MINDFULNESS MEDITATION AND MIND WANDERING

BY

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# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>List of Tables</td>
<td>iv</td>
</tr>
<tr>
<td>List of Appendices</td>
<td>v</td>
</tr>
<tr>
<td>Acknowledgments</td>
<td>vii</td>
</tr>
<tr>
<td>Abstract</td>
<td>viii</td>
</tr>
<tr>
<td>Introduction</td>
<td>1</td>
</tr>
<tr>
<td>What is Attention and Mind Wandering?</td>
<td>1</td>
</tr>
<tr>
<td>Sustained Attention</td>
<td>2</td>
</tr>
<tr>
<td>Mind Wandering and Sustained Attention</td>
<td>3</td>
</tr>
<tr>
<td>Inhibition</td>
<td>6</td>
</tr>
<tr>
<td>Mind Wandering and Inhibition</td>
<td>6</td>
</tr>
<tr>
<td>Mindfulness Meditation</td>
<td>8</td>
</tr>
<tr>
<td>Mindfulness Meditation and Sustained Attention</td>
<td>10</td>
</tr>
<tr>
<td>Mindfulness Meditation and Inhibition</td>
<td>15</td>
</tr>
<tr>
<td>Current Study</td>
<td>21</td>
</tr>
<tr>
<td>Hypotheses</td>
<td>23</td>
</tr>
<tr>
<td>Method</td>
<td>27</td>
</tr>
<tr>
<td>Participants</td>
<td>27</td>
</tr>
<tr>
<td>Materials</td>
<td>27</td>
</tr>
<tr>
<td>Audio Recordings</td>
<td>27</td>
</tr>
<tr>
<td>Self-Report Measures</td>
<td>28</td>
</tr>
<tr>
<td>Attention Tasks</td>
<td>29</td>
</tr>
<tr>
<td>Page</td>
<td></td>
</tr>
<tr>
<td>------</td>
<td></td>
</tr>
<tr>
<td>References .......................................................................................................................... 61</td>
<td></td>
</tr>
<tr>
<td>Appendices .......................................................................................................................... 65</td>
<td></td>
</tr>
<tr>
<td>Curriculum Vitae .................................................................................................................. 72</td>
<td></td>
</tr>
</tbody>
</table>
### LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Demographic Information by Group</td>
</tr>
<tr>
<td>2</td>
<td>Mean (SE) Percentage Mind Wandering Frequency in the Number Go/No-Go Task</td>
</tr>
<tr>
<td>3</td>
<td>Median (SE) Reaction Times (msec) for the Four Trials Preceding Thought Probe Responses in the Number Go/No-Go Task</td>
</tr>
<tr>
<td>4</td>
<td>Mean (SE) Percentage Key Presses in Response to Non-Targets in the Number Go/No-Go Task</td>
</tr>
<tr>
<td>5</td>
<td>Mean (SE) Percentage Key Presses in Response to Targets in the Number Go/No-Go Task</td>
</tr>
<tr>
<td>6</td>
<td>Mean (SE) Percentage Mind Wandering Frequency in the Word Go/No-Go Task</td>
</tr>
<tr>
<td>7</td>
<td>Median (SE) Reaction Times for the Four Trials Preceding Thought Probe Responses in the Word Go/No-Go Task</td>
</tr>
<tr>
<td>8</td>
<td>Mean (SE) Percentage Key Presses in Response to Non-Targets in the Word Go/No-Go Task</td>
</tr>
<tr>
<td>9</td>
<td>Mean (SE) Percentage Key Presses in Response to Targets in the Word Go/No-Go Task</td>
</tr>
<tr>
<td>10</td>
<td>Mean (SE) Percentage Word-Stem Completion in the Word Retrieval Task</td>
</tr>
<tr>
<td>11</td>
<td>Mean (SD) Group Scores on PANAS Subscales</td>
</tr>
<tr>
<td>12</td>
<td>Number of Participants in each Group Responding Yes or No to Manipulation Checks</td>
</tr>
<tr>
<td>13</td>
<td>Mean (SE) Group Scores in Response to Manipulation Check Questions</td>
</tr>
</tbody>
</table>
# LIST OF APPENDICES

