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The Effects of Mindfulness Meditation on Attention and Rumination

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Attention and Rumination

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MASTER'S THESIS

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Diana David
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A Thesis
Presented to
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Abstract

Mindfulness meditation (MM) has grown in popularity over the recent years, becoming a way in which to achieve awareness of the present moment. Benefits of MM include decreased rates of mind wandering, depression, and anxiety, as well as improvements in well-being and attention. However, MM researchers using novice meditators usually compare them to a passive control group or a control group that completes relaxation training. The present study used a cognitively active control group as a comparison group to examine the way attention, rumination, and mind wandering are affected by a short-term MM training. Participants were randomly assigned to complete one week of MM training or one week of poetry analysis. Participants completed measures before and after training, as well as seven days of experience sampling following the completion of training. Results indicated that all participants showed improvements in mindfulness and attention and declines in rumination, and that the two groups did not differ in the magnitude of these effects. Additionally, our longitudinal results indicated that attention did not mediate the relationship between mindfulness and rumination, but our experience sampling results suggested that state mind wandering mediated the relationship between state mindfulness and state rumination. These results suggest that individuals may need to reach intermediate levels of MM training before seeing effects distinct to MM practice.

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The Effects of Mindfulness Meditation on Attention and Rumination

Despite practices dating back thousands of years (Sujato, 2012), only recently has meditation been a topic of scholarly research. While meditation is a lifestyle in many Eastern cultures, the primary goal of meditation from a Western cultural perspective is to achieve a state of nonjudgmental awareness of one's present-moment experience (Kabat-Zinn, 1990). Although there are many styles of meditation that can be employed to achieve such a state, two of the most common meditation practices are focused attention (FA) and open-monitoring meditation (OM) (Ainsworth, Eddershaw, Meron, Baldwin, & Garner, 2013; Lutz, Slagter, Dunne, & Davidson, 2008; Manna et al., 2010). Focused attention teaches people awareness through focusing on one thought or feeling. For example, meditators may concentrate on the physical sensation of their breath as it enters and leaves their body. Open-monitoring meditation achieves awareness through an observer-like perspective of the present experience, encouraging non-judgmental acceptance of whatever thoughts or feelings enter the mind (Bishop et al., 2004; Kabat-Zinn, 1982). Mindfulness meditation (MM) is a technique that uses a combination of both FA and OM in order to achieve a state of awareness (Lutz et al., 2008).

Researchers examining many types of meditation, including FA and MM, have demonstrated a number of physical, psychological, and cognitive benefits. Physical benefits include decreased pain following mindfulness-based practice, specifically among individuals suffering from chronic pain (e.g., Kabat-Zinn, 1982). Psychological benefits of meditation include decreased rates of depression and anxiety (e.g., Jain et al., 2007). Reductions in depression and anxiety have been observed in both disordered (e.g., Hofmann, Sawyer, Witt, & Oh, 2010) and healthy participants (e.g., Eberth & Sedlmeier, 2012). Ramel, Goldin,

Carmona, and McQuaid (2004) have specifically argued that the decrease in depression following MM training is due to a decrease in ruminative thinking patterns that consist of perseverative, automatic negative thoughts (sometimes called ruminative thoughts) that can be maladaptive to coping. Cognitive benefits of MM include improvements in working memory and attention (Chiesa, Calati, & Serretti, 2011; Lutz et al., 2008). However, relatively little research has examined the way cognitive benefits of MM influence the psychological benefits of MM. Specifically, the reduction in rumination and improvement in attention following MM merit additional attention. The purpose of the current study was to examine the way in which attention influences rumination as a result of MM training.

Mindfulness Meditation and Mind Wandering

Most conscious experience is spent in a state where the mind is not focused on a particular task (Killingsworth & Gilbert, 2010). The phenomenon of mind wandering occurs when task-unrelated thoughts disrupt attentional focus. Indicators of mind wandering include habitual and automatic responding, thoughts jumping from topic to topic, and absent-mindedness (Mrazek, Smallwood, & Schooler, 2012). Neuroscience researchers have examined the neural correlates of mind wandering, and they describe the related collective brain regions involved in mind wandering as the default mode network (Dickenson, Berkman, Arch, & Lieberman, 2013; Hasenkamp, Wilson-Mendenhall, Duncan, & Barsalou, 2012; Malinowski, 2007). Specifically, the default mode network is activated when attention is not allocated towards a specific task. Attention networks are required to recognize mind wandering and re-deploy attention (Hasenkamp et al., 2012). Researchers examining the neural components of the default mode network have uncovered multiple brain regions comprising this network. These regions include the posterior cingulate cortex,

the posterior parietal lobe, the posterior temporal lobe, the medial prefrontal cortex, and the parahippocampal gyrus (Hasenkamp et al., 2012; Malinowski, 2007). The functions of these brain regions include memory, self-reference, self-evaluation, and sensation. Taken together, the patterns of activation in these regions suggest that during mind wandering, the brain tends to be internally focused (e.g., past- or future-focused thoughts).

Mindfulness meditation encourages a sense of awareness by promoting focus and concentration (Bishop et al., 2004). Attention networks are required to be engaged during mindfulness meditation. Hasenkamp et al. (2012) examined the brains of long-term meditators during meditation to elucidate the regions of the brain that are involved in meditation and mind wandering. Meditators were asked to press a button any time they noticed their minds wandering. They discovered four different neural patterns: one during mind wandering, one during the awareness of mind wandering (immediately preceding and including the button press), one during the shifting of attention back to the meditation (immediately following the button press), and one during the sustained attention to the meditation. The researchers suggested that there were two distinct overarching neural networks at play: the default mode network and a task-positive network (a network activated by an externally-focused, attention-demanding task) that included the awareness of mind wandering, the shift back to the task, and the sustained attention. The default mode network correlated with mind wandering, whereas the task-positive network correlated with successful mindfulness. Other research provides evidence for the theory that mind wandering and mindfulness are oppositional (e.g., Mrazek et al., 2012).

The neuroimaging research on MM that supports the theory that MM has an oppositional role to mind wandering has revealed a number of brain regions affected by MM

(Way, Creswell, Eisenberger, & Lieberman, 2010). Two of these brain regions are the anterior cingulate cortex and the medial prefrontal cortex. The anterior cingulate cortex has been implicated in processes such as attention (Posner & Rothbart, 2007) and self-regulation (Posner & Rothbart, 2007; Seeley et al., 2007) as well as an individual's ability to inhibit attention to emotional stimuli (Disner, Beevers, Haigh, & Beck, 2011). Xue, Tang, and Posner (2011) examined changes in efficiency (i.e., higher information transmission with less connectivity cost) after only 11 hours of Integrative Body-Mind Training (IBMT), a meditation technique that incorporates body relaxation and MM techniques. Compared to participants who completed only relaxation training, participants who completed IBMT showed topographical changes in the anterior cingulate cortex at rest that indicated an increase in the efficiency of the anterior cingulate cortex. Considering the role that the anterior cingulate cortex plays in alerting the brain to mind wandering (Hasenkamp et al., 2012), an increase in efficiency of the anterior cingulate cortex would indicate an enhanced ability to recognize mind wandering during times when attention is required for a task. In addition, the anterior cingulate cortex is also thought to be involved in both cognitive and emotional self-regulation (Seeley et al., 2007), indicating that greater connectivity between the anterior cingulate cortex and other brain regions involved in self-regulation processes could lead to better long-term control over behavior, thoughts, and emotions. Furthermore, an enhanced ability to recognize mind wandering may, in turn, allow attention to be shifted to task-relevant stimuli.

Mindfulness meditation also affects brain regions involved in self-evaluation. Specifically, the medial prefrontal cortex appears to be affected by MM. In a study of experienced meditators, practitioners who reported having spent more total hours (> 2,000)

meditating tended to show less medial prefrontal cortex activation than those who reported spending fewer total hours (< 1,200) meditating (Haskencamp et al., 2012). Researchers have suggested individuals who tend to be more neurotic and focused on the inner-self also demonstrate more activation in the medial prefrontal cortex in response to negative stimuli compared to individuals who tend to be less neurotic and less focused on the inner-self (e.g., Lemogne et al., 2011). Mindfulness mediation may decrease activity in these self-evaluative regions of the brain because it discourages judgment of thoughts and feelings, reducing the level of reactivity an individual has to what might normally be considered "negative" stimuli.

Thus the anterior cingulate cortex and medial prefrontal cortex are of particular interest in the context of attention and rumination, as researchers have suggested that these regions are both involved in the ability to control attention (Posner & Rothbart, 2007) and also rumination (Cooney, Joormann, Eugène, Dennis, & Gotlib, 2010; Kühn, Vanderhasselt, De Raedt, & Gallinat, 2012). Furthermore, Tang, Hölzel, and Posner (2015) suggested that activity in these brain regions is affected by amount of MM expertise. Cross-sectional studies suggest that anterior cingulate cortex activity during meditation may be higher in intermediate training, relative to novice and experienced meditators (Brefczynski-Lewis, Lutz, Schaefer, Levinson, & Davidson, 2007). Activity in the prefrontal cortex follows this same pattern and is activated in early stages by attention in the context of emotional stimuli. It may be the case that intermediate meditators may require more resources to be allocated to meditation relative to novice meditators because they have better technique and skill in meditation than do novice meditators, whereas more experienced meditators require fewer resources to be allocated to the same task relative to the intermediate meditators. Therefore,

it would be expected the MM would differentially affect attention and rumination, depending on the amount of practice an individual has completed.

A component of MM that the prefrontal cortex and anterior cingulate cortex may affect is mind wandering. Specifically, Christoff, Gordon, Smallwood, Smith, and Schooler (2009) found that the medial prefrontal cortex and anterior cingulate cortex were more active during mind wandering. Because the neural processes involved in active and focused MM are oppositional to those in mind wandering (Hasenkamp et al. 2012), it is useful to also consider the role of mind wandering in the relationship between MM and attention, and MM and rumination. However, according to Tang et al. (2015), effort to reduce mind wandering begins at intermediate levels of MM practice. If effects of MM on mind wandering do not appear until intermediate stages of MM training, there may be no change or even an increase in mind wandering in earlier stages of practice. In such a case, there may be no observable effect of mind wandering on the relationships between MM and attention, and MM and rumination, even if there is an effect at later stages.

Distinguishing Between State and Trait Mindfulness

In addition to considering the way that mind wandering and MM are related, and to fully understand the effect of MM on attention and rumination, it is important to distinguish between two different ways of thinking about mindfulness. Although current literature includes measures of both state and trait mindfulness, fewer studies consider potential differences between the two approaches to conceptualizing mindfulness. State mindfulness is transient, whereas trait mindfulness is a disposition towards mindfulness that is relatively consistent over time (Hölzel et al., 2011).

Although researchers have suggested that MM can increase state and trait mindfulness, researchers have also suggested that state and trait mindfulness may be different constructs (Brown & Ryan, 2003; Thompson & Waltz, 2007). Changes in state mindfulness may be seen in as little as 15 minutes (Vernon, Stiksma, Levy, & Earles, 2015), while changes in trait mindfulness likely take at least a week to become measurable (Baer, Carmody, & Hunsinger, 2012). A large portion of research measures the effects of MM on only trait mindfulness, and therefore brief MM training interventions that measure only trait mindfulness may inadvertently neglect effects of MM on state mindfulness. Considering the length of the MM training program used in this study is one week, it is important to examine state and trait mindfulness as separate constructs.

The Effects of Mindfulness Meditation on Attention

Attention is required for successful MM practice, and MM requires the ability to regulate attention specifically because of its emphasis on attending to the present moment (Shapiro, Carlson, Astin, & Freedman, 2006). Attending to the present moment can involve observation of both internal and external stimuli, while simultaneously resisting the impulse to react, judge, and elaborate on those stimuli (Bishop et al., 2004). An inability to regulate attention could therefore be presumed to impede the ability to be mindful (Smalley et al., 2010).

Although attention is commonly thought of as a single process, it may encompass multiple subtypes, all of which can be affected by MM. Attention is most commonly broken down into three different types: executive, orienting, and alerting (Chiesa et al., 2011; Fan, McCandliss, Sommer, Raz, & Posner, 2002). Greater efficiency in each type of attention indicates enhanced ability in that particular attentional process. Therefore, an increase in

efficiency as the result of MM practice indicates that MM is improving that attentional process. Executive efficiency and orienting efficiency are the attentional processes central to the present study, and therefore improvements in efficiency with MM training are a primary focus.

Executive attention is considered conflict monitoring attention—a system that monitors when attention shifts away from stimuli that are not consistent with the attentional goal (Chiesa-et al., 2011; Fan et al., 2002). Executive attention is required for the disengagement of attention from task-irrelevant stimuli. For example, a driver may be distracted by a car accident on the side of the road; the accident represents a deviation of attention from a task-relevant goal (e.g., watching the car ahead) to a task-irrelevant stimulus (i.e., looking at the mangled car). The executive attention system is what alerts the brain to this shift away from task-relevant stimuli.

Researchers have also found that MM affects executive attention differentially based on the amount of MM experience an individual has. Jha, Krompinger, and Baime (2007) compared a convenience sample of three groups varied in their MM practice history and intervention. The first group consisted of experienced meditators (with 4-360 months of experience) who attended a month-long MM retreat where they spent 10-12 hours a day engaged in formal meditation. The second group consisted of novices completing a standard 8-week Mindfulness-Based Stress Reduction (MBSR; teaches MM techniques) class, where they participated in a 3-hour instructional class each week (learning how to practice MM) and practiced 30 minutes per day at home. The final group consisted of control participants who had no history of MM experience and did not complete any MM practice. They found that prior to training, experienced meditators in the retreat group had higher executive

efficiency than did MBSR novices and control group participants. These results can be interpreted to mean that those with more MM experience can more effectively monitor and recognize when the mind has moved away from task-relevant stimuli, allowing for the disengagement of attention from task-irrelevant stimuli. In addition, MM practice may enhance the ability disengage from stimuli outside of MM practice by reducing habitual elaboration of thoughts and feelings (Lutz et al., 2008).

A second type of attention—although less studied in the context of MM—is orienting attention, which is required to shift attention from one stimulus to another (Chiesa et al., 2011; Fan et al., 2002). For example, when a driver is distracted by a car accident but needs to pay attention to the car ahead, orienting attention is engaged in order to shift attention away from the car accident and to the car ahead. In MM, orienting attention allows the meditator to shift attention from MM-unrelated thoughts (e.g., past events or potential future events) to present-moment thoughts. Compared to non-meditators, meditators have been shown to have higher orienting efficiency, suggesting that practicing MM may improve orienting attention (van den Hurk, Giommi, Gielen, Speckens, & Barendregt, 2010). Other research also supports the claim that MM requires orienting attention (e.g., Dickenson et al., 2013). The vital role orienting attention plays in successful MM practice makes it an important aspect of attention to examine in the present study.

When mind wandering occurs during MM practice, both executive and orienting attention may be required in order for the meditator to shift attention back to the present moment. As the mind begins to wander during MM practice, executive attention would alert the meditator to the fact that attention is focused on unrelated thoughts (Hasenkamp et al., 2012). Orienting attention would then be engaged in order to shift focus back to the present

moment. Such a process would suggest that with increased MM practice, mind wandering should decrease as a result of improvements in executive and orienting efficiency.

Although not central to this thesis, alerting attention is still relevant to MM. Alerting attention is typically thought of as sustained attention and is involved in vigilance and monitoring for unexpected stimuli. For example, while driving a car, drivers are constantly monitoring for unexpected stimuli (e.g., a deer that jumps out of the woods) to allow for quick reallocation of attention to biologically relevant stimuli (e.g., the deer that might jump in front of the car). Jha et al. (2007) found that after training, experienced meditators who participated in a retreat demonstrated higher alerting efficiency than the MBSR participants and novices. This pattern in alerting efficiency suggests that meditation practice predicts an increased ability to monitor for unexpected stimuli, but that this improvement may require more practice than is required through a typical 8-week MBSR program.

