time slot.
    - Materials needed
        - copy of an informed consent form
        - Qualtrics Program
        - E*prime & Automated OSPAN

2. Welcome the participant(s) to the experiment, and you may ask their name(s). You will then lead the participants into the testing space, and show them where they can leave their books and/or backpacks. Have them take a seat in the testing space. For example:
3.

    Hi, [Insert name here] Thank you so much for coming in today. Please follow me, and I will show you where you can safely leave your things while you are participating in the experiment.

    After the participant is comfortable …**You will be completing Phase One of the study today. Let me show you your seat.**

    After the participant is seated **Please read over this Informed Consent form. It tells you all about the study, and what the guidelines are for participation. I'll be back in a few minutes to answer your questions.**

4. Leave the participant to read the form for a few minutes. While they read, you can seat any other participants who may be sharing the same timeslot. When all of the participants have been seated and have been given a few minutes to read over the informed consent form, you will return to check on them.

5. At this time, you will review the informed consent form with the participant, and will explicitly describe the expectations of the experiment. You will read the informed consent with the participant, or ensure that the participant has indeed read the form to completion. When doing this, it is important to make sure that the participant is aware that the study is
    - A multi-phase experiment. They will have sign up for timeslots to come back 7 times: for 6 intervention sessions and 1 wrap-up session
    - Each session should take about 30-40 minutes of their time.
    - They will receive one research credit per session they attend. The whole study is worth 8 credits, which is the amount require for full course credit. *Make sure to emphasize this point with the participant, and reinforce that this is a positive and efficient way to get their credits.*
    - Obtain a signature, or the participant is free to leave.

6. Once the participant has signed the informed consent form, you will open the Automated OSPAN program on the computer. You will enter the PID number in the program. DO NOT FORGET TO MAKE SURE THE PID NUMBER ON THE FORM IS ENTERED INTO THE COMPUTER. THIS IS ESSENTIAL TO DATA COLLECTION AND ANALYSIS.

7. Inform the participant that the first part of the session is to have them complete a computerized task. Instruct the participant to hit the “Begin” button on the program when they are ready to begin. Tell the participant to notify you when they have finished the task by opening the computer station door.

8. When the participant is finished with the OSPAN and has opened the door, enter the room, thank them for completing the task, and then tell them that their next task is to complete the Participant Information packet. Give them the packet, and ask them to bring it to you when they have completed all of the pages.

9. After the participant has completed the Participant Information packet, inform them that they have finished with Phase One of the experiment. At this time, ask the participant to schedule their next session with you. You will show them the calendar of open time-slots for Phase Two of the study, and help them to sign up for a time-slot that works for them.

Phase Two

Phase Two will take place over 6 sessions. The script will remain the same for each session.

1. *Arrive to set-up the computers and paperwork no later than 15 minutes before the participants arrive for their time slot.* Check the schedule to see how many participants will be attending during that specific time slot. Turn on each computer and set-up the specified intervention for each participant (as specified by which condition the participant has been randomly assigned) and Automated OPSAN program.
    a. Experimental Condition: Materials needed
        i. Computer and headphones
        ii. MBI recording
        iii. Qualtrics program
    b. Comparison Condition: Materials needed
        i. Computer and headphones
        ii. Safe Place recording
        iii. Qualtrics program
    c. Control Condition: Materials needed
        i. Computer and headphones
        ii. Newspaper
        iii. Qualtrics program

2. Greet the participant and thank them for coming (e.g. **Hi _____. It's good to see you again. Thank you for coming back. Follow me right this way, and we will get started.)**
3. Guide them to their assigned space, and show them the materials that they will use for the intervention.
   a. Experimental Condition: **You will be participating in a guided relaxation recording. Please put on your headphones and make yourself comfortable. When you are ready, press this start button, here, to begin the recording. Please notify me when you have finished the recording by opening the door.**
   b. Comparison Condition: **You will be participating in a guided relaxation recording. Please put on your headphones and make yourself comfortable. When you are ready, press this start button, here, to begin the recording. Please notify me when you have finished the recording by opening the door.**
   c. Control Condition. **You will be participating in relaxation through sitting down and taking the time to read the newspaper and listening to some white noise. Please put on your headphones and make yourself comfortable. I will leave you for about 15 minutes, and will come back to let you know when it is time to move on to the next task.** After 15 minutes has passed, inform the control participants that it is time to move on to the next task.

4. After the intervention has been completed, you will enter the room and bring up the automated OSPAN program. Enter the unique number specific to the assigned participant. BE SURE TO BE ACCURATE IN ENTERING THIS NUMBER, AS IT IS ESSENTIAL FOR VALID DATA ANALYSIS. Inform the participant that they will now complete the same computer task that they did in previously. You may also give them the Phase II Participant Information packet, which consists of the covariate measures. Remind them of the instructions. First, they will complete the OSPAN, and when they have finished, they can fill out the thoughts and feelings measures.

5. After the participant has completed the Participant Information packet, inform them that they have finished with this session of the experiment. At this time, ask the participant to schedule their next session with you. You will show them the calendar of open time-slots for Phase Two sessions, and help them to sign up for a time-slot that works for them.

6. After the participant has completed 6 Phase 2 sessions, inform them that they have completed Phase 2, and that their next session will be the final session in which they will complete Phase Three of the study.