<table>
<thead>
<tr>
<th>Appendix</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>General Questionnaire</td>
<td>65</td>
</tr>
<tr>
<td>B</td>
<td>Positive Affect Negative Affect Schedule (PANAS)</td>
<td>66</td>
</tr>
<tr>
<td>C</td>
<td>Manipulation Checks</td>
<td>67</td>
</tr>
<tr>
<td>D</td>
<td>Thought Probe and Instructions Given to Participants</td>
<td>70</td>
</tr>
<tr>
<td>E</td>
<td>Completion Stems</td>
<td>71</td>
</tr>
</tbody>
</table>
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MINDFULNESS MEDITATION AND MIND WANDERING

Thesis under the direction of Janine M. Jennings, Ph.D., Associate Professor of Psychology, Wake Forest University.

Prior research has suggested that mind wandering is an automatic behavior that reduces both sustained attention and response inhibition. Mindfulness meditation has been shown to improve both attentional processes and reduce automatic behaviors, and thus this study was designed to determine the effects of short-term mindfulness meditation training on mind wandering, sustained attention, and response inhibition. Participants were administered two continuous performance tasks and a word retrieval task over the course of two days, and underwent two training sessions of meditation or focused listening, the latter of which served as a control. Both the Positive Affect Negative Affect Schedule (PANAS) and a series of questions assessing the meditation experience served as manipulation checks. Mind wandering frequency was determined through self-report in response to thought probes administered throughout each continuous performance task. Sustained attention and response inhibition were measured via omission and commission errors during the continuous performance tasks. Results indicated no significant group differences for mind wandering frequency, sustained attention, or response inhibition, although meditation was shown to enhance attentional processing of individual stimuli as seen through the word retrieval task. Lastly, the Meditation intervention was not shown to impact positive or negative affect, but did lead to an increase in calmness.
INTRODUCTION

Failing to pay attention to a task, when the goal is to stay focused on the task, is often detrimental to one’s cognitive performance. Considering that the process of mind wandering tends to occur automatically, we are typically unaware that we have lapsed into non-goal related thoughts. If we could reduce the frequency of mind wandering, it is feasible that we could enhance both our ability to concentrate and our task performance. One potential means of reducing this habit is by practicing mindfulness meditation, a burgeoning practice that can have myriad positive benefits even for novice practitioners, including improving performance on cognitive tasks and the ability to pay attention over extended periods of time (Chambers, Lo, & Allen, 2008; Zeidan, Johnson, Diamond, David, & Goolkasian, 2010). As such, this study serves to examine the effects of a brief mindfulness meditation training intervention on mind wandering, and subsequently on cognitive performance and attention.

What is Attention and Mind Wandering?

Attention is defined as selectively focusing on specific information in order to provide input to the brain for further processing (Banich, 2004), and is a basic component of several complex cognitive mechanisms including executive control, which governs higher-order processes, and working memory, which involves the manipulation and temporary storage of information. Mind wandering, also known as stimulus-independent or task-unrelated thinking, is defined as paying attention to thoughts or feelings unrelated to a primary task, often without the awareness of doing so. According to Smallwood and Schooler (2006), mind wandering can be thought of as an automatically initiated “situation in which executive control shifts away from a primary task to the processing of
personal goals” (p. 946). While mind wandering can be beneficial at times, such as for problem solving (Smallwood & Schooler, 2006), task-unrelated thoughts are associated with causing up to 25% more task errors compared to task-related thoughts (McVay, Kane, & Kwapiil, 2009). Moreover, mind wandering has been associated with decreased levels of happiness (Killingsworth & Gilbert, 2010). In fact, Killingsworth and Gilbert (2010) contend that mind wandering is “a cognitive achievement that comes at an emotional cost” (p. 932), and thus is a viable topic for scientific research. Of particular concern is the finding that people tend to mind wander, on average, at least one-third of the time, whether that be while completing a lab-based task (Christoff, Gordon, Smallwood, Smith, & Schooler, 2009; McVay et al., 2009; Smallwood, McSpadden, Luus, & Schooler, 2007a) or simply progressing through their day (Killingsworth & Gilbert, 2010; McVay et al., 2009).