A concern of many MM-attention studies is that they have not used random assignment. For example, although Jha et al. (2007) found that MBSR participants had improved orienting efficiency compared to the experienced retreat meditators and controls, their study did not use random assignment. Although conclusions must be drawn with caution, their results suggest that after 8 weeks of MBSR training, participants improved their ability to shift their attention. However, the retreat participants—despite having more meditation experience than the MBSR participants—did not show increased orienting efficiency following their month-long retreat. It is unclear if this finding is the result of the intervention, the MM practice history, or another variable. Many other studies comparing experienced meditators and novice meditators are similar in that they did not utilize random assignment in their designs. Because of this lack of random assignment, differences found

between novice and experienced meditators may be due to prior differences between the two groups. Those who self-select to participate in MM may be individuals with poorer attention regulation, stronger interest in learning MM, or other characteristics that can distort the true effects of MM on attention. For example, some researchers have suggested that unexpected results may indicate pre-existing differences and predispositions between individuals who pursue long-term meditation practice and those who do not (e.g., Davidson & Kaszniak, 2015; Luders, Clark, Narr, & Toga, 2011). Therefore, randomized studies are necessary in order to assess the true effects of MM on attention.

Additionally, because much of the research on attention and MM has used cross-sectional designs, the longitudinal effects of MM on attention have not been extensively studied. The main concern with cross-sectional research is that there is no way to determine the mechanism by which MM works, or the extent to which changes develop over time with increasing MM experience. Therefore, longitudinal designs are necessary to better examine the way attention is affected by MM training.

Some studies have utilized randomized, longitudinal designs to assess the effects of MM training. However, a common concern in these studies is the small sample sizes, which make it difficult to draw conclusions. For example, Semple (2010) found that participants who completed a four-week MM training program demonstrated improvements on an alerting attention measure, but not on an executive attention measure. A potential explanation for the lack of improvement in executive attention may be that the sample size for each of the three conditions was 14-16 participants, which could mean there were not enough participants to detect a true change following the MM training. Therefore, in addition to longitudinal, randomized designs, studies should also ensure a large enough

sample size to detect effects resulting from MM training. In a meta-analysis of MM effects, Eberth and Sedlmeier (2012) found that MM improves attention (d = .63). Using this effect size, a study with power of .80 would require approximately 80 participants for a study with two conditions (40 participants in each group) to detect effects of MM on attention.

The Effects of Mindfulness Meditation and Attention on Rumination

Both MM and attention have been shown to affect rumination, a potentially maladaptive thought pattern that contributes to depression (Ramel et al., 2004). Rumination consists of an automatic, negative, repetitive focus on thoughts and feelings related to distress, prolonging a distressing state (Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008). Rumination can be both adaptive or maladaptive, depending on the perspective the ruminator has towards the distressing thoughts and feelings. Treynor, Gonzalez, and Nolen-Hoeksema (2003) differentiated two subtypes of rumination: reflective pondering and brooding. Although both have been shown to contribute to depression (e.g., Nolen-Hoeksema et al., 2008), reflective pondering tends to be more focused on problem-solving and may lead to greater negative affect in the short-term (Treynor et al., 2003). For example, people might engage in reflective pondering during a test. If they have severe test anxiety, they might spend a lot of time thinking about how to decrease anxiety during the test. These thoughts could be focused on why they suffer from such severe anxiety. In the short-term, negative affect may be heightened as they become frustrated with themselves, but in the long-term they may come up with a solution to decrease their test anxiety.

Brooding involves enhanced levels of moody pondering, typically involving a "Why me?" mentality and self-criticism (Nolen-Hoeksema et al., 2008). For example, people might also engage in brooding during a test. If they have severe test anxiety and a tendency

to brood, they might spend a lot of time during a test berating themselves for having so much test anxiety. Compared to reflective pondering, brooding is more strongly correlated with concurrent and future depression (Treynor et al., 2003).

There are multiple theories as to the mechanism by which MM reduces rumination. MM works to combat the emotional reactivity and self-criticism that are at the core of rumination, both for brooding and reflective pondering. Considering that researchers have demonstrated a reduction in depressive symptoms following MM training (e.g., Jain et al., 2007) and have suggested that rumination plays a role in depression (e.g., Treynor et al., 2003), the reduction in depressive symptoms after MM training may actually be the result of a reduction in rumination.

Another potential explanation for the reduction of rumination following MM is the notion that MM reduces mind wandering, which in turn reduces the opportunity for rumination. Smallwood, Fitzgerald, Miles, and Phillips (2009) used videos to induce a positive, neutral, or negative mood in participants. Participants then completed an objective measure of sustained attention in which they were required to inhibit a response to an infrequent target. Errors during the task were indicative of mind wandering. They found that a negative mood was associated with greater errors and therefore more mind wandering than a positive mood. A potential explanation for these findings is that individuals are more self-focused during a negative mood, and therefore are less focused on a given task. The mind may wander from the negative mood to other self-evaluative topics, such as past mistakes or personal shortcomings. Poerio, Totterdell, and Miles (2013), utilizing non-MM research experience sampling reports, also found that negative mood was related to greater mind wandering 15 minutes later, but they additionally found that sad mind wandering was more

likely to predict a later negative mood than happy mind wandering. Therefore, mood and mind wandering may be cyclically linked. Jones, Lehman, Kirsch, and Hennessy (2015) contributed further to explaining this cyclical model, suggesting that rumination can help to prolong negative affect. Considering the self-evaluative nature of rumination, these results indicate that rumination may also play a role in the bidirectional link between mood and mind wandering. Negative mood may predict mind wandering, and once mind wandering begins, the content may be more ruminative in nature, leading to greater negative affect and continuing the cycle. MM may break that cycle and reduce rumination by reducing mind wandering. MM training teaches an individual to cope with a negative mood by becoming more present in the moment in a non-judgmental way, and also discourages elaboration on current thoughts or sensations. Therefore, an individual is encouraged to maintain attention on the present task—mindfulness—and not allow a negative mood to progress into ruminative mind wandering.

The theory that MM reduces rumination may more specifically be the result of MM improving attention. In other words, MM may act on executive and orienting attention to reduce rumination. There is a plethora of evidence that negative stimuli result in greater attentional allocation than positive stimuli (e.g., Smith, Cacioppo, Larsen, & Chartrand, 2003). For an individual to shift attention from negative information to healthier, more positive information, executive attention is required for the disengagement from the ruminative topic. Researchers have found that individuals with no history of depression but a tendency to brood have higher activation in the dorsolateral prefrontal cortex when disengaging from negative information (e.g., Vanderhasselt, Kühn, & De Raedt, 2011). Given evidence that the dorsolateral prefrontal cortex is involved in executive attention

(Posner & Rothbart, 2007), these results may indicate that people who tend to brood may have poorer executive attention, and therefore may have a more difficult time disengaging from negative stimuli.

In terms of orienting attention, some researchers have suggested that attention-shifting impairments are most prominent under specific conditions. Specifically, individuals who score high in trait rumination demonstrate deficits in shifting attention in contexts where the focus is on negative information (Lo, Lau, Cheung, & Allen, 2012; Pêcher, Quaireau, Lemercier, & Cellier, 2011). Rumination requires both judgment and elaboration of information. For example, an individual may judge a specific thought as negative (e.g., "I hope my coworker does not get that promotion.") and begin elaborating on that thought (e.g., "Why am I hoping that this does not work out for her?). As the amount of time spent on judgment and elaboration increases, a ruminative cycle is established. Mindfulness meditation discourages judgment and elaboration and encourages a focus on being nonjudgmental in the present moment. Therefore, it may be the case that MM training helps individuals stop judgmentally elaborating on negative information and enables them to shift attention to other thoughts and feelings related to the present moment.

Since the focus of the present research is on the relationship between MM and rumination, alerting attention (i.e., monitoring attention) is not central to the theorized mechanism of action by which MM reduces rumination. Although some researchers examine the effects of MM on alerting attention (e.g., Jha et al., 2007; Tang et al., 2007) and some argue that alerting attention may play a role in the likelihood that an individual attends to negative information (De Lissnyder, Koster, Derakshan, & De Raedt, 2010; Koster, De Lissnyder, & De Raedt, 2013), once rumination begins, executive and orienting attention

would be theorized to be critical in the shift from ruminative thoughts to more positive thoughts (e.g., Koster, De Lissnyder, Derakshan, & De Raedt, 2011). Shifting attention from the negative information that one is ruminating on would require the mind to disengage from the negative information (i.e., employ executive attention) and then shift attention to more adaptive information (i.e., employ orienting attention).

Taken together, researchers have concluded that attention plays a role in rumination. Specifically, greater levels of rumination and greater attention deficits—particularly in executive and orienting attention—appear to be related. However, the exact mechanism of this relationship is unknown. Rumination may lead to attention deficits, attention deficits may promote rumination, or both might influence each other. Malinowski (2007) suggested that changes in attention precede changes in rumination. He argues that attention regulation directly affects rumination, so a decrease in rumination cannot occur before an increase in attentional regulation. It should be noted that Pêcher et al. (2011) concluded the opposite, that inducing rumination led to a decrease in orienting attention efficiency, suggesting that rumination may affect attentional regulation. However, research on the other two types of attention (especially executive attention) has not supported the conclusion that an increase in rumination leads to a decrease in attention, casting doubt on the theory that rumination influences attention. Furthermore, researchers have suggested that mind wandering has a negative effect on mood (e.g., Killingsworth & Gilbert, 2010), potentially indicating that if state mindfulness combats mind wandering, there may be a downstream decrease in rumination.

If a decrease in mind wandering occurs before a decrease in rumination, studies examining shorter intervals of MM training would be important to distinguish intermediate

effects of MM training. While much research has supported the notion that MM reduces rumination (e.g., Jain et al., 2007) and improves attention (e.g., Chiesa et al., 2011), these effects are typically seen following an 8-week MBSR class (or other programs of similar or longer length). Little research has examined whether there is an effect of dosage of MM to determine how much MM practice is required before improvements in attention and reductions in rumination occur. The few studies that do examine dosage effect of MM provide evidence that improvements in mindfulness and reductions in stress can occur in as little as 30 minutes per day for seven days (David & Lehman, 2015; Jones, 2015), indicating that improvements in attention may also occur following one week of MM training. However, in the context of rumination, as individuals increase MM practice, there may be a period of time early in training in which rumination increases before it decreases. An explanation for such results may be that with MM training comes an increase in emotional awareness. That is, individuals may be better able to recognize when they are ruminating, and therefore subjectively report greater levels of rumination regardless of whether objective levels of rumination have changed. Additionally, individuals may become initially frustrated by the training, which could elevate levels of rumination. Considering that most studies examining rumination in MM training consist of training intervals that are eight or more weeks long, the effects of MM may not be evident early on when participants may become frustrated with the process. Therefore, it is important to consider the amount of time participants spend meditating during the course of training. Participants who meditate more may show decreases in rumination, whereas participants who meditate less may show no change or even an increase in rumination.

The Use of Comparison Groups in Mindfulness Meditation Research

When studying the effects of MM, researchers use a variety of comparison groups. Many of these comparison groups are passive, such as a no-intervention control group. Although these control groups are useful in ruling out specific confounds in MM research, they are not as effective in providing information about the mechanism by which MM works. Other researchers use active comparison groups to compare to MM groups. Specifically, relaxation-only control groups as comparison groups are common in the field of MM research. The use of relaxation-only comparison groups helps to control for physiological factors that may contribute to effects observed with MM practice. Researchers have found that the effects of MM on attention are different than the effects of relaxation training. For example, Jain et al. (2007) found that participants who completed MM training showed less distress following the training, but this distress reduction was not observed in a relaxation group. These results suggest that MM may uniquely reduce distress, potentially due to the discouragement of self-judgment that is not a part of relaxation training.

Not only have researchers found that the effects of MM are different from the effects of relaxation in terms of rumination, but they have also found that MM has distinct effects from attention. For example, Tang et al. (2007) found that after five days of 20-minute IBMT practice per day, participants improved in executive efficiency, indicating an increased ability to monitor for task-irrelevant stimuli. The increase in executive efficiency was not observed in relaxation-only control participants. Similarly, Jensen, Vangkilde, Frokjaer, and Hasselbalch (2011) found that participants who completed MBSR training showed improvement on a selective attention task that is considered a measure of executive

functioning relative to relaxation-only control participants. These findings indicate that MM might affect executive attention in a way that relaxation does not.

Other researchers have examined the effects of MM on executive attention using cognitive training control groups. For example, researchers have found that executive attention may improve with as little as two days of attention control training (Fox, Dutton, Yates, Georgiou, & Mouchilanitis, 2015). The attention control training task consisted of a flanker task in which participants were instructed to identify a target letter (x or z) among an array of five identical distractor letters (e.g., o o o x o o), while ignoring a face that appeared above or below the letters. Although following the attention training, Fox et al. did not find a statistically significant difference between the training group and control group in terms of level of intrusive thoughts during a thought suppression task, the effect sizes were considerably larger for the attention training group (d = .71) than for the control group (d = .10). The goal of MM training is to increase present moment awareness, which requires executive attention in order to disengage from non-present moment thoughts and feelings. Therefore, MM training may produce effects on executive attention that are similar to those seen after an attention training intervention. Specifically, MM training may help an individual learn to ignore distracting stimuli during meditation (e.g., a recent transgression or an uncomfortable sensation) rather than focusing and elaborating on those particular stimuli.

Similar to the attention control training, Creswell, Pacilio, Lindsay, and Brown (2014) used an analytic cognitive control training as a comparison group. The training was designed to promote analytic focus that would facilitate effective problem-solving skills. Participants were asked to analyze poetry, focusing on elements such as structure, imagery,

and symbolism over three, 25-minute training sessions. Another group of participants received the same amount of MM training. Participants across both the analytic cognitive control training group and MM group were similarly engaged in the training, but the participants in the MM group reported significantly less stress reactivity to a social evaluative task relative to the analytic cognitive control group. These results indicate that MM may affect distress in a way that is unique from an analytical-focused training.

Using cognitive comparison groups rather than relaxation-only control groups is important because relaxation-only control groups provide a comparison to MM only in terms of physical effects, whereas cognitive comparison groups allow for understanding the way MM works in terms of thoughts, attention, and emotions. Therefore, it is important that research incorporate the use of cognitive comparison groups, especially when examining the cognitive effects of MM, such as rumination and attention. The use of poetry in comparison groups is especially novel, despite the incorporation of poetry into some MM practices. Poetry analysis outside of the context of MM practice would not be expected to encourage nonjudgment to the same extent that MM practice does, therefore providing a comparison group that could act as a window into the mechanism of MM training.

The Current Study

I used a randomized, controlled pre-training/post-training design to observe changes in trait mindfulness, attention, and rumination as a function of meditation practice. Additionally, I utilized experience sampling techniques to observe short-term fluctuations in state mindfulness, mind wandering, and rumination on a moment-to-moment following MM training.

Test of meditation effectiveness. I first hypothesized that there would be differences between participants who receive one week of MM training (a total of 240 minutes) and participants who receive one week of poetry analysis training (a total of 240 minutes). Specifically, I expected to see greater increases in mindfulness, orienting efficiency, and executive efficiency, as well as greater decreases in rumination in MM participants compared to poetry analysis participants from pre-training assessments to post-training assessments.

Additionally, I expected to see correlations between mindfulness, attention, and rumination. I expected that individuals who spend more time meditating would show more mindfulness and more attentional efficiency, and less rumination between pre-training and post-training. I also predicted correlations between post-training mindfulness, attention, and rumination. Specifically, I predicted that individuals with greater post-training mindfulness would have greater executive and orienting efficiency, and also report less trait rumination. I also predicted that individuals who have greater executive and orienting efficiency would tend to ruminate less.

Mediated model. The central model I tested was a mediation model, shown in Figure 1. Specifically, I expected that post-training attention (executive and orienting, separately) would partially mediate the relationship between post-training mindfulness and post-training rumination. I predicted that individuals with greater post-training mindfulness would show better post-training attention, and that individuals with greater levels of post-training attention would tend to have less post-training rumination. Furthermore, I expected that the individuals with greater post-training mindfulness would tend to report less rumination. However, I predicted that when orienting and executive efficiency were

considered as mediator variables, the decrease in rumination could be partially explained by an increase in attention.

Additionally, the mediation model described above may be affected by meditation practice, both by condition and reported minutes practiced. I hypothesized that individuals who received MM training would have stronger relationships between post-training mindfulness and post-training attention, post-training attention and post-training rumination, and post-training mindfulness and post-training rumination. In terms of dosage, I hypothesized that individuals who meditated more would show stronger relationships between post-training mindfulness and post-training attention, post-training attention and post-training rumination, and post-training mindfulness and post-training rumination. I expected the relationship between post-training mindfulness and post-training rumination to be stronger for individuals who received MM training, compared to individuals who did not receive MM training. This differential effect of training was expected because individuals who do not receive MM training may use coping strategies aside from mindfulness (e.g., reappraisal) in an attempt to decrease rumination, while individuals who do receive MM training may be more likely to use mindfulness-related coping strategies in an attempt to decrease rumination.