Phase Three

1. *Arrive to set-up the computers and paperwork no later than 15 minutes before the participants arrive for their time slot.* Check the schedule to see how many

participants will be attending during that specific time slot. Turn on each computer and set-up the Automated OPSAN program. Enter the unique number specific to the assigned participant. BE SURE TO BE ACCURATE IN ENTERING THIS NUMBER, AS IT IS ESSENTIAL FOR VALID DATA ANALYSIS.

2. Welcome the participant and thank them for coming. Lead them into the testing room, and inform them that they will complete the computerized test and the Participant Information packet one final time.

3. After the participant has completed the OSPAN and Participant Information packet, thank them for their participation.

4. Present the participant to experiment debrief form. Briefly explain the debrief form to them, with the summary of the experiment (see Debrief Script). Ask them if they have any questions about the study and their participation. Ask them if they would like our contact information for further information or questions. Complete the experimental credits form and enter the necessary data in SONA computer systems database to ensure that the participant receives credit for participation.

Appendix J

AaRT: Debriefing

This study is concerned with how mindfulness-based interventions impact attentional processes and individual working memory capacity. Previous studies (e.g. Mrazek, Franklin, Phillips, Baird & Schooler, 2013) have found that working memory capacity and attention span have increased for individuals after using a mindfulness-based intervention. The purpose of AaRT was to see if there were differences between students' performance on working memory and attention tasks when they received mindfulness intervention rather than a relaxation or reading task.

<u>How was this tested?</u>

Upon giving consent, you started the initial phase of a three phase study. During the first session, you began and completed the automated OSPAN test as well as four different surveys or tests intended to measure your working memory capacity, general intelligence, emotion, amount of mind-wandering, and demographic information. For the second phase, you were randomly assigned to one of three interventions, including either a mindfulness based intervention, a relaxation task, or a control task of reading a newspaper. The second phase, totaling six sessions, included taking part in the assigned intervention and then two surveys or tests intended to measure your emotion and mind wandering. During the fourth session participants were asked to complete an OSPAN test in-between the intervention task and the other two measures. The third phase took place during the eighth and final session. At that time, you took part in the intervention and then completed the OSPAN test along with surveys or tests intended to measure emotions, amount of mind wandering, and opinions regarding the treatment. The conclusions and results for the study will be drawn by analyzing and comparing the OSPAN and survey or test results from the first session to those in the fourth, and last sessions. These results will show how different types of interventions impact your cognitive functioning and allow researchers to develop more studies concerning mindfulness based interventions and their effects.

Hypotheses and main questions:

In our research we aim to understand how effective mindfulness based intervention is for increasing working memory capacity and attention. We expect to find that when participants receive the mindfulness based intervention their OSPAN scores or working memory capacity and attention scores will increase in comparison to those that participate in relaxation and control task.

Why is this important to study?

The ability to regulate attention is essential to student success in the classroom. Cognitive research shows that a person's ability to regulate their attention is an essential part of their working memory capacity and cognitive abilities. Understanding how mindfulness based intervention strategies may train participants' mind to wander less and focus more could help develop many research hypotheses. This research could have implications for how to intervene with students who struggle with low working memory capacity or attentional regulation, for example children with attention deficit hyperactive disorder. By demonstrating that mindfulness based interventions can help participants increase working memory and attention scores, researchers can hopefully use the knowledge to help younger students succeed in their academic endeavors.

What if I want to know more?

If you are interested in learning more about the effects that mindfulness based interventions has on working memory capacity and attention for participants you could look over http://www.mindful.org/ or email umcresp@gmail.com with questions.

If you would like to receive a report of this research when it is completed or a summary of the findings, please contact Erin Yosai at erin.yosai@umconnect.umt.edu or (406)-243-6089.

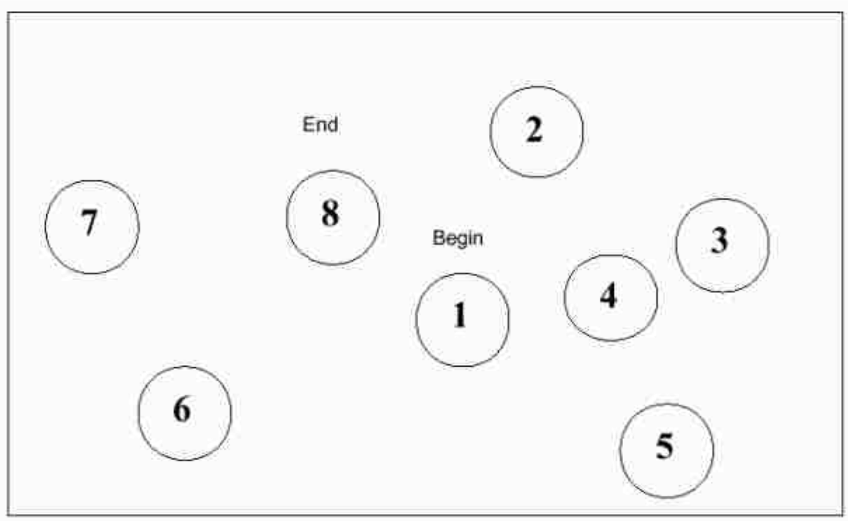
If you have concerns about your rights as a participant in this experiment, please contact the University of Montana IRB Secretary at 406-243-6672 or IRB@umontana.edu.

Thank you again for your participation.

Appendix K

Samples of the Trail Making Task (Reitan, 1958)

Trail Making Test Part A – *SAMPLE*



Trail Making Test Part B – *SAMPLE*