To better understand the nature of mind wandering, it is helpful to identify how lapses in attention can lead to task-unrelated thoughts, and which activities can foster or decrease mind wandering. While there are several forms of attention, this study focuses on those most associated with mind wandering, namely sustained attention and response inhibition, and the impact mindfulness meditation has on each one.

**Sustained Attention**

Sustained attention, or vigilance, refers to the ability to maintain continuous, repetitive performance over time (Banich, 2004). Conners’ Continuous Performance Task (CPT; Conners, 1994) is a frequently used measure that assesses sustained attention. There are several versions of this task, but the basic elements tend to be the same; individual letters are displayed on a computer screen one at a time in fairly quick
succession, and the participant is instructed to pay attention to the letters and press a chosen button on the keyboard each time a letter other than the predetermined letter is presented (Spreen & Strauss, 1998). For example, the participant is told to press a key every time a letter other than “X” (the target) is displayed. Continuous performance tasks that involve an inhibitory component, such as this one, are also called “go/no-go tasks” because for each trial one has to determine whether s/he should go ahead and make a response or refrain from doing so. This task requires sustained attention because the participant must pay attention continuously and vigilantly to the letters in order to reduce errors of omission in which the participant fails to press the key to any letter other than “X.” Errors of omission thus reflect a lapse or decrease in the ability to sustain attention (Cheyne, Solman, Carriere, & Smilek, 2009).

Mind wandering and sustained attention. As might be expected, failing to pay attention to the task at hand, or mind wandering while performing a sustained attention task, can lead to performance errors. Christoff et al. (2009) supported this notion by investigating mind wandering through the use of the Sustained Attention to Response Test (SART) and administering thought probes to identify under what conditions subjects made performance errors. The SART is similar to the CPT, and in the version used by Christoff et al. (2009), the stimuli were numbers instead of letters and the task required participants to press a key for every number that was not ‘3.’ Christoff et al. (2009) presented stimuli every 2 seconds, and targets constituted only 5% of the stimuli. Students were presented with intermittent text thought probes that requested they indicate on a 7-point Likert scale to what degree they were on-task or off-task (i.e., mind wandering), and also how aware they were of being on-task or off-task at the time. These
thought probes provided a means for determining the impact of mind wandering on task performance. In the 10-second intervals before thought probes that were answered with an “off-task” response, participants made significantly more errors of omission in response to nontargets (i.e., numbers other than ‘3’) compared to the 10-second intervals before probes answered with an “on-task” response.

The frequency of mind wandering during a sustained attention task can be influenced by the probability of a target appearing. Further, when there is a low probability of a target occurring, reaction times in response to non-targets can provide clues about the automaticity of responses. Using a word version of the SART (in which ‘XXXXX’ was the target), Smallwood, McSpadden, and Schooler (2007) divided participants into either a low-probability (LP) or a high-probability (HP) group, wherein the target stimulus was present either 20% or 40% of the time, respectively. As in Christoff et al.’s (2009) study, thought probes were administered periodically every 60 or 90 seconds. Reaction times (RTs) were recorded for each trial in order to determine if there was a correlation between self-reported mind wandering and RTs before thought probes that were answered with an “on-task,” “off-task aware” or “off-task unaware” response. In the LP target condition, mind wandering without awareness (“off-task unaware” responses) was associated with shorter RTs when responding to the word stimuli relative to trials in which participants reported no mind wandering (“on-task”). These findings suggest that mind wandering without awareness leads to greater automatization. In contrast, mind wandering with awareness (“off-task aware”) was associated with longer RTs for the word stimuli than mind wandering without awareness, and did not differ significantly from staying on task. Moreover, in the HP target
condition, participants experienced less mind wandering overall and longer RTs associated with mind wandering without awareness than LP participants, suggesting there was greater cognitive control and less automatization, respectively, in the HP target condition relative to the LP target condition.