Experience sampling. Experience sampling approaches provide unique tools for research, as they decrease bias and distortion that may be present when retrospectively answering questions about previous experiences, and allow for theory testing in a more naturalistic setting. Considering that trait mindfulness may not predict state mindfulness (e.g., Brown & Ryan, 2003), it is important to examine the way state mindfulness affects state rumination. State mindfulness is transient, and therefore, it is critical to examine the

model's ability to predict behavior on a momentary level. The experience sampling reports were taken after all MM training was complete, so that I could assess our model's ability to explain behavior outside of the lab. The experience sampling mediation model, as shown in Figure 2, is similar to the model described above. I expected that state mindfulness would be negatively related to mind wandering and also negatively related to state rumination. Additionally, I predicted that mind wandering would be positively related to state rumination (i.e., how much time the participant has spent focused on feelings and problems in the 10 minutes prior). Furthermore, I expected that indicators of meditation practice (i.e., MM/control condition and minutes meditated) would act as moderators in this model.

Method

Participants

Participants were recruited for the study from Western Washington University. I used the University's human subject pool (the Sona System) to recruit participants. The study was advertised as a stress reduction study in order to eliminate any expectancy effects of a study advertised as a MM study. The participants who completed all parts of the study received six research credits and were entered into a raffle to win one of fourteen $25 prizes.

To participate in the study (see Appendix A for recruitment survey), participants were required to be meditation-naïve; participants were asked if they had ever engaged in formal meditation practice or yoga. Participants who had recently meditated or performed yoga were ineligible, as were those who had ever received formal MM training.

A total of 115 students participated in the study, 88 (76.5%) identified as female, 26 (22.6%) identified as male, and one (0.9%) identified as "non-binary". Participants were predominately Caucasian (Caucasian 69.6%, Asian American 13.0%, Latino 6.1%, Pacific

Islander 1.7%, Middle Eastern American 0.9%, African American 0.9%, American Indian/Native American 0.9%, Mixed Ethnicity 6.1%, and Other 0.9%). The average age of participants was 19.93 years (*SD* = 4.03, range 18-43).

Procedure

The study was carried out over a five-week period, with four waves of 30 participants (see Table 1). In each wave, 15 participants were randomly assigned to receive MM training (experimental condition) and 15 were randomly assigned to receive poetry analysis training (active control condition; adopted from Creswell et al., 2014). When debriefed at the end of the study, participants assigned to the control condition were given the opportunity to practice MM using recordings they could access on SoundCloud (SoundCloud Limited, 2016), a social sound platform that allows users to upload recordings of sounds. After consenting to participate (see Appendix B), all participants completed pre-training and post-training measures, as well as a set of experience sampling measures.

Pre-training and post-training. Participants completed a pre-training assessment at the beginning of the study, and a post-training assessment eight days later. Both the pre-training and the post-training assessments were completed in a group setting in a computer lab using the online software Qualtrics (2005). Pre-training measures included trait mindfulness, trait rumination, and an objective measure of attention. Post-training measures included the trait mindfulness, trait rumination, and attention measures as used in the pre-training.

Mindfulness intervention. Participants randomly assigned to the MM group received a two-part MM training. The first part was a 2-hour class that the participants attended which was led by the Executive Director of Mindfulness Northwest, Tim Burnett.

He has been a formal MM training instructor since 2009 and has worked for the Center of Mindfulness (University of Massachusetts) and the Seattle Veteran's Administration Hospital in addition to Mindfulness Northwest in Bellingham, Washington. Mr. Burnett has also taught multiple MM classes for research conducted at Western Washington University (e.g., Jones, 2015). The MM class was based on a Mindfulness-Based Stress Reduction (MBSR) course and incorporated in a body-scan and sitting meditation, totaling 60 minutes of active MM during the class. For the body-scan meditation, participants were directed to pay attention to each part of their bodies one at a time, progressing through the body from toes to head. The sitting meditation encouraged less focus on a particular thought or sensation as well as more awareness of the participant's present moment experience and their breath (e.g., the sensation of it entering their nostrils or lungs, or feeling its effects in specific areas of the body). Throughout the session, Mr. Burnett emphasized correct posture (e.g., spine upright, feet flat on the floor or legs crossed), and encouraged participants to gently return their attention to their present experience or breath when it wandered away from the task. For specific examples of Mr. Burnett's body scan and sitting meditations, please visit the Mindfulness Northwest webpage (http://www.mindfulnessnorthwest.com/tim). In addition to the two types of meditations, participants learned how MM works and what a typical mediation practice session involves, and had the opportunity to ask any questions they may have had. Participants also had the opportunity to share their meditation experience after each of the two practice sessions and to discuss it with the instructor.

Following the class, the second phase of MM training was implemented. MM participants were asked to complete 30 minutes of MM practice each day using recordings

made by Tim Burnett, for a total of 180 minutes of at-home MM practice over six days (see Appendix C). Participants were able to access the recordings using an online storage program, SoundCloud (SoundCloud Limited, 2016). Participants with smartphones used their own phones to access the recordings, while participants without smartphones borrowed an iPod Touch (see Appendix D). Only one participant borrowed an iPod to listen to recordings. Participants had the option to choose a type of meditational approach (sitting/breathing meditation, mindful check-in, or body scan), and each meditation lasted between nine and 30 minutes. Participants were asked to complete one or more meditation recordings to reach 30 minutes per day. Participants were also able to complete the same recordings each day, or vary the recordings, depending on personal preference. Prior research using this approach suggests that more variety in the types and lengths of meditation practices was related to more minutes devoted to meditation (David, Jones, & Lehman, 2015).

After each at-home meditation session (regardless of practice length), participants were asked to complete a Mindfulness Report describing their meditation experience (see Appendix E). The report included a number of questions, such as which meditation recording was completed (these data were used to calculate total minutes meditated), whether participants ruminated during their practice, and how much their mind wandered during the meditation. Only the data on the number of minutes meditated from these reports is included in this study.

Control condition. Control participants completed a non-mindfulness poetry-analysis intervention, adapted from Creswell et al. (2014), to parallel the MM training program format. Control participants spent one hour (the equivalent time the MM

participants completed MM during their class) analyzing a total of six poems during a class led by a trained research assistant. The trained male research assistant used a script during each class to ensure reliability of instruction. Additionally, he practiced a portion of the script to elicit feedback from other lab members regarding his pace, intonation, and demeanor. He also practiced poem recitation using recordings and attended MM sessions led by Mr. Burnett during previous research projects. The script the research assistant used included six poems selected from Creswell et al., as well as from *Norton Introduction to Poetry* (Hunter, Booth, & Mays, 2006). Criteria for the inclusion of poems included length (short enough to read within two minutes), relatively neutral in tone (i.e., not strongly uplifting, nor strongly depressing), and also a paired analysis from either Creswell et al. or from *Norton Introduction to Poetry*. The paired analyses were used to provide instructions for analysis during the class and in the recordings. Analyses included aspects of the poem, such as meaning, imagery, structure, and rhythm. For example, in the poem *Night Journey* by Theodore Roethke, the narrator writes about experience of traveling on a train. Participants were asked to think about the images (e.g., people, places, or things) that the author conveys. During the class, participants listened to the same poem multiple times and were instructed to identify and analyze specific aspects of the poem, with a separate aspect assigned to each repetition of the poem. Additionally, as in the MM class, participants had the opportunity to share their analysis of the poem during the class and receive feedback from the research assistant regarding their analysis. Participants in the poetry condition practiced analyzing poetry for a total of 60 minutes. Participants appeared to be as engaged in the poetry analysis class as they did in the MM class. Of the 107 (93% response rate) participants who provided feedback about their participation in the study, seven MM

participants reported enjoying the MM class and no MM participants gave negative feedback about the class. Six poetry analysis participants gave positive feedback about the class and two gave negative feedback about the class. The negative feedback from the two poetry analysis participants was about the length of the class.

Like MM participants, control participants were asked to practice poem analysis for 30 minutes per day for six days, for a total of 180 minutes of poetry analysis practice (see Appendix F). Each poem analysis lasted approximately 15 minutes, so participants were asked to complete two each day to reach 30 minutes per day. Participants could complete them back-to-back, or at separate times during the day. Following the poem analysis, participants completed a parallel report to that completed by MM participants (see Appendix G). More specifically, control participants answered questions about their poem analysis experience, including questions about which poems they listened to, if they ruminated during their analysis, and how much their mind wandered during the practice.

Experience sampling. Starting on the final day of meditation or poetry analysis practice and continuing for seven days, all participants were asked to complete experience sampling reports (see Appendix H). Participants with their own smartphones were able to access the experience sampling reports via their phone's internet browser, while other participants used iPod touches. Participants were signaled three times per day over the course of six days to complete an experience sampling report (at noon, 5:00 p.m., and 9:00 p.m.). Each experience sampling report asked the participants about their current mindfulness, level of rumination, mind wandering, and stress.

Debrief. Following the experience sampling, participants reported to a small computer lab in small groups, and were debriefed on the study (see Appendix I). Participants

were informed of the two different conditions, and control participants were provided with the link to SoundCloud, where they could access the MM recordings. Additionally, participants were asked questions about their experience participating in the study (see Appendix J), including whether they were aware of the actual purpose of the study. Participants were also asked not to share any details of their participation with others in an effort to preserve the true purpose of the study.

Measures

Pretest and post-training measures.

Trait mindfulness. The Five-Facet Mindfulness Questionnaire (FFMQ; Baer, Smith, Watkins, & Toney, 2006) was used to assess trait mindfulness. Participants were asked to rate how much each of the 39 items was true for them, using a Likert-scale from 1 ("never or very rarely true") to 5 ("very often or always true"). Higher scores indicate greater mindfulness. The FFMQ has five subscales of mindfulness: observing, describing, nonjudging, nonreacting, and acting with awareness. The observing subscale ($\alpha = .75$) consists of eight items that measure the ability to pay attention to bodily sensations. Items include "When I take a shower or bath, I stay alert to the sensations of water on my body" and "I pay attention to sensations, such as the wind in my hair or sun on my face". The describing subscale ($\alpha = .91$) uses eight items to measure the ability to put one's current experience into words. An example of an item is "I'm good at finding words to describe my feelings". Of the eight items, three of them are reverse-coded items, such as "It's hard for me to find the words to describe what I'm thinking." The nonjudging scale ($\alpha = .90$) consists of eight items that measure the extent to which individuals are able to avoid criticizing their thoughts and emotions. All eight items were reverse-coded, such as "I tell myself I shouldn't

be feeling the way I'm feeling." The nonreacting subscale (α = .74) uses seven items to measure how well individuals are able to avoid responding to their thoughts and feelings. Items include "When I have distressing thoughts or images, I just notice them and let them go" and "In difficult situations, I can pause without immediately reacting". The acting with awareness (α = .88) subscale consists of eight items that measure an individual's ability to pay attention to a task, without the mind wandering. All eight items are reverse-coded, and examples include "I rush through activities without being really attentive to them" and "I do jobs or tasks automatically without being aware of what I'm doing". The FFMQ is widely used in mindfulness research, and has been shown to reliably measure the different facets of mindfulness, allowing for a more in-depth analysis of which mindfulness skills are being affected by an intervention (Baer, Walsh, & Lykins, 2009). I calculated a mean item score for all subscales combined (α = .87), as well as means item scores for each of the subscales.

Additionally, I assessed trait mindfulness using the Mindful Attention Awareness Scale (MAAS; Brown & Ryan, 2003). This measure of mindfulness was collected but not analyzed in this thesis, so as to reduce the length and number of analyses. The MAAS consists of 15 items on a 1 ("almost always") to 6 ("almost never") scale, and is designed to measure the extent to which an individual is attending to the present experience. Example questions include "I find myself doing things without paying attention" and "I find myself listening to someone with one ear, doing something else at the same time". A mean composite score was calculated, with higher scores indicate higher levels of trait mindfulness. Reliability was estimated by Cronbach's alpha at .84. The scale has been widely used in MM research, and has been shown to be reliable and valid with college students and the general adult population (Brown & Ryan, 2003).

Rumination. Trait rumination was measured using two of the three subscales from the Ruminative Response Scale (RRS; Treynor et al., 2003), reflection and brooding. Participants were asked to what extent the items applied to them over the last week, using a 1 ("almost never") to 4 ("almost always") Likert scale. Higher scores indicate more rumination. Reliability of the whole scale was estimated by Cronbach's alpha at .87. The reflection subscale ($\alpha = .79$) consists of five items that measure the extent to which an individual engages in rumination that is focused on problem-solving. An example of a reflection item is "How often do you analyze recent events trying to understand why you are depressed". Due to the focus of brooding in this study, the reflective rumination subscale was not used in analyses, except for calculating the composite score of rumination. The brooding subscale ($\alpha = .83$) consists of five items that measure the extent to which an individual engages in brooding rumination, rumination that is more negative and self-critical in nature. An example of a brooding item is "How often do you think 'What am I doing to deserve this?'". The RRS is widely used in rumination research, and has been shown to be internally consistent and reliable (e.g., Nolen-Hoeksema & Morrow, 1991; Sakamoto, Kambara, & Tanno, 2001) and valid (e.g., Sakamoto, Kambara, & Tanno, 2001). Additionally, it and has been validated with numerous populations, both clinical (e.g., Nolen-Hoeksema & Morrow, 1991; Sakamoto, Kambara, & Tanno, 2001) and nonclinical (e.g., Moberly & Watkins, 2010; Watkins, Moulds, & Mackintosh, 2005). All analyses were conducted using both a mean composite score of rumination as well a mean score for the brooding subscale.

Attention. Attention was measured using the Attentional Network Task (ANT; Fan et al., 2002). The ANT is a computerized task of attention that measures alerting,

orienting, and executive attention. A diagram of the task is shown in Figure 3. The participants see a center cross, and then either a cue (*) or no cue. If the cue appears above or below the cross, it indicates to the participant that the target will appear immediately in the location of the cue (spatial condition). If the cue appears both above and below the cross simultaneously, it indicates that the target will appear immediately, but does not provide any information on whether the target will be above or below the cross (double cue condition). If the cue appears in the place of the cross, it indicates that the target will appear immediately, but does not prime the participant to attend to a particular area of the screen (center cue condition). The target consists of a series of five arrows. When the target appears, the participant is instructed to indicate the direction of the center arrow and ignore the arrows on either side (flankers) of the center arrow. Participants are told to complete this task as quickly as possible using the keyboard. The central arrow may be facing the same direction as the flankers (congruent; ← ← ← ← ←), or it may be facing the opposite direction of the flankers (incongruent; ← ← → ← ←). Using the reaction times (RTs) of responses, each type of attention receives a score that indicates the level of efficiency of that type of attention, such that higher scores indicate greater efficiency for orienting and alerting attention, and poorer efficiency for executive attention (Wang, Fan, & Johnson, 2004).

Formulas are used to calculate each of the subscales. For alerting attention, the mean reaction time for the double cue condition is subtracted from the mean reaction time of the no cue condition. Higher scores indicate better alerting attention. For orienting attention, the mean reaction time for the spatial cue condition from the mean reaction time of the center cue condition. Higher scores indicate better orienting attention. Executive attention is calculated by subtracted the mean reaction time for congruent targets from the mean reaction

time from incongruent targets. In this case, I would expect that participants perform better in the congruent condition (because the congruent flankers do not pose a distraction) than in the incongruent condition (because the incongruent flankers do pose a distraction), higher scores indicate poorer executive efficiency.

Mind wandering. Trait mind wandering was assessed using the Mind Wandering Scale (Carriere, Seli, & Smilek, 2013). Participants were asked to what extent each statement reflects their daily experience, on a scale from 1 ("Rarely") to 7 ("A lot"). Higher scores indicate a higher level of mind wandering throughout the day. Reliability was estimated at .90 using Cronbach's alpha. The deliberate subscale ($\alpha = .89$) consists of four items that measure the degree to which participants purposely let their mind wander. Items include "I allow my thoughts to wander on purpose" and "I enjoy mind wandering". The spontaneous subscale ($\alpha = .84$) consists of four items that measure the degree to which participants purposely let their mind wander. Items include "It feels like I don't have control when my mind wanders" and "I mind wander even when I'm supposed to be doing something else". The scale has been demonstrated to be valid and both subscales have been shown to have reliabilities similar to ours as well as small-medium correlations with attention control and attention shifting (Carriere, Seli, & Smilek, 2013). Because I was interested in mind wandering as a whole, a mean composite score for both subscales was used.

Experience sampling measures.

State mindfulness. State mindfulness was measured using two subscales from the FFMQ, the acting with awareness subscale and the nonjudging subscale, as described in the pretest and post-training measures (Baer et al., 2006). I chose to use only two subscales in

order to ease the burden of participants, who were completing these surveys on their smartphones. The acting with awareness and nonjudging subscales seemed most relevant to our model; acting with awareness requires attentiveness, and resisting judgment of oneself requires both attention and a decrease in ruminative thought patterns. The participant was instructed to rate each of the 16 items on a scale from 1 ("never or very rarely true") to 5 ("almost always true"), as it was true for them in the 10 minutes prior to the report. Higher scores indicated greater mindfulness, after reverse coding all 16 items. As indicated by multilevel modeling, Raudenbush and Bryk (2002) indicated that state mindfulness had an internal consistency of .76 for the nonjudging subscale and .75 for the acting with awareness subscale, both of which were deemed acceptable. Both subscales were negatively skewed, and I opted to use robust standard errors to account for this.

Additionally, state mindfulness was measured using five items from the MAAS that correspond to a wide variety of activities, as determined and validated by Brown and Ryan (2003). Similar to the pre-training and post-training measure of MAAS, this measure of state mindfulness was collected but not analyzed in this thesis, so as to reduce the length and number of analyses. Participants were asked to indicate on a scale from 1 ("almost always") to 6 ("almost never") the extent to which they were having a specific experience. Example items included "…staying focused on what's happening in the present" and "rushing through activities without being really attentive to them". Higher scores indicated higher levels of state mindfulness over the previous 10 minutes. Our reliability analyses revealed that the MAAS had an alpha of .80.

Rumination. State rumination was measured using two items from Moberly and Watkins (2008). Participants used a slider scale from .10 ("less") to 10 ("more") to answer

each item. The statements asked over the past 10 minutes to what extent "I was focused on my problems" and "I was focused on my feelings". The scales had a marker set to the middle of the scale, and participants used their fingers to drag the marker along the slider scale. If participants did not touch the marker, no response was recorded. Research has suggested that this two-item scale has acceptable reliability (Jones et al., 2015; Moberly & Watkins, 2010). Our reliability estimates using multilevel modeling indicated that the two items had poor internal consistency ($\alpha = .26$), so I tested these two questions separately. The poor reliability for this measure makes conceptual sense, considering the separation between reflective rumination (problem-focused) and brooding rumination (feeling-focused). An individual may be thinking a lot about a current problem, but not about the feelings surrounding that problem. Similarly, rumination about current feelings does not require those feelings to be framed within a particular problem.

Mind wandering. I also assessed mind wandering using experience sampling. Considering that mind wandering consists of task-unrelated thoughts, transient changes in mind wandering may parallel transient changes in attention. State mind wandering was measured using a single item adapted from Killingsworth and Gilbert (2010). The original question from Killingsworth and Gilbert asked about current mind wandering, however our question asked the participant about mind wandering over the previous 10 minutes. Specifically, the item asked the participant "How much have you been thinking about something other than what you were currently doing?" The participant answered using a slider scale from .10 ("almost never") to 10 ("almost always"). Higher scores indicated greater mind wandering.

Results

Data Cleaning

Dosage. Participants were asked to complete reports after each practice session, providing us with information about which recording they completed. A sum of minutes from each reported recording was calculated for every participant. Each participant completed 60 minutes of their respective technique in their class, but was also asked to complete a total of 180 more minutes of practice at home. However, participants' reported practice ranged from 60 minutes to 386 minutes, averaging 186.29 minutes (*SD* = 69.73). Participants in the MM group practiced statistically significantly more minutes (*M* = 151.72, *SD* = 50.07) than participants in the poetry analysis group (*M* = 108.63, *SD* = 73.57), $t(103) = -3.55$, $p < .001$, Cohen's $d = .68$.

Reaction time data. A total of 16 different conditions were calculated using the attention data (session [2] x target congruency [2] x cue type [4]). Exclusion criteria for reaction time trials was determined *a priori*. See Figure 4 for a visualization of the exclusion criteria and number of trials removed from analysis. Only correct responses were used in data analysis. Across all trials both sessions, participants failed to respond to 2.8% of targets presented, and incorrectly responded to 4.8% of targets presented. The correct reaction time data contained high variability and non-normal distributions. Distributions tended to be positively skewed. Scores below 200ms or above 1200ms were also removed (1.7% of all trials), as reported in other studies (Ishigami & Klein, 2011; Tortella-Feliu et al., 2014). Remaining outliers were then identified on a participant-level basis. Research describing techniques used for identifying outliers in the ANT is limited. Therefore, I used person-level means so that all reaction times were compared to responses that were typical for that

participant. Using each participant's mean reaction time for each condition (congruency x cue), reaction times for each trial were converted into person-level *z*-scores. Using this technique, I removed trials that were atypical for that particular participant. Any *z*-scores above 3.3 were removed (1.2% of all trials). Additionally, because it was important to get an accurate mean attention score for each participant, participants should have at least five trials per condition. Therefore, participants with fewer than five correct responses in a given condition were not included in the analysis for that condition (0.1% of all trials). All of these approaches resulted in a total of 10.6% of trials being removed from all further analyses. Only three participants were missing both orienting and executive attention scores at pretest as a result of these exclusions, but no participants were missing scores for both types of attention at posttest.

Multivariate outliers. To examine any multivariate outliers, Mahalanobis distance was calculated prior to any hypothesis testing. I tested all pretest scores together using pretest scores of mindfulness (FFMQ composite score and MAAS composite score), all three attention subtypes, rumination (composite score and brooding subscore), and mind wandering (composite scores for Mind Wandering Scale and Mind Wandering Questionnaire). The analysis revealed two multivariate outliers, one from the MM group and one from the control group. Although there was nothing to distinguish these participants from other participants, their data were excluded from analysis because their responses had undue influence on data analysis.

Attrition. Four participants dropped from the study, all between pre-training and the class night. To assess whether attrition was different between groups (mindfulness vs. control), I performed a chi-square test examining drops (coded 0 = present for pre-training,

class night, and post-training, 1 = dropped from the study between pre-training and class night). The results were not statistically significant (1, N =115) = 1.23, p = .268, indicating that attrition was similar for both groups. Additionally, independent samples t-tests indicates there were no pretest differences between individuals who completed the study and individuals who dropped from the study on measures of mindfulness, rumination, attention, and rumination (all p's > 0.5). See Table 2 for t-statistics. Therefore, our results indicate that study attrition was random.

Group pretest differences. Pretest differences between those randomly assigned to the MM group and the control group were examined using measures of mindfulness (FFMQ), rumination, executive attention, alerting attention, orienting attention, and mind wandering. Independent samples t-tests revealed that there were no statistically significant differences between the mindfulness condition and the control condition (all p's > .05). See Table 3 for statistics by group. Additionally, because data collection occurred across four waves of participants, pretest differences were also examined between waves. A one-way ANOVA revealed that there were also no statistically significant differences between the four waves on the pretest scores for the variables of interest (all p's > .05). See Table 4 for statistics by wave.

Attention and mind wandering. Additionally, I used multilevel modeling to look at the state mind wandering question and post-training ANT, to determine if state mind wandering accurately assesses attention in the moment as intended. If mind wandering does assess attention, individuals who score lower on the ANT would be expected to report higher state mind wandering. Our results revealed that executive attention was not statistically significantly related to state mind wandering, and orienting attention was not

statistically significantly related to mind wandering. See Table 5 for coefficients, standard errors, and *p* values. Therefore, our results suggest that state mind wandering is not an adequate substitute for momentary attention.

Data Preparation

Pre-training and post-training data. Prior to running analyses, data were checked to ensure they met all assumptions for Analysis of Variance (ANOVA) and regression. All data from variables of interest were approximately normally distributed, at pre-training and at post-training. Additionally, minutes meditated (MM group) was approximately normally distributed, however minutes analyzed (control group) was somewhat bimodal. However, the distribution for minutes analyzed was not transformed, to allow for ease of interpretation. Data were analyzed using a 2 x 2 mixed ANOVA for comparisons between conditions over time, while regression was used for comparison between conditions using minutes practiced to examine the effects of both condition and minutes practiced on outcome variables. Minutes meditated was centered and used to create an interaction term with condition. Specifically, both the mean effect of minutes meditating and main effect of condition were entered into the equation together with the interaction. Hierarchical regression was used, with pretest score entered at step one, and condition, minutes practiced (centered), and the minutes practiced (centered) x condition term were entered in the second step.

Experience Sampling Data. Participants averaged 17.15 reports over the course of seven days (*SD* = 5.32, range 0-25). Participants who completed fewer than seven reports (9.7% of all participants) were removed from analysis (as recommended by T. Conner, personal communication, December 7, 2015). Aside from the slight negative skew in the

state mindfulness reports, mentioned above, state rumination and state mind wandering both had approximately normal distributions, and there were no concerns about outliers in any of the scales.

Changes from Pre-training to Post-training

I used SPSS 23.00 to analyze all data. See Table 6 for means and standard deviations of all variables, by time and condition.

By condition. I expected a statistically significant interaction between training condition (MM training vs. control) and assessment time (pre-training vs. post-training) for mindfulness, attention, and rumination. I predicted that MM participants would show statistically significantly more post-training trait mindfulness than the control participants at post-training. Additionally, I expected statistically significantly greater orienting and executive efficiency, and less rumination in MM participants compared to control participants. See Table 7 for *F* values, degrees of freedom, and *p* values.

Results of a 2 x 2 mixed factorial ANOVA indicated that there was a significant effect of time on overall FFMQ, $F(1,107) = 18.37$, $MSE = 0.07$, $p < .001$, with participants across both groups increasing in mindfulness from pre-training to post-training. However, there was no difference between the two groups in the amount change in mindfulness over time, $F(1,107) = 0.29$, $MSE = 0.07$, $p = .634$. Further analysis was completed using the subscales of FFMQ to determine if changes in overall FFMQ were being driven by any particular subscale(s). Results revealed that increase over time in the FFMQ scores across all participants was driven by the nonjudge scale, $F(1,109) = 70.55$, $MSE = 0.30$, $p < .001$. There was no difference between pre-training and post-training on the observe subscale, $F(1,109) = 0.09$, $ME = 0.13$, $p = .765$, describe subscale, $F(1,109) = 0.68$, $MSE = 0.15$, $p =$

.412, acting with awareness subscale, $F(1,109) = 2.32$, $MSE = 0.20$, $MSE = .16$, $p = .131$, or the nonreact subscale, $F(1,109) = 1.40$, $MSE = 0.16$, $p = .240$. These results indicate that participation in both mindfulness meditation and poetry analysis predicted improved ability to resist evaluating and criticizing internal thoughts and feelings.

In terms of rumination, results revealed there was there was no change in overall rumination between pre-training and post-training for all participants, $F(1,107) = 2.51$, $MSE = 0.15$, $p = .116$, and there was no interaction between time and condition, $F(1,107) = .27$, $MSE = 0.15$, $p = .607$. Because I was interested specifically in the way brooding is affected by mindfulness meditation, the ANOVA was repeated with brooding as the dependent variable. Results indicated there was a decrease in brooding from pre-training to post-training, $F(1,107) = 6.60$, $MSE = 0.19$, $p = .012$, but that this change did not differ between the two groups, $F(1,107) = 0.86$, $MSE = 0.19$, $p = .356$. Therefore, although there was not a change in overall rumination, participants in both groups reduced the degree to which they were negative and self-critical during rumination.

Separate tests of attention were calculated each subscale. There was a decrease in executive attention (indicating improvement in executive attention ability) between pre-training and post-training, $F(1,96) = 62.83$, $MSE = 497.88$, $p < .001$, however this change did not differ between the two conditions, $F(1,96) = 0.02$, $MSE = 497.88$, $p = .882$. Because lower scores in executive attention indicate better ability to disengage, these results indicate that participants improved their executive attention from pre-training to post-training. There was also a decrease in orienting attention from pre-training to post-training, $F(1,103) = 5.19$, $MSE = 665.13$, $p = .025$, but this change did not differ between the two conditions, $F(1,103)$

= 0.07, *MSE* = 665.13, p = .798. A decrease in scores over time indicates that participants' ability to shift their attention declined between pre-training and post-training.

By dosage. Additionally, regression analyses were conducted using minutes practiced as a predictor variable. Pretest scores were entered as covariates. I expected a statistically significant interaction between minutes practiced (centered) and pre-training score for post-training trait mindfulness, post-training attention (orienting and executive), and post-training rumination. Condition was also included in regression analyses. See Table 8 for all intercepts and slopes.

Results indicated there was a main effect of minutes practiced on overall FFMQ (β = .23, p = .001), with participants who practiced more reporting higher levels of post-training mindfulness. There was no main effect of condition (β = -.04, p = .595) or interaction between minutes practiced and condition (β = .05, p = .397). Each subscale of FFMQ was also examined to determine what subscales may be driving the overall effect of mindfulness. There was a main effect of minutes practiced for the acting with awareness scale (β = .22, p = .003) and the nonjudge scale (β = .19, p = .019), with participants who practiced more indicating higher levels of both. There were no main effects of condition or interactions between minutes practiced and condition for either scale. There was a main effect of minutes practiced for the nonreact scale (β = .17, p = .041), indicating that participants who practiced more reported higher levels of nonreactivity. Additionally, there was an interaction between minutes practiced and condition (β = .17, p =.025), with participants in the MM condition increasing nonreactivity more per minute meditated than participants in the control condition. There was no main effect of condition on nonreactivity. See Figure 5 for a graph of the interaction. In terms of the observe and describe subscales, there were no main effects

of minutes practiced or condition, and no interactions between minutes practiced and condition (*p*'s > .05).

There were no main effects of minutes practiced (β = -.08, *p* = .298) or condition (β < .01, *p* = .971) on overall rumination, and no interaction between minutes practiced and condition (β = -.04, *p* = .610). The same results were found for the brooding subscale, with no main effect of minutes practiced (β = -.13, *p* = .101) or condition (β = -.06, *p* = .436), and no interaction (β = -.01, *p* = .851). These results indicate that amount of practice and condition did not affect post-training rumination.

In terms of executive attention, there were no main effects of minutes practiced (β = .16, *p* = .056) or condition (β = -.06, *p* = .436) on executive attention, and no interaction between minutes practiced and condition (β = -.01, *p* =.851). Identical results were found for orienting attention, with no main effects of minutes practiced (β = .17, *p* = .076) or condition (β = -.13, *p* = .163) on orienting attention, and no interaction between minutes practiced and condition (β =.12, *p* = .195).

Post-training correlations. I expected a statistically significant positive relation between post-training mindfulness and post-training attention (orienting and executive), a statistically significant negative relation between post-training attention and post-training rumination, and a statistically significant negative relation between post-training mindfulness and post-training rumination. If the correlational results are not all statistically significant, the hypothesized mediation model cannot be tested. See Table 9 for all correlations.

Participants who reported higher levels of post-training mindfulness as measured by the FFMQ reported statistically significantly lower levels of post-training rumination (*r* = -

.45, $p < .001$). There was no statistically significant relationship between post-training mindfulness and post-training attention (executive, $r = -.16$, or orienting, $r = .08$; ps $> .05$). Participants who reported less post-training rumination scored statistically significantly higher on post-training executive attention ($r = .19$, $p = .046$), indicating poorer ability to disengage attention from distracting information. There was no statistically significant relationship between post-training rumination and post-training orienting attention ($r = -.01$, $p = .953$).

Mediation model. The proposed mediation model required all variables to be correlated. See Figure 1 for the proposed mediated relationship. I predicted that individuals with greater post-training mindfulness would show better post-training attention (path "a"), and that individuals with greater levels of post-training attention would tend to have less post-training rumination (path "b"). Furthermore, I expected that the individuals with greater post-training mindfulness would tend to report decreased levels of rumination (path "c"). However, I predicted that when orienting and executive efficiency were considered as mediator variables, the strength in path c would be lessened, thereby suggesting that the decrease in rumination could be partially explained by an increase in attention (path "c'").

Post-training mindfulness was not statistically significantly correlated with post-training executive attention, and post-training orienting attention was not statistically significantly correlated with post-training attention or post-training rumination. Therefore, I did not test the hypothesized mediation model. However, I used regression to test the separate relationships between the variables.