In order to further investigate the amount of attentional engagement during the HP and LP target conditions, subjects were given a word retrieval task that differentiated between responses based on familiarity versus conscious recollection to try to illustrate that increased mind wandering, and thus decreased attention, results in reduced recollection with no impact on familiarity. Results indicated that recollection in the LP target condition was greater when participants were on task rather than mind wandering, implying that reduced cognitive control, and thus less cognitive engagement, led to decreased word recollection. Further, mind wandering in the LP target condition was associated with decreased recollection irrespective of awareness level (Smallwood et al., 2007b).

In the HP target condition, there was no significant difference in recollection during mind wandering, regardless of awareness level, relative to being on task. The authors contend that that the HP participants were able to use the higher probability of a target occurring, an external influence, to maintain their attention and reduce the negative effects of mind wandering, an internal influence. As such, the HP participants did not experience the reduction in recollection when mind wandering that the LP participants did.
**Inhibition**

While the focus has been on sustained attention so far, inhibition is a key component of many sustained attention tasks. Response inhibition is the act of withholding a prepotent response when necessary. As can be seen in Conners’ CPT (1994) described above in the section on sustained attention, participants not only have to pay attention over a prolonged period of time in order to respond to all letters except “X,” but they also have to inhibit pressing a key when the letter “X” does occur. If a key is pressed in response to the target (‘X’), this is known as an error in response inhibition, or an error of commission.

**Mind wandering and inhibition.** Errors of commission have been found to be associated with mind wandering relative to staying on task (Smallwood et al., 2004). Smallwood et al. (2004) found that, when administering a continuous response task similar to the SART with thought probes, more errors of commission were made for items preceding an “off-task” response as opposed to an “on-task” response. In other words, more response inhibition errors were made when participants were mind wandering.

In Smallwood et al.’s (2007b) study examining the effect of target frequency on mind wandering, they also found that errors of commission were associated with mind wandering, specifically mind wandering without awareness. As stated in the prior section on sustained attention, participants in the LP target condition were presented with a target 20% of the time while participants in the HP target condition saw the target 40% of the time. In the LP target condition, mind wandering without awareness was associated with decreased response inhibition (more key presses to the ‘XXXXX’ targets) relative to
trials in which participants reported no mind wandering. This finding provides further support for the notion that mind wandering without awareness leads to a lack of cognitive control during a task and greater automatization. Interestingly, mind wandering with awareness was not associated with a decline in response inhibition, suggesting that participants were able to maintain sufficient cognitive control to inhibit responses during the task while simultaneously engaging in unrelated thoughts. In addition, participants in the HP condition were better able to inhibit their responses than those in the LP condition. As mentioned before, these advantages in task performance for the HP group were attributed to the higher frequency of occurrence of the target stimulus, which led participants to focus their attention on the task more than LP participants (Smallwood et al., 2007b).

Manly, Robertson, Galloway, and Hawkins (1999) also found that decreasing target probability was associated with increased errors of commission, and that more errors of commission were made during a long SART task (225 trials) than during a series of short SART tasks (five blocks with 45 trials each), reflecting that task duration influences response inhibition. As with the studies discussed in the sustained attention section, faster mean reaction times in response to the four non-targets presented immediately before target stimuli were found to be predictive of more errors of commission. The authors also had participants rate themselves on the Cognitive Failures Questionnaire (Broadbent, Cooper, FitzGerald, & Parkes, 1982) designed to determine the rate at which each person made cognitive errors in daily life, and found that individuals who reported being more absent-minded and prone to making errors in daily life made more errors of commission on the SART task.
The literature described thus far has shown that mind wandering is detrimental to both sustained attention and response inhibition. Presumably, decreasing the rate at which our mind wanders would, in turn, increase our ability to sustain attention and inhibit a response when necessary. It is thus possible that mindfulness meditation, which has been associated with both increased sustained attention and inhibition, might decrease mind wandering and improve performance on cognitive tasks. As such, this next section details the benefits of mindfulness meditation and the association between mindfulness meditation and improved sustained attention and inhibition.