I examined the interactions between post-training variables using meditation experience (condition and minutes practiced) as a moderator. I hypothesized that individuals

who receive MM training would have stronger relationships between post-training mindfulness and post-training attention, post-training attention and post-training rumination, and post-training mindfulness and post-training rumination. In terms of dosage, I hypothesized that individuals who meditated more would show stronger relationships between post-training mindfulness and post-training attention, post-training attention and post-training rumination, and post-training mindfulness and post-training rumination. I expected path c' to be larger for individuals who received MM training, compared to individuals who did not receive MM training.

Although they are not presented here in detail, there were no statistically significant moderated relationships between mindfulness and orienting attention, mindfulness and executive attention, mindfulness and rumination, executive attention and rumination, or orienting attention and rumination (*p*'s > .05)

Experience sampling analysis

Experience sampling data were used to evaluate mind wandering as the mediator of the relationship between state mindfulness and state rumination. Multilevel modeling was used to analyze experience sampling data, with reports of state mindfulness, mind wandering, and rumination comprising level one state predictors, and condition and minutes meditated analyzed separately as level two predictors (i.e., characteristics of the individual participants). State mindfulness was analyzed using the FFMQ two subscales (nonjudging and acting with awareness), to determine if they had differential effects. As described above, due to poor reliability in the state rumination measure, the two questions (problem-focused and feeling-focused) were analyzed separately. I first tested whether MM practice (both condition and dosage) predicted state mindfulness, mind wandering, and rumination. In

these analyses, I used robust standard errors. See Table 10 for means and standard deviations of all state variables.

There was no effect of condition on state nonjudging (p = .264), but there was an effect of minutes practiced on nonjudging, such that participants who reported practicing more (regardless of type of practice) tended to report greater state nonjudging (p = .004). There was no interaction between condition and minutes practiced (p = 271). Similar patterns were observed for state awareness, such that there was no effect of condition on state awareness (p = .377), but there was an effect of minutes practiced on awareness, such that participants who reported practicing more tended to report greater state awareness (p = .001). There was no interaction between condition and minutes practiced (p = .316). See Table 11 for coefficients, standard errors, and p values of all dependent variables.

In terms of mind wandering, there was a statistically significant effect of condition on mind wandering (p < .001), such that participants in the MM group reported more state mind wandering than control participants. There was also a statistically significant effect of minutes practiced on mind wandering, where participants who reported more practice reported less state mind wandering (p = .006). However, there was no interaction between condition and practice (p = .639), indicating no differential effects of practice between the two groups.

In regard to rumination, there was no effect of condition on state problem-focused rumination (p = .074), but there was an effect of minutes practiced on state problem-focused rumination, such that participants who reported practicing more tended to report less problem-focused rumination (p = .008). There was no interaction between condition and minutes practiced (p = .681). In terms of feelings-focused rumination, there was no effect of

condition (p = .178), minutes practiced (p =.522), and no interaction between condition and practice (p = .990).

The proposed mediation model (see Figure 1) was tested using experience sampling data, with mind wandering as the mediator. Bivariate relationships among all three variables (state mindfulness, mind wandering, and rumination) were first evaluated, separating state mindfulness into nonjudging and awareness, and rumination into feelings-focused and problems-focused. Relationships were tested with one variable as a Level 1 predictor (group mean-centered) and the other variable as an outcome. Random components were first used in analyses to account for between-person variability in the relationships. However, if random components did not predict variability $p < .10$, then fixed effects were used (Lehman & Conley, 2010). All relationships between mindfulness variables, mind wandering, and rumination variables were statistically significant. Individuals who reported greater state FFMQ nonjudging tended to report less mind wandering and less problem-focused feelings-focused rumination (all ps < .001). Individuals who reported greater state FFMQ awareness tended to report less mind wandering and less problem-focused and feelings-focused rumination (all ps < .001). Individuals who reported greater mind wandering tended to report less rumination ($p < .001$). See Table 12 for all coefficients, standard errors, and p values between the different variables.

Tests of moderated mediation were then conducted, with state mind wandering as a mediator, and meditation experience (practice and condition) as a moderator. I predicted that those in the MM condition would show statistically significantly larger relationships between state mindfulness and mind wandering, mind wandering and state rumination, and state mindfulness and state rumination, compared to those in the control condition. I also

expected that the c' path (linking mindfulness and rumination after mind wandering was statistically considered) would be statistically significantly smaller for the MM participants than for the control participants, indicating that mind wandering explained more of the relationship between state mindfulness and state rumination for the MM participants compared to the controls.

Mediation analyses revealed that mind wandering statistically significantly mediated the relationship between mindfulness (nonjudging and awareness) and rumination (feelings-focused and problem-focused; all *p*s < .001). However, neither condition nor practice moderated any relationships in the mediation model (all *p*'s > .05). See Table 13 for all coefficients and standard errors for the mediation models.

Discussion

The goal of the present study was to examine the effects of a weeklong MM intervention on mindfulness, rumination, and attention between two different groups of participants, one that completed MM and another cognitively active control group that completed poetry analysis. To my knowledge, this is the first study to utilize an active cognitive control group in short-term MM research. I predicted that participants who completed one week of MM would show more beneficial effects (in both state and trait measures) than poetry analysis participants. Specifically, I hypothesized that greater reported levels of mindfulness would predict greater attention and less rumination, and that this effect would be stronger for MM participants than poetry analysis participants. Similarly, I predicted that practice would strengthen the relationships between mindfulness, attention, and rumination, and that these relationships would be even stronger for MM participants relative to poetry analysis participants. Furthermore, I hypothesized that

changes in attention would mediate the relationship between mindfulness and rumination. Additionally, considering my theory that attention was related to mind wandering, I predicted that state mind wandering would mediate the relationship between state mindfulness and state rumination.

Results revealed that although there were changes in mindfulness, attention, and rumination after MM training—suggesting that benefits of MM can begin in as little as one week—these effects were not distinct to MM. Rather, both MM and control participants showed increases in mindfulness and attention, and decreases in brooding rumination, after one week of training. There were no overall differences between the two groups on measures of state mindfulness and state rumination. Additionally, my results suggest that state mind wandering does not accurately assess state attention. Although attention did not mediate the relationship between mindfulness and rumination on a trait level, state mind wandering did mediate the state mindfulness-state rumination. This finding indicates that participants who were more mindful in the minutes prior to the report were less likely to be engaged in mind wandering during that period of time, which may have then led to a decrease in ruminative thought patterns.

Differences Between Groups

Longitudinal results. Following the week of intervention, participants in both groups reported greater mindfulness and executive attention ability, less brooding, and a decline in orienting attention. The increase in mindfulness was specifically driven by the increase in the nonjudging component of mindfulness. These results indicate that one week of focused cognitive activity may be enough to see changes in mindfulness, rumination, and attention.

It is of most interest that the changes from pre-training and post-training did not appear to be different between the control group and the MM group. There were no overall effects of condition on post-training measures of mindfulness, rumination (including brooding), or attention. Notably, however, there was an effect of condition on the nonreactivity component of mindfulness, such that participants who practiced their respective technique more reported greater levels of nonreactivity when they were in the MM group as opposed to the control group. This result is discussed in greater detail below, however the lack of group differences on the other components of mindfulness indicates that reduced reactivity may be the first detectable effect of increased MM practice over time.

Although to my knowledge, no other research study has included an active cognitive control group as a comparison group as part of a very brief MM training program, these results are consistent with other research using longer MM training programs. MacCoon et al. (2012) compared an active control group to eight weeks of MBSR training. Control participants in MacCoon et al.'s study completed the Health Education Program, which paralleled an MBSR class in terms of structure. The Health Education Program incorporated in cognitive components such as learning about and discussing the food pyramid. Four weeks after the interventions ended, participants in both groups did not differ from one another on measures of distress, hostility, and anxiety. Although there were other, non-cognitive components of the Health Education Program that paralleled the MBSR class (e.g., education about walking, posture, and relaxation) and the variables of interest differed, MacCoon et al.'s results suggest that active control groups that incorporate in cognitive activities may not differ from MM training groups, at least after only eight weeks of training. Poetry analysis is similar to the Health Education Program in that both encourage

critical thinking, however poetry analysis also includes a connection to and awareness of internal states that may arise during analysis, and invites more abstract thought about topics such as love and self-growth. Therefore, it may be even less likely a difference between poetry analysis and MM is observed, especially after only one week of training.

Although one week of training may be too short to detect differences between non-MM cognitive interventions and MM interventions, differences may be detectable later in practice. According to Tang et al. (2015), MM practice can be divided into three stages: an early stage, in which the practitioner is engaged in effortful doing; an intermediate stage, in which effort is directed toward the reduction of mind wandering; and an advanced stage, in which the practitioner is effortlessly able be present in the moment. It may be the case that interventions that encourage focus and attention—such as poetry analysis, the Health Enhancement Program, and MM—may look similar to each other in early stages, when participants allocate substantial cognitive resources to complete practice and training. However, in later stages, differences between the trainings could become more observable and measurable. With more practice, individuals may begin to master more training-specific goals (e.g., picking up on subtle tones in poems, improving health by applying nutrition knowledge, or acceptance of emotions). Additionally, it may be the case that poetry analysis distracts participants from their problems in early stages of training, resulting in a decrease in rumination from pre-training to post-training that resembles the reduction in rumination observed after MM training. In such a case, over time the two groups would diverge, as MM remained effective at reducing rumination, and the reduction in rumination resulting from poetry analysis begins to wane. Therefore, I would expect that with increased practice, MM

participants would engage in less mind wandering, and therefore less rumination, relative to poetry analysis participants.

A second explanation for the lack of differences between the two conditions in terms of rumination may relate to the way rumination is measured. Effects of MM on rumination may differ depending on whether the focus of research is on frequency of rumination or length of ruminative cycles. The current study measured rumination in terms of length (i.e., how much time was spent ruminating), rather than frequency (i.e., how many times did rumination occur). Initially, an individual who is learning MM may report the same number of ruminative episodes as prior to MM training, but the extent to which the episodes are disruptive as well as the length of the episodes may decrease following training. Such findings would indicate that as individuals learn MM, they learn how to be more mindful and break the cycle of rumination in the moment, even if their level of day-to-day mindfulness has not changed. As dispositional mindfulness increases (i.e., mindfulness becomes more relatively consistent over time), the frequency of ruminative episodes may decrease as a mindful state becomes more habitual. Prior research has not distinguished between frequency and length of rumination following MM training. However, the distinction is an important consideration for understanding the way MM affects rumination. The results of this study indicate that length of ruminative episodes decreases after both poetry analysis and MM training, however it is unclear if the frequency of episodes changed. I recommend future research examine both length and frequency of ruminative episodes. Additionally, administering a survey measuring the extent to which participants report rumination as being disruptive could provide different information on the way MM affects rumination, in such cases where frequency and length do not appear to change after training.

In addition to the consistent increase in well-being for both the MM group and the poetry analysis group, the pattern of results for attention also warrants consideration. In terms of executive and orienting attention, results were mixed. Participants—regardless of condition—demonstrated an increase in executive attention and a decrease in orienting attention. An increase in executive attention indicates an improved ability to disengage from distracting stimuli. This finding is consistent with other MM research demonstrating improved executive attention ability (Tang et al., 2007). Therefore, the evidence suggests that one week of focused cognitive activity may improve the ability to ignore distracting information and potentially improve concentration. It was, however, unexpected that after one week of active cognitive training, participants demonstrated a decline in orienting attention. A *decrease* in orienting attention indicates a decline in the ability to shift attention. This finding is surprising and does not appear to be consistent with other MM research (e.g., Jha et al., 2007; Tang et al., 2007). It should be noted, however, that there is scarce research examining effects of short-term MM on the different networks of attention. It is possible that this is a fatigue effect, suggesting that participants were less invested in using the cues the second time they took the test. Disputing this theory is the evidence that executive attention ability improved, which could indicate either that participants were still engaged in the task, or there was a practice effect of the test. A more plausible explanation for the decline in orienting attention ability is that participants were more consciously attempting to disengage their attention from distracting stimuli. Therefore, they used more attentional resources to accomplish that particular goal, at the cost of the ability to shift their attention and use the cues efficiently. This conclusion, however, warrants caution and further research.

Experience sampling results. The experience sampling results followed a relatively similar pattern to the longitudinal results in terms of differences between groups, but not in terms of effects of practice. There were no differences between the two groups on state mindfulness or state rumination. There was, however, a difference between the two groups with regard to state mind wandering. Specifically, participants in the MM group reported greater levels of momentary mind wandering compared to the poetry analysis group. These results are inconsistent with the theory that MM encourages mindfulness and therefore results in decreases in mind wandering. However, results from Tang et al. (2015) could help explain this phenomenon. Tang et al. suggest that MM practitioners must reach intermediate stages of MM training before they are able to effectively reduce mind wandering. However, the ability to understand what mind wandering is and to realize when one is engaging in mind wandering must come at earlier stages of MM training for it to be addressed in later stages. Poetry analysis training did not discourage mind wandering, nor teach participants about mind wandering, so an increase in mind wandering would not be expected in that group. When participants filled out reports and were asked about their thoughts and feelings in the 10 minutes prior to the report, MM participants may have been more aware of their previous mind wandering than poetry analysis participants. This increase in awareness would result in greater reports of mind wandering without indicating an actual difference in time spent mind wandering. Therefore, it may be in later stages of MM training that the emphasis on present moment awareness will actually reduce mind wandering. Future research would benefit from not only longer training periods, but also a control group that is educated about mind wandering, to determine if the increase in mind wandering reports is a result of knowledge or of MM practice.

Dosage

Longitudinal results. Considering that there was variability in the amount of time participants spent practicing their respective techniques, practice was also incorporated into analyses of post-training variables. Interestingly, there was no effect of minutes practiced on rumination or attention. Although much MM research does not consider variance in practice a variable of interest in analyses, these results conflict with a large body of research that supports the theory that MM training has beneficial effects on rumination (e.g., Eberth & Sedlmeier, 2012; Hoffman et al., 2010) and attention (e.g., Chiesa et al., 2011; Jha et al., 2007; Semple, 2010). Therefore, the lack of effect of MM on rumination and attention indicate that four hours of MM training may not be enough practice to see these effects. However, the format of MM training may also be influencing how early results of MM training are detectable. Tang et al. (2007) found that 100 minutes of Integrative Mind-Body Training (IBMT) improved executive attention, however each training session consisted of face-to-face training from a coach who provided participants immediate feedback about their practice. The consistent presence of a coach who provides face-to-face training may influence the success of training, and therefore future research should examine the way structure of a short-term MM training affects outcomes.

Although there was no effect of practice on attention and rumination, there was a positive relationship between practice and mindfulness. Interestingly, analyses suggested this finding was driven by the awareness, nonjudgment, and nonreactivity components of mindfulness. There were no differences between the two conditions on these components of mindfulness, except for nonreactivity. Specifically, the MM participants showed greater nonreactivity than the poetry analysis group when both groups practiced for the same

amount of time. The effect of condition on nonreactivity is consistent with the goals of MM, which include a decrease in reactivity to uncomfortable or negative thoughts and feelings (Bishop et al., 2004). The poetry analysis control intervention did not emphasize a lack of nonreactivity, and therefore can explain this differential effect. Additionally, although poetry analysis intervention did not explicitly encourage awareness in the same way MM did, it may have inadvertently encouraged present moment awareness as a result of its emphasis on concentration. This would explain why both groups increased in awareness with more practice. It is notable that there was no difference between the two groups on nonjudgment, despite the emphasis on nonjudgment in MM training but not in poetry analysis training. Therefore, this aspect of mindfulness in particular deserves further attention in research when comparing MM training to active cognitive control groups. Nevertheless, this finding supports the theory that with more MM experience, there may be a more detectable difference between an active cognitive control group and a MM group.

Experience sampling results. Unlike the longitudinal results, there were effects of practice on state levels of mindfulness, rumination, and mind wandering. Participants in both groups who practiced more over the week of training reported greater state mindfulness, and less state mind wandering. This result has implications for the above-mentioned finding that MM participants reported greater mind wandering overall, compared to poetry analysis participants. Rather than being an effect of practice (which would be a concern considering the MM participants practiced more than the poetry analysis participants), these results suggest that the greater state mind wandering reports resulted from learning about the construct of mind wandering, which occurred in MM training but not poetry analysis training. Therefore, though both groups reported greater state mindful awareness with

increased practice, the outcomes of that increase may differ by group. Poetry analysis participants were not taught about mind wandering, and therefore may have been less aware of their tendency to mind wander than were the MM participants. The MM participants, on the other hand, were encouraged to be more mindful and reduce their mind wandering, and therefore may have been more attuned to when their minds wandered. Further research should test this theory using different measures of awareness, as well as compare groups that are more similar in terms of practice amount.

In addition to practice effects on state mindfulness and state mind wandering, participants who practiced more reported less state problem-focused rumination. Interestingly, amount of practice did not affect state feelings-focused rumination. It is unclear why practice would be related to state problem-focused rumination, but not state feelings-focused rumination. Participants may have been less aware of state feelings-focused rumination relative to state problem-focused rumination. Future research using long-term poetry analysis practice and MM practice should track the change in state rumination more closely over the course of practice, focusing separately on problem-focused rumination and feelings-focused rumination.

Mediation Models

Mediation models were hypothesized for both longitudinal results and experience sampling results. I hypothesized that trait attention would mediate the relationship between trait mindfulness and trait rumination, whereas state mind wandering was hypothesized to be an accurate measure of state attention, and therefore mediate the relationship between state mindfulness and state rumination. Following training, trait attention did not mediate the relationship between trait mindfulness and trait rumination. Additionally, post-training

results suggested that trait mind wandering is not an accurate measure of trait attention, indicating that mind wandering and attention are not the same constructs. State mind wandering did, however, mediate the relationship between state mindfulness and state rumination.

This state mediation model suggests that the negative relationship between state mindfulness and state rumination is partially driven by less momentary mind wandering among those who are more mindful in a given moment. The lack of group differences between MM and poetry analysis participants in this mediation analysis indicates that activities requiring cognitive effort may increase attentional resource allocation in the moment, which decreases mind wandering and thereby decreases rumination that would normally result from mind wandering. Furthermore, this mediation model can also help to explain the greater state mind wandering reported by MM participants compared to poetry analysis participants. A phenomenon has been observed in MM research, in which MM participants sometimes report greater levels of rumination early in training (Davidson & Kaszniak, 2015). One theory to explain this phenomenon is that individuals in MM training are learning how to become more aware of their inner experience, and thereby become better able to identify when their minds wander. The result of this increased awareness may be an increase in self-reported mind wandering in MM participants. Considering greater momentary mind wandering is linked with greater momentary rumination (Killingsworth & Gilbert, 2010), it is plausible that higher reports of mind wandering may be linked with increased rumination. However, my results indicated that although the MM group reported higher levels of state mind wandering, they did not differ from controls on levels of state

rumination, contradicting the theorized relationship between rumination and mind wandering.

There are two potential explanations for this finding. The first explanation is the timing of the experience sampling reports. Participants had already completed one week of practice when the experience sampling reports started. Therefore, although the MM participants likely still required great effort to reduce mind wandering (Tang et al., 2015), they may have been better able to reduce the state rumination that resulted from greater state mind wandering. Further research examining these changes during training rather than after training could further explore this theory, using the timing of changes in state mind wandering and state rumination to delineate the progression of change during MM training.

The second explanation for the lack of higher reported state rumination in MM participants compared to control participants is that the MM participants were simply more aware of their wandering mind, rather than actually spending more time mind wandering. In such a case, although there are greater state mind wandering reports, mind wandering episodes are not greater in frequency or length, and therefore no change in state rumination would be expected. One challenge to this theory is that MM participants would be expected to also be more aware of their ruminative episodes, which could result in an increase in reports of state rumination as well. As stated above, future research should utilize a group that receives education about mind wandering to compare to MM training. Such a group would provide information about whether greater mind wandering reports is a result of knowledge or a result of MM training.

Limitations and Applications

Although there are a number of strengths in this study—such as experience sampling methodology, the use of an active cognitive control group, and the use of objective measures of attention—a number of limitations should be addressed in future research. The first limitation of the current study involved the use of the poetry analysis active control training. Participants who completed the poetry analysis training practiced significantly less than participants who completed the MM training. The first potential explanation for this difference in practice is that the poetry analysis instructor received less training than the MM instructor, which may have led to differences in participant expectations of future practice, or willingness to engage in practice. Another potential explanation for the practice differences may be the recordings provided; poetry analysis participants received the same number of recordings as MM participants, but the individual recordings were shorter than many of the MM recordings. However, in participant feedback forms, 12 poetry analysis participants indicated they would have preferred greater variety in the number and/or length of recordings, whereas 10 MM participants indicated the same. Six other MM participants responded that they did not like some aspect of the recording, such as the background noise or instructor voice. Therefore, although an increase in the variety of poems participants can choose from is recommended for future research utilizing poetry analysis as a comparison group, the feedback forms suggest that lack of poetry variety did not result in an overestimation of distinct MM effects. Nevertheless, it is important that the comparison training be as similar to the MM training in structure and practice as possible.

A second limitation of the current study was the use of the ANT as a measure of attention. Participants demonstrated effects of time in both groups, however it is unclear

whether this change was a result of training or a result of practice effects. Despite the use of a practice session prior to each testing session, a number of participants struggled with the task during the pre-training testing session, resulting in four participants who did not have enough correct trials for both attention network scores to be used in data analysis, and nine participants without either executive or orienting attention network scores. Therefore, future research might include a baseline testing session prior to the pre-training testing session, or require participants to get a certain number of practice responses correct before beginning the testing session.

Despite these limitations, this study has broad clinical implications. These findings are consistent with clinical research that suggests that MM is related to decreases in rumination and depression (e.g., Eberth & Sedlmeier, 2012; Hofmann et al., 2010; Jain et al., 2007). However, many individuals find that MM training is either not appropriate for them or is not available to them. These results indicate that in such cases, other cognitively active interventions such as poetry analysis may have similar effects. However, further research is needed to determine if this effect occurs with other cognitively demanding tasks and to examine these effects over a longer period of time. Additionally, considering the current sample is a non-clinical sample, it is unclear how these effects would extend to clinical populations.

Conclusions

The current study utilized a unique blend of longitudinal methodology and experience sampling methodology to examine the effects of a short-term MM training. The combination of pre-training and post-training measurement, as well as experience sampling techniques, allowed for a new examination of the way MM affects well-being and cognition

on both a trait and state level. Furthermore, the use of a randomly assigned, active cognitive control provided a unique comparison group for MM training. My results suggest that one week of MM training is enough time to see benefits of practice on mindfulness, attention, and rumination, but not enough time to see effects of MM that are distinct from other kinds of cognitive activities. Additionally, these results indicate that the mechanism by which MM reduces rumination is not via improvements in attention. Rather, my results suggest that MM-related reductions in mind wandering may actually lead to the reductions in rumination that have been previously observed with increasing mindfulness (e.g., Jain et al., 2007). Future studies should continue to investigate the effects of MM using active cognitive control groups, such as poetry analysis, over longer periods of time and with a stronger focus on mind wandering.

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Table 1

The Study Schedule for Each of Four Waves of Data Collected

	Day 1	**Day 2**		**Days 3-8**		**Days 8-14**	**Day 9**	**Day 15**
Condition	Pre-training testing	MM Class	Poetry Analysis Class	MM Practice and Reports	Poetry Practice and Reports	Experience Sampling	Post-training testing	Debrief
Experimental (MM)	X	X		X		X	X	X
Control	X		X		X	X	X	X

Table 2
Attrition by Pretest Measures of Mindfulness, Rumination, Attention, and Mind Wandering

	t	*df*	*p*
Mindfulness	-0.755	113	.452
Rumination	0.307	113	.760
Executive Attention	-0.151	108	.881
Orienting Attention	0.301	110	.764
Alerting Attention	0.695	110	.488
Mind Wandering	-0.264	113	.792

Table 3
Pretest Differences in Mindfulness, Rumination, Attention, and Mind Wandering Between Mindfulness Meditation and Poetry Analysis Control Conditions

	t	*df*	*p*
Mindfulness	-0.097	113	.923
Rumination	-0.925	113	.357
Executive Attention	0.306	102	.760
Orienting Attention	0.331	109	.741
Alerting Attention	-0.330	110	.742
Mind Wandering	-1.114	113	.268

Table 4
Pretest Differences in Mindfulness, Rumination, Attention, and Mind Wandering Between Waves

	df	*F*	*p*
Mindfulness	3, 111	0.40	.750
Rumination	3, 111	1.18	.322
Executive Attention	3, 100	0.76	.522
Orienting Attention	3, 107	1.00	.394
Alerting Attention	3, 108	0.11	.952
Mind Wandering	3, 111	1.29	.281

Table 5
The Relationship Between State Mind Wandering and Post-training Measures of Attention

	Coefficient	Standard Error	*p*
Intercept	40.73	3.49	< .001
Executive Attention	0.01	0.04	.806
	Coefficient	Standard Error	*p*
Intercept	43.16	2.31	< .001
Orienting Attention	-0.05	0.05	.341

Table 6
Means (Standard Deviations) for All Pre-Training and Post-Training Variables by Condition

	Mindfulness Meditation		Control	
	Pre-training	Post-training	Pre-training	Post-training
Mindfulness (FFMQ)				
Overall	3.18 (0.45)	3.34 (0.53)	3.14 (0.45)	3.27 (0.53)
Observe	3.42 (0.68)	3.46 (0.75)	3.41 (0.70)	3.34 (0.90)
Describe	3.28 (0.94)	3.25 (0.94)	3.29 (0.85)	3.22 (0.85)
Act with Awareness	3.08 (0.72)	3.24 (0.78)	3.10 (0.76)	3.12 (0.93)
Nonjudge	3.06 (0.82)	3.70 (0.82)	3.02 (0.95)	3.63 (1.08)
Nonreact	3.08 (0.62)	3.11 (0.68)	2.92 (0.62)	3.03 (0.68)
Rumination				
Overall	2.19 (0.65)	2.08 (0.75)	2.09 (0.70)	2.03 (0.73)
Brooding	2.36 (0.69)	2.16 (0.75)	2.27 (0.82)	2.16 (0.81)
Attention				
Executive	95.04 (41.20)	70.12 (37.00)	100.53 (40.23)	74.66 (36.52)
Orienting	38.39 (33.06)	29.33 (31.26)	44.11 (32.22)	36.89 (33.14)

Table 7
Longitudinal Differences by Condition (Poetry Analysis vs. Mindfulness Meditation) on Mindfulness, Rumination, and Attention

	Mindfulness			
	df	*F*	*MSE*	*p*
Overall	1,107		0.07	
Time		18.37		< .001
Condition		0.40		.528
Time x Condition		0.23		.634
Observe	1,109		0.13	
Time		0.09		.765
Condition		0.21		.651
Time x Condition		1.26		.265
Describe	1,109		0.15	
Time		0.68		.412
Condition		< .01		.951
Time x Condition		0.16		.690
Act with Awareness	1,109		0.20	
Time		2.32		.131
Condition		0.17		.681
Time x Condition		1.47		.229
Nonjudge	1,109		0.30	
Time		70.55		< .001
Condition		0.11		.740
Time x Condition		0.07		.795
Nonreact	1,109		0.16	
Time		1.40		.240
Condition		1.07		.304
Time x Condition		0.54		.464
	Rumination			
	df	*F*	*MSE*	*p*
Overall	1,107		0.15	
Time		2.51		.116
Condition		0.35		.556
Time x Condition		0.27		.607
Brooding	1,107			

(continued)

Table 7 (continued)

Time		6.60		.012
Condition		1.00		.757
Time x Condition		0.86		.356
		Attention		
	df	*F*	*MSE*	*p*
Executive Attention	1,96		497.88	
Time		62.83		< .001
Condition		0.49		.448
Time x Condition		11.12		.882
Orienting Attention	1,103		665.13	
Time		5.19		.025
Condition		1.60		.209
Time x Condition		0.07		.798

Table 8
Effects of Minutes Practiced and Condition on Mindfulness, Rumination, and Attention

Post-Training Overall Mindfulness				
	Intercept	*B (SE)*	*Beta*	*p*
Pre-Training Mindfulness	0.49	.892 (.07)	.76	< .001
Minutes Practiced		.002 (<.01)	.23	.001
Condition		-.019 (.04)	-.04	.595
Minutes Practiced x Condition		.001 (< .01)	.05	.397
Post-Training Observing Mindfulness				
	Intercept	*B (SE)*	*Beta*	*p*
Pre-Training Mindfulness	0.18	.941 (.07)	.78	< .001
Minutes Practiced		.001 (< .01)	.08	.251
Condition		.035 (.05)	.04	.500
Minutes Practiced x Condition		< .001 (< .01)	.02	.733
Post-Training Describe Mindfulness				
	Intercept	*B (SE)*	*Beta*	*p*
Pre-Training Mindfulness	0.55	.823 (.06)	.83	< .001
Minutes Practiced		.001 (< .01)	.09	.149
Condition		-.007 (.05)	-.01	.898
Minutes Practiced x Condition		-.001 (< .01)	-.04	.477
Post-Training Awareness Mindfulness				
	Intercept	*B (SE)*	*Beta*	*p*
Pre-Training Mindfulness	0.71	.798 (.08)	.69	< .001
Minutes Practiced		.003 (< .01)	.22	.003
Condition		.011 (.06)	.01	.857
Minutes Practiced x Condition		< .001 (< .01)	.02	.793
Post-Training Nonjudging Mindfulness				
	Intercept	*B (SE)*	*Beta*	*p*
Pre-Training Mindfulness	1.51	.707 (.08)	.66	< .001
Minutes Practiced		.003 (< .01)	.19	.019
Condition		-.033 (.07)	-.04	.647
Minutes Practiced x Condition		< .001 (< .01)	.02	.755

(continued)

Table 8 (continued)

Post-Training Nonreactivity Mindfulness				
	Intercept	*B (SE)*	*Beta*	*p*
Pre-Training Mindfulness	0.94	.695 (.08)	.64	< .001
Minutes Practiced		.002 (< .01)	.17	.041
Condition		-.050 (.05)	-.07	.348
Minutes Practiced x Condition		.002 (< .01)	.17	.025
Post-Training Rumination				
	Intercept	*B (SE)*	*Beta*	*p*
Pre-Training Rumination	0.42	.768 (.08)	.70	< .001
Minutes Practiced		-.001 (<.01)	-.08	.298
Condition		.002 (.054)	<.01	.971
Minutes Practiced x Condition		<.001 (<.01)	-.04	.610
Post-Training Brooding Rumination				
	Intercept	*B (SE)*	*Beta*	*p*
Pre-Training Brooding	0.55	.699 (.08)	.68	< .001
Minutes Practiced		-.001 (<.01)	-.13	.101
Condition		-.010 (.06)	-.01	.866
Minutes Practiced x Condition		<.001 (<.01)	-.03	.720
Posttest Executive Attention				
	Intercept	*B (SE)*	*Beta*	*p*
Pre-Training Executive Attention	11.83	.622 (.07)	.69	< .001
Minutes Practiced		.080 (.04)	.16	.056
Condition		-2.250 (2.88)	-.06	.436
Minutes Practiced x Condition		-.008 (.04)	-.01	.851
Post-Training Orienting Attention				
	Intercept	*B (SE)*	*Beta*	*p*
Pre-Training Orienting Attention	16.09	.384 (.09)	.39	< .001
Minutes Practiced		.079 (.04)	.17	.076
Condition		-4.318 (3.07)	-.13	.163
Minutes Practiced x Condition		.059 (.04)	.12	.195

Note. Conditions were coded as mindfulness meditation = 1 and poetry analysis control group = -1. Minutes practiced was a centered variable.

Table 9
Correlations Between Post-Training Mindfulness, Post-Training Rumination, and Post-Training Attention

	Mindfulness (FFMQ)	Rumination	Executive Attention	Orienting Attention
Mindfulness (FFMQ)	--			
Rumination	-.454**	--		
Executive Attention	-.164	.192*	--	
Orienting Attention	.081	-.006	.350**	--

Note. * $p < .05$, ** $p < .01$.