**Mindfulness Meditation**

Mindfulness meditation is sometimes called opening-up, open-monitoring, receptive, or insight meditation. This form of meditation is oftentimes practiced while sitting with closed or downcast eyes, and involves focusing on all sensations and experiences. Put another way, the focus is on one’s breath, thoughts, bodily sensations, external sounds and smells, and anything else that can be perceived in that moment (Manna et al., 2010). There is a heightened awareness of one’s present environment and thoughts instead of reflections on the past or hypothetical future. In addition, thoughts are understood to be transient, ever-changing, and not subject to judgment because they are seen as separate from the self (Baer, 2003). The mindfulness meditator embraces an acceptance of one’s thoughts, self, and others and remains open to any and all experiences.

There are varying views of mindfulness meditation, but most have common elements that include non-judgment, awareness, and acceptance of one’s self and others (Herwig, Kaffengerber, Jancke, & Bruhl, 2010; Holzel et al., 2007). Bishop et al. (2004)
determined that there were two over-arching components of mindfulness, namely self-regulation of attention and orientation to experience. Self-regulation of attention is defined as monitoring one’s current mental state, which leads to greater understanding of that mental state and in turn enables the individual to “respond”, instead of “react” to an event. In this sense, responding entails thinking objectively about a situation and coming to a conclusion about how one would like to act, then doing so. Reacting, on the other hand, involves very little thinking and can be thought of as an automatic act triggered by an event. In addition to responding instead of reacting, Bishop et al. (2004) felt that one must develop a non-judgmental attitude of openness and acceptance toward one’s self and others. This idea is reflected by the second component of orientation to experience. Although this two-component model has gained some acceptance, it has also been proposed that the model is not comprehensive enough because it does not reflect that engaging in mindfulness meditation is voluntary (Shapiro, Carlson, Astin, & Freedman, 2006). Consequently, Shapiro et al. (2006) proposed a three-component model that includes intention, attention, and attitude. While the attention and attitude components correspond to Bishop et al.’s (2004) concepts of self-regulation of attention and orientation to experience respectively, the intention component is novel. Here, intention is said to be important because an individual must voluntarily decide to be mindful. Shapiro et al. (2006) argue that intention, attention, and attitude together lead to a change in thinking termed reperceiving, which in turn leads to a better ability to regulate one’s self; realize and clarify one’s personal values; promote overall cognitive, emotional, and behavioral flexibility; and expose oneself to one’s emotions. Regardless of the specific terms used to operationalize mindfulness, there is a consensus that mindfulness involves
attention, non-judgment/openness, a greater awareness and acceptance of one’s thoughts, the self, others, and the overall environment in the present moment.

**Mindfulness Meditation and Sustained Attention**

A number of studies have shown that long- and short-term mindfulness meditators are better able to sustain their attention than non-meditators (e.g., Lutz, Slagter, Rawlings, Francis, Greischar, & Davidson, 2009; Valentine & Sweet, 1999). Valentine and Sweet (1999) in particular were able to establish this difference in performance by administering the Wilkins’ Counting Test, a common measure of sustained attention, to long- and short-term meditators (defined as greater or less than 24 months of experience, respectively) trained in mindfulness and/or concentrative meditation (a simpler form of meditation in which one is taught to focus solely on the breath) as well as undergraduates with no prior meditation experience. For this task, auditory bleeps were played at different rates with either a consistent or varied time interval between the stimulus presentations. It was found that mindfulness meditators in particular were better able to keep track of the number of bleeps heard when compared to non-meditators, such that meditators counted significantly more bleeps overall. This suggests that mindfulness meditators were better able to sustain their attention over time and continuously keep track of the task at hand than non-meditators.