Table 10
Means (Standard Deviations) for All State Variables by Condition

	Mindfulness Meditation			Control		
	Mean (SD)	Min	Max	Mean (SD)	Min	Max
Mindfulness (FFMQ)						
Act with Awareness	4.15 (.79)	1	5	4.15 (.82)	1	5
Nonjudge	4.02 (.81)	1	5	4.05 (.86)	1.38	5
Rumination						
Problem-Focused	3.97 (3.01)	0	10	3.52 (3.10)	0	10
Feelings-Focused	4.60 (2.90)	0	10	4.17 (3.15)	0	10
Mind Wandering	4.58 (2.07)	0	10	3.59 (3.03)	0	10

Table 11
Effects of Condition (Poetry Analysis vs. Mindfulness Meditation) and Minutes Practiced on State Measures of Mindfulness, Rumination, and Mind Wandering

State Mindfulness – Nonjudging			
Predictor	*Intercept*	*Coefficient (SE)*	*p*
	4.033		
Condition		-.066 (.06)	.264
Minutes Practiced		.002 (< .01)	.004
Condition x Minutes Practiced		-.001 (< .01)	.271
State Mindfulness – Awareness			
Predictor	*Intercept*	*Coefficient (SE)*	*p*
	4.140		
Condition		-.051 (.06)	.377
Minutes Practiced		.003 (< .01)	.001
Condition x Minutes Practiced		-.001 (< .01)	.316
State Rumination – Problems-Focused			
Predictor	*Intercept*	*Coefficient (SE)*	*p*
	3.810		
Condition		.305 (.17)	.074
Minutes Practiced		-.006 (< .01)	.008
Condition x Minutes Practiced		.001 (< .01)	.681
State Rumination – Feelings-Focused			
Predictor	*Intercept*	*Coefficient (SE)*	*p*
	4.451		
Condition		.270 (.20)	.178
Minutes Practiced		-.001 (< .01)	.522
Condition x Minutes Practiced		< .001 (< .01)	.990
State Mind Wandering			
Predictor	*Intercept*	*Coefficient (SE)*	*p*
	4.163		
Condition		.543 (.14)	< .001
Minutes Practiced		-.005 (< .01)	.006
Condition x Minutes Practiced		-.001 (< .01)	.639

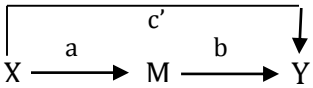
Note. Hierarchical Linear Modeling was used to test all relationships. Standard errors reflect robust standard errors. Conditions were dichotomized, such that poetry analysis was -1 and mindfulness meditation was 1. Minutes practiced reflects amount of time practiced regardless of condition.

Table 12
Bivariate Relationships Between State Measures of Mindfulness, Mind Wandering, and Rumination

State Problem-Focused Rumination			
Predictor	*Intercept*	*Coefficient (SE)*	*p*
Mind Wandering	3.84	0.31 (.03)	< .001
Nonjudging Mindfulness	3.84	-1.42 (.13)	< .001
Awareness Mindfulness	3.84	-1.38 (.15)	< .001
State Feelings-Focused Rumination			
Predictor	*Intercept*	*Coefficient (SE)*	*p*
Mind Wandering	4.50	0.26 (.03)	< .001
Nonjudging Mindfulness	4.48	-0.98 (.13)	< .001
Awareness Mindfulness	4.49	-1.06 (.13)	< .001
State Mind Wandering			
Predictor	*Intercept*	*Coefficient (SE)*	*p*
Nonjudging Mindfulness	4.18	-1.59 (.11)	< .001
Awareness Mindfulness	4.18	-2.00 (.11)	< .001

Note. The variable listed as the header was entered as the outcome variable in Hierarchical Linear Modeling.

Table 13
Tests of Multilevel Mediation for State Measures of Mindfulness, Mind Wandering, and Rumination

Mediation Models	Coefficient Pathways		
	a coefficient (SE)	b coefficient (SE)	c' coefficient (SE)
1.Nonjudging → MW → FF Rum	-2.04 (.11)**	0.20 (.03)**	-0.60 (.13)**
2.Nonjudging → MW → PF Rum	-2.03 (.11)**	0.23 (.03)**	-0.94 (.13)**
3. Awareness → MW → FF Rum	-1.63 (.12)**	0.22 (.03)**	-0.69 (.12)**
4. Awareness → MW → PF Rum	-1.60 (.12)**	0.27 (.03)**	-0.88 (.13)**

Notes: MW = Mind Wandering, FF Rum = Feelings-Focused Rumination, PF = Problem-Focused Rumination. The mediation models are shown with the independent variable (X) left, the mediator variable (M) in the middle, and the outcome variable (Y) on the right (Bauer, Preacher, & Gil, 2006). Coefficient a represents the relationship between X and M, b represents M and Y, and c' represents the relationship between X and Y after M is statistically considered. Robust standard errors were used. * $p < .05$, ** $p < .01$.

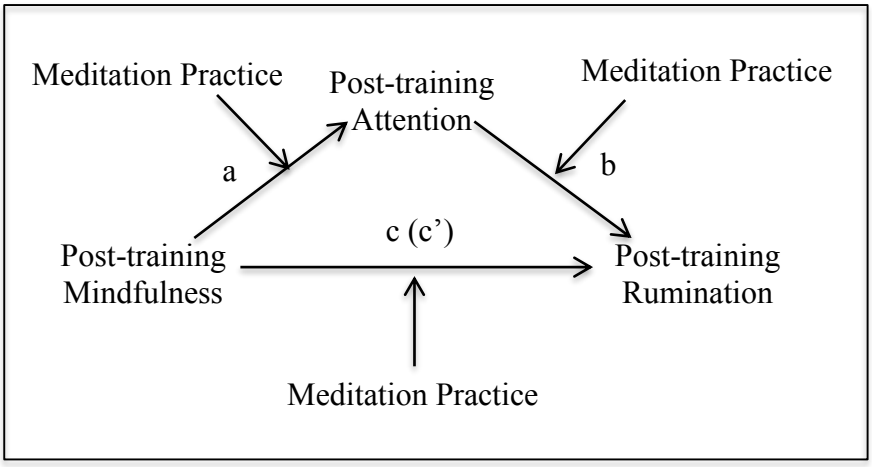


Figure 1. The hypothesized model of mechanism by which mindfulness meditation reduces rumination. The two types of attention of interest were executive attention and orienting attention.

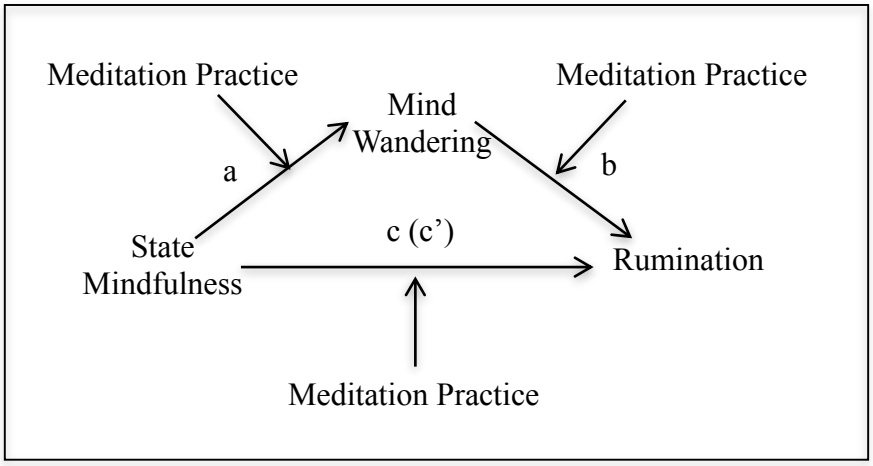


Figure 2. The hypothesized model of mechanism by which mindfulness meditation reduces rumination on a momentary level. The two types of attention of interest were executive attention and orienting attention.

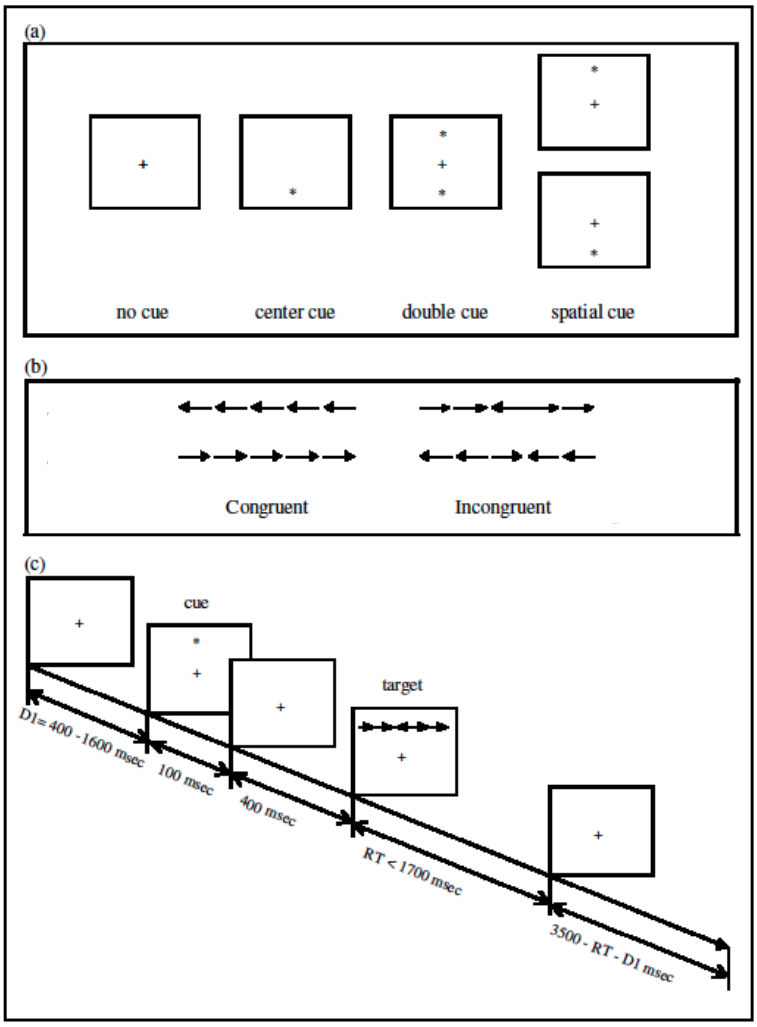


Figure 3. A diagram of the Attentional Network Task procedure. (a) The four cue conditions. (b) The two flanker conditions. (c) The time sequence of the task. (Taken from Fan et al., 2002.)

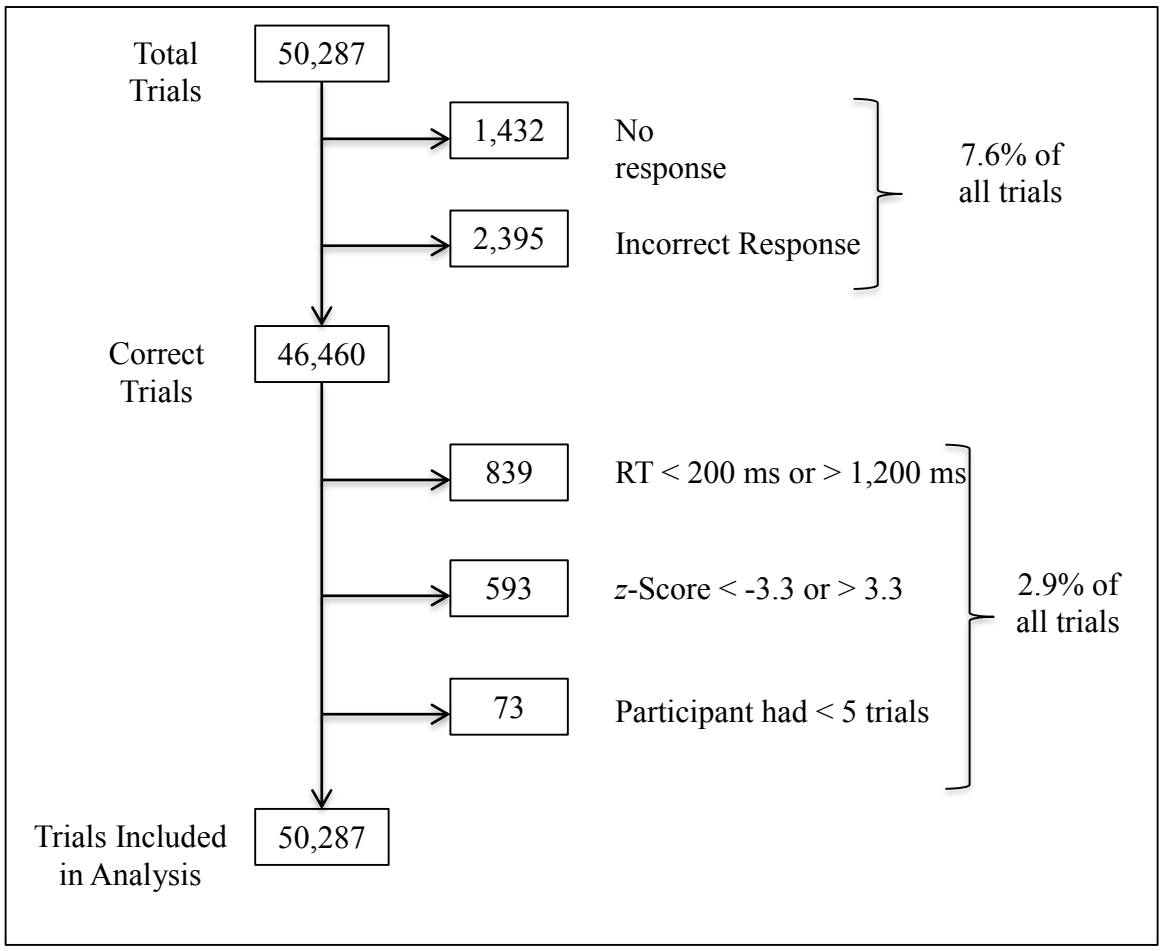


Figure 4. The process by which reaction time (RT) data from the Attention Network Test was cleaned.

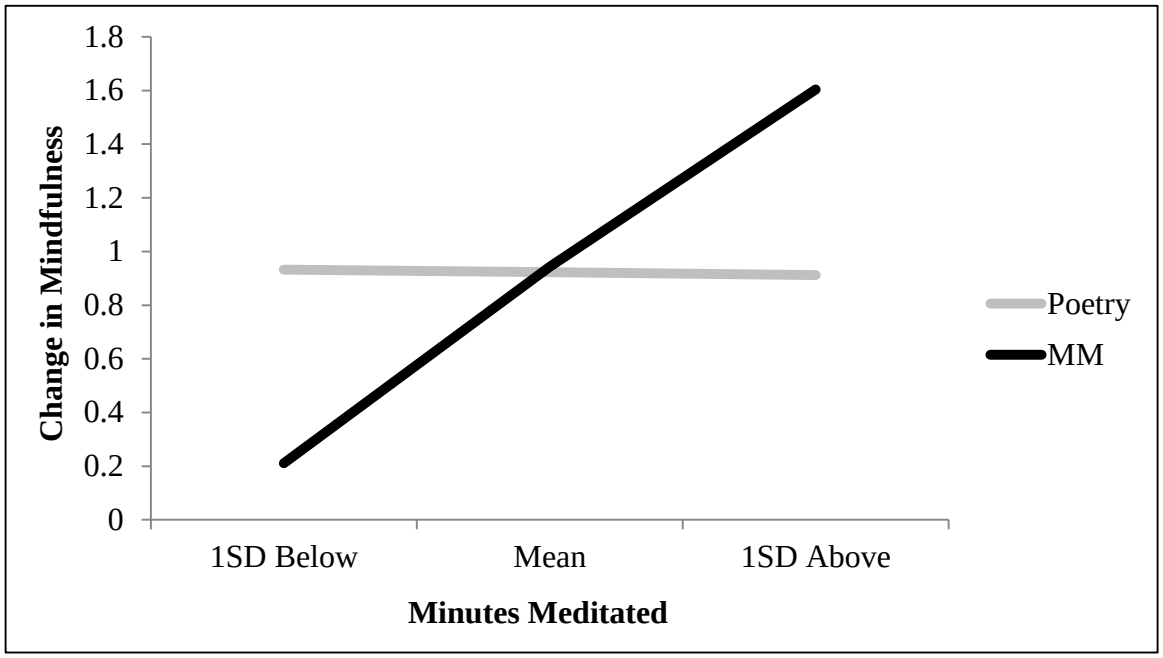


Figure 5. The predicted values of the interaction between minutes meditated and nonreactivity mindfulness between participants who completed a poetry analysis training and participants who completed mindfulness meditation (MM) over the course of one week.

Appendix A. Recruitment Questionnaire

Questionnaire

1. Age: _____

2. Have you previously engaged in meditative yoga practice? _____ Yes _____ No

    a. If "Yes", have you ever practiced regularly (e.g., 2 or more times a week)? _____Yes _____No

    b. If "Yes", how long has it been since you last did yoga? _____

3. Have you previously engaged in other meditative practice (e.g., mindfulness)? ____ Yes _____ No

    a. If "Yes", have you ever practiced regularly (e.g., 2 or more times a week)? _____Yes _____No

    b. If "Yes", how long has it been since you last meditated? _____

Appendix B. Consent Form

CONSENT TO PARTICIPATE IN RESEARCH

Stress Reduction Study

Purpose and Benefit:
Stress can cause a number of problems, both physical and mental. Studies have examined ways in which decreasing stress can improve physiological and emotional well-being, however specific techniques of stress reduction receive less attention than others. Understanding the best techniques to decrease stress can provide information for the development of stress reduction programs.

DESCRIPTION OF PARTICIPATION:

1. As a part of this study you will be asked to attend three separate sessions. The first session (Day 1) will last 40 minutes, the second session (Day 2) will last two hours. The third session (Day 9) will last 40 minutes, and the final session (Day 16) will last 20 minutes. In two of the sessions, you will complete computerized questionnaires that will ask you questions about a number of areas of your life, such as your health history, patterns of thoughts, and methods of coping with stress. You will also complete a computerized task that will ask you to respond to an item as quickly as possible. The second session will consist of a class designed to help reduce stress. In the final session, we will debrief you on the study. The total time commitment to this study is approximately seven hours.

2. All participants will have the opportunity to participate in a stress reduction technique. You will receive the equipment necessary to complete your specific technique. You will be asked to practice your technique at home for 30 minutes a day for 6 days. You will be instructed how to practice your stress reduction technique by the research staff. As participants will receive their training at different points during the quarter, it is important that you keep your own participation schedule confidential. Only you and the research staff should know your precise activities.

3. There are no anticipated risks with participation. However, you should be aware that participation in this study may lead you to think more closely about your everyday social and emotional experiences, as well as more generally about your social and emotional tendencies, previous life experiences, and future life experiences.

4. You will benefit from the study by receiving stress reduction information that may help you better cope with stress and to learn about the research process. Participants who participate in all sessions will be entered in a drawing to win one of six $25 cash prizes.

5. Your participation is voluntary, and you may choose not to answer certain questions, to withdraw from participation at any time, or to request that your data be erased and not used in the study. However, you must return all equipment that you may borrow. Please understand that the researcher will continue to contact you if you have not returned the equipment. Failure to return equipment will be considered theft.

6. All information gathered in this study is confidential. Identification numbers rather than names will be assigned to all completed forms. The materials linking identification numbers with names will be kept in a locked filing cabinet. Your name will not be associated with any of your responses at any time.

7. Your signature on this form does not waive your legal rights of protection.

8. You must be at least 18 years of age to participate in this study. By signing this form you are indicating that you are at least 18 years of age.

9. This experiment is being conducted by Diana David and Dr. Barbara Lehman. If you have any questions about this study, please contact them at (360)650-4356 (lab), (360)650-2212 (office), or email dailybp@gmail.com or davidd2@students.wwu.edu. If you have any questions about your participation or your rights as a research participant, contact Janai Symons, WWU Human Protections Administrator (HPA), at (360)650-3220. IF during or after participation in this study you suffer from any adverse effects as a result of participation, please notify the researcher directing the study or the WWU Human Protections Administrator.

SIGNATURE OF RESEARCH PARTICIPANT

I have read the above description and agree to participate in this study.

_____ _____

Participant's Signature Date

_____

Participant's PRINTED NAME

Appendix C. Mindfulness Instructions and Questionnaire

Mindfulness Instructions

You will use your smartphone or an iPod touch in order to practice mindfulness meditation. If you are using a loaned iPod touch, all of the programs you need will be on the main iPod screen.

Mindfulness Meditation Training. You will use SoundCloud to access your meditation practice. If you are using your own smartphone, you should receive an email from us tonight with four URLs that you will use to practice. If you are using a loaner iPod touch, you should open the Notes app, and the list of the four URLs will be there. Each URL is a different meditation, either 15 or 30 minutes long. You should listen to at least one 30-minute recording, or two 15-minute recordings each day. When you have a space of time (either 15 or30 minutes) to meditate, please do the following.

- You can set an alarm to alert you when you would like to meditate. Participants with the iPod touch loaners will use Mindjogger to set reminders to meditate (depending on what time of day you would prefer to meditate). Participants using their own smartphones can download the Mindjogger app and set alarms, or they can use their own smartphone alarms to remind them to meditate. You don't have to practice at the time an alarm goes off, but you should meditate for at least ½ hour per day.
- Find a place where you can be free from interruption and silence your phone. You will probably want to sit or lie down.
- Click on one of the links in the email/Notes app to access a meditation recording.
- Be sure to follow the meditation you've chosen until the second bell rings, indicating that the recording is over. Try your best to pay attention and stay awake.
- After you are done you may listen to another recording, or come back later in the day to complete more of them. Just keep track of which recordings you have chosen.
- As soon as you are done, open the last URL, which will take you to a report. Complete one form for each recording you listened to. Please answer all questions.

Poetry Analysis Instructions

You will use your smartphone or an iPod touch in order to practice analyzing poems. If you are using a loaned iPod touch, all of the programs you need will be on the main iPod screen.

Mindfulness Meditation Training. You will use SoundCloud to access your analysis practice. If you are using your own smartphone, you should receive an email from us tonight with four URLs that you will use to practice. If you are using a loaner iPod touch, you should open the Notes app, and the list of the four URLs will be there. Each URL is a poetry analysis, each 15 minutes long. You should listen to at least two 15-minute recordings each day. When you have a space of time (either 15 or30 minutes) to practice, please do the following.

- You can set an alarm to alert you when you would like to practice. Participants with the iPod touch loaners will use Mindjogger to set reminders to practice (depending

on what time of day you would prefer to practice). Participants using their own smartphones can download the Mindjogger app and set alarms, or they can use their own smartphone alarms to remind them to practice. You don't have to practice at the time an alarm goes off, but you should practice for at least ½ hour per day.

- Find a place where you can be free from interruption and silence your phone. You will probably want to sit or lie down.
- Click on one of the links in the email/Notes app to access an analysis recording.
- Be sure to follow the practice you've chosen until the second bell rings, indicating that the recording is over. Try your best to pay attention and stay awake.
- After you are done you may listen to another recording, or come back later in the day to complete more of them. Just keep track of which recordings you have chosen.
- As soon as you are done, open the last URL, which will take you to a report. Complete one form for each recording you listened to. Please answer all questions.

Appendix D. Research Equipment Use Agreement (for those that require equipment)

WESTERN
WASHINGTON UNIVERSITY
Dr. Barbara Lehman
Psychology Department
AIC 165 East
360-650-2212

Research Equipment Use Agreement

Research Equipment Description: **iPod touch in case**
iPod touch recharger (in plastic bag)

I have agreed to participate in a research project conducted by Dr. Barbara Lehman. As part of Dr. Lehman's project, I have been assigned the use of the research equipment described above. I am aware that the device I am using is a delicate piece of equipment and due to the high cost of replacement it is necessary to ensure that the monitor and its accessories are returned in proper working order. I will avoid getting either the iPod wet, and will keep the iPod touch in its case and with me at all times. I hereby agree to the following:

- To use and care for the equipment in a responsible manner and in accordance with instructions provided by Dr. Lehman and her research team.
- To protect the equipment from theft, loss, damage and deterioration.
- Not disassemble or make any alterations or modifications to the equipment.
- To keep the equipment in my custody and not to loan, or otherwise provide the equipment to any other person.
- Inform Dr. Lehman's team immediately of any problem, malfunction, loss, damage or theft of the equipment. To report problems, call 360-201-6251 or email Barbara.lehman@wwu.edu.

I agree to return the equipment in the same condition as originally delivered.
I have read and understand this Research Equipment Use Agreement.

_____ _____
Signature of Student Date

_____ _____
Name of Student (Please Print) W#

Appendix E. Post-Practice Reports – Mindfulness Meditation

ID number

Time/Date

What type of recording did you listen to?
Purchased Meditations

- ☐ Awareness of Breathing (16 min)
- ☐ Body Scan (28 min)
- ☐ Loving Kindness (15 min)
- ☐ Mindful Check-In (9 min)
- ☐ Mindfulness of Breathing (22 min)
- ☐ Self Compassion (18 min)
- ☐ Sitting Meditation (30 min)

Were you able to listen until the end of the recording (Yes/No)

Was your practice interrupted (Yes/No)

Did you fall asleep (Yes/No)

How much did you find that your mind wandered from your meditation practice? ("Not at all" --- "Most of the time" slider scale)

How much of the time did you focus on your problems? ("Not at all" --- "Most of the time" slider scale)

How much were you able to maintain your concentration on your meditation practice? ("Not at all" --- "Most of the time" slider scale)

How successful did you feel this practice was for you? (Not at all---Very Successful slider scale)

Appendix F. Poetry Analysis Instructions and Questionnaire

Poetry Analysis Instructions

You will use your smartphone or an iPod touch in order to practice analyzing poems. If you are using a loaned iPod touch, all of the programs you need will be on the main iPod screen.

Poetry Analysis Instructions You will use SoundCloud to access your analysis practice. If you are using your own smartphone, you should receive an email from us tonight with four URLs that you will use to practice. If you are using a loaner iPod touch, you should open the Notes app, and the list of the four URLs will be there. Each URL is a poetry analysis, each 15 minutes long. You should listen to at least two 15-minute recordings each day. When you have a space of time (either 15 or30 minutes) to practice, please do the following.

- You can set an alarm to alert you when you would like to practice. Participants with the iPod touch loaners will use Mindjogger to set reminders to practice (depending on what time of day you would prefer to practice). Participants using their own smartphones can download the Mindjogger app and set alarms, or they can use their own smartphone alarms to remind them to practice. You don't have to practice at the time an alarm goes off, but you should practice for at least ½ hour per day.
- Find a place where you can be free from interruption and silence your phone. You will probably want to sit or lie down.
- Click on one of the links in the email/Notes app to access an analysis recording.
- Be sure to follow the practice you've chosen until the second bell rings, indicating that the recording is over. Try your best to pay attention and stay awake.
- After you are done you may listen to another recording, or come back later in the day to complete more of them. Just keep track of which recordings you have chosen.
- As soon as you are done, open the last URL, which will take you to a report. Complete one form for each recording you listened to. Please answer all questions.

Appendix G. Post-Practice Reports – Poetry Analysis

ID number

Time/Date

What type of recording did you listen to?
Purchased Meditations

- ☐ Delay Full Analysis (10 min)
- ☐ Delay (6 min)
- ☐ From Blossoms (11 min)
- ☐ Love Poem (7 min)
- ☐ Night Journey (11 min)
- ☐ Sudden Journey Full Analysis (7 min)
- ☐ Sudden Journey (6 min)

Were you able to listen until the end of the recording (Yes/No)

Was your practice interrupted (Yes/No)

Did you fall asleep (Yes/No)

How much did you find that your mind wandered from your poem analysis practice? ("Not at all" --- "Most of the time" slider scale)

How much of the time did you focus on your problems? ("Not at all" --- "Most of the time" slider scale)

How much were you able to maintain your concentration on your poetry analysis practice? ("Not at all" --- "Most of the time" slider scale)

How successful did you feel this practice was for you? (Not at all---Very Successful slider scale)

Appendix H. Experience Sampling Reports

Experience Sampling Reports:

1. ID Number
2. Date/Time
3. Emotional Scale (1-100 slider scale)

    a. Happy
    b. Satisfied
    c. Relaxed
    d. Quiet
    e. Sleepy
    f. Ashamed
    g. Anxious
    h. Sad
    i. Aroused
    j. Angry
    k. Embarrassed
    l. Bored

    Reference:
    Feldman, L. (1995). Variations in the circumplex structure of mood. *Personality and Social Psychology Bulletin, 25*, 806-817. (I did not include all of them, and added others)

4. Stress:

    Questions about perceived stress. Questions 1-8 are not event-specific

    Please indicate which of the following have been true for you in the last 10 minutes.
    1. The situation was stressful.
    2. "Strongly disagree" to "strongly agree" (Slide bar)
    3. I could have done something else if I chose to.
       "Strongly disagree" to "strongly agree" (Slide bar)
    4. The outcome of what I was doing was important to me.
       "Strongly disagree" to "strongly agree" (Slide bar)
    5. I had control over the activity or outcome.
       "Strongly disagree" to "strongly agree" (Slide bar)
    6. I was worried about others' reactions to me.
       "Strongly disagree" to "strongly agree" (Slide bar)

5. State Rumination

Please indicate how true each statement has been for you in the past 10 minutes.

1. I was focused on my problems. (Slide bar)
2. I was focused on my feelings. (Slide bar)

6. State Mindfulness

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

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

_____ 1. I criticize myself for having irrational or inappropriate emotions.

_____ 2. When I do things, my mind wanders off and I'm easily distracted.

_____ 3. I don't pay attention to what I'm doing because I'm daydreaming, worrying, or
otherwise distracted.

_____ 4. I tell myself I shouldn't be feeling the way I'm feeling.

_____ 5. I am easily distracted.

_____ 6. I believe some of my thoughts are abnormal or bad and I shouldn't think that way.

_____ 7. I make judgments about whether my thoughts are good or bad.

_____ 8. I find it difficult to stay focused on what's happening in the present.

_____ 9. It seems I am "running on automatic" without much awareness of what I'm doing.

_____ 10. I tell myself that I shouldn't be thinking the way I'm thinking.

_____ 11. I rush through activities without being really attentive to them.

_____ 12. I think some of my emotions are bad or inappropriate and I shouldn't feel them.

_____ 13. I do jobs or tasks automatically without being aware of what I'm doing.

_____14. When I have distressing thoughts or images, I judge myself as good or bad, depending what the thought/image is about.

_____ 15. I find myself doing things without paying attention.

_____ 16. I disapprove of myself when I have irrational ideas.

Slider bar from "Almost Always" to "Almost Never"
In the last 10 minutes…

a. I found it difficult to stay focused on what's happening in the present.
b. I have rushed through activities without being really attentive to them.
c. I did jobs or tasks automatically, without being aware of what I was doing.
d. I found myself preoccupied with the future or the past.
e. I found myself doing things without paying attention.

7. Mind wandering
   Slider bar from "Almost Always" to "Almost Never"
   In the last 10 minutes…
   a. How much have you been thinking about something other than what you were currently doing?

8. This final question is to ensure no responses were made accidentally or incorrectly.
   Did you answer all the questions intentionally and accurately?
   Yes
   No

Appendix I. Debriefing Form

Stress Reduction Study
Debriefing Form

Although this study was advertised as a stress reduction study, the true purpose of this study was to investigate the influence of mindfulness meditation on attention and rumination. By advertising it as a stress reduction study, we can reduce any effects that can result from the expectations of participation in a mindfulness meditation study. This study is important because it helps to illuminate the extent to which mindfulness meditation can help improve mental health. Your participation may help us to understand if the mindfulness meditation training was effective at increasing attention and decreasing rumination.

In order for our study to accurately reflect the effects of mindfulness meditation on rumination, we needed to have some participants that completed both testing and mindfulness meditation training ("mindfulness" group), and some participants that completed the testing and poetry analysis training ("control" group). All participants were randomly assigned to a group. You were in the _____ group. Participants randomly assigned to the control group will have the opportunity to receive a CD version of mindfulness meditations that they can take home and use.

To keep our study as untainted as possible, it is important for you to keep the design of the study confidential. Please do not share details of your participation with others, as it may influence their results.

Some questions and tasks you completed during the study may have made you think about some sensitive topics or may have affected your mood. Throughout this study you have been focusing on your emotional states, as well as other emotions that may arise during mindfulness meditation. Because of this, all participants are receiving information about campus health and psychological services as well as some basic information on stress and coping.

If you have any questions about the study, please contact Diana David at davidd2@students.wwu.edu, or Dr. Barbara Lehman at barbara.lehman@wwu.edu.

Thank you for your participation!

Study Staff Signature _____ Date _____

Participant Signature _____ Date _____

Appendix J. Debriefing Evaluation Form

Stress Study
Participant Feedback Form

Thank you for your participation in this study. We would like to get some feedback from you on your experience during the study. This form is completely voluntary and any feedback you give will remain anonymous to the researchers.

Did you know our study was on mindfulness meditation, rather than stress reduction? If so, did you know whether you were in the experimental group or the control group?

What did you like about our study?

What did you not like about our study?

Did you like the variety that was provided to you in terms of the meditation practices/poetry analysis practices (dependent on which training you received)?

Any other feedback for us?