In addition, it was found that concentrative and mindfulness meditators performed similarly in the *expected* condition in which the bleeps were presented sequentially with equivalent interstimulus time intervals, but mindfulness meditators reported more accurate counts in the unexpected condition where the timing between the bleeps was changed. The authors explained this finding using Posner and Snyder’s (1975) theory of
expectancy, which states that not only is the ability to focus one’s attention better for expected stimuli, but also that unexpected events require a shift in attention. As such, mindfulness meditators demonstrated lower expectancy effects than concentrative meditators because they were better able to distribute their attention, did not get as “caught up with particular stimuli” (p. 62), and could shift more easily. Lastly, long-term mindfulness meditators counted significantly more bleeps than short-term mindfulness meditators, suggesting that increased meditation experience might increase one’s ability to sustain attention.

Lutz et al. (2009) also explored the effects of meditation on sustained attention but did so by comparing a group of long-term meditators (mindfulness practitioners and participants with concentrative meditation experience) who undertook a 3-month meditation retreat to a control group of non-meditators who underwent short-term meditation training for one week. Both the retreat and short-term training involved Vipassana meditation, which is a combination of both mindfulness and concentrative meditation. Before and after their respective training, participants were administered a dichotic listening task in which they had to listen to recurrent bleeps in one ear and press a key each time a deviant tone was heard. Concurrent bleeps were also presented to the other ear, but participants were instructed to ignore them and focus only on the tones heard in the primary ear. This task is typically used to assess selective attention, but in this study, RT variability (the standard error of the RTs) was examined in order to assess sustained attention with the idea that those able to continuously maintain their attention on the task would respond at an approximately equal pace to each letter while those who would periodically stop paying attention, due to a decreased ability to sustain attention,
would have more variable RTs across trials. Following training, the results showed that both groups exhibited decreased RT variability between trials in response to deviant tones, but the retreat participants’ RTs were even less variable indicating that the advanced, retreat meditators were better able to sustain and monitor their attention over time. These findings suggest that both short- and long-term training in mindfulness and concentrative meditation are associated with decreased RT variability but long-term training with experienced meditators has an even greater impact.

A more recent study conducted by Josefsson and Broberg (2010) found an effect of mindfulness itself on sustained attention when comparing experienced mindfulness meditators (more than two years of experience), a subset of whom also had concentrative meditation experience, to non-meditators, and compared high-frequency meditators (average meditation frequency of eight times per week) to non-meditators on SART performance. While no differences in accuracy were seen between the groups, it was found that responses to the Five Facets of Mindfulness Questionnaire (FFMQ; Baer, Smith, Hopkins, Krietemeyer, & Toney, 2006) predicted SART errors, indicating that greater reported overall mindfulness correlates with better sustained attention.

Further evidence for the connection between mindfulness and sustained attention comes from work by Schmertz, Anderson, and Robins (2009) who looked at trait mindfulness in non-meditators to determine if mindfulness itself is correlated with better sustained attention. Using a variety of mindfulness scales and a version of the CPT (CPT-II), Schmertz et al. (2009) found that higher mindfulness scores were negatively correlated with target omissions on the CPT-II, meaning that fewer targets were missed.
(omitted) by individuals with higher mindfulness scores, indicative of greater sustained attention.

Studies addressing the effects of short-term mindfulness meditation on sustained attention have also found positive results. For example, Chambers et al. (2008) looked at the performance of individuals with no prior meditation experience who either participated in a 10-day mindfulness meditation course or did not receive any training by administering the Internal Switching Task (IST) to each group. The IST is a continuous set-switching task involving affective stimuli that partially measures the capacity for sustained attention because it involves continuous performance and repetitive behavior: participants are asked to keep a silent count of how many words belong to each of two distinct categories, and subsequently press a key when they have updated their count so they can receive a new word. Reaction times are recorded for each trial, and Chambers et al. (2008) suggest that small or fast RTs are indicative of continuous attention, while increased or slow RTs reflect lapses in attention. It is important to note that in the mind wandering literature, faster RTs indicate more automatization and less cognitive control, but in this study, participants have to keep information in their working memory, and thus the RTs recorded in this set-switching task reflect the speed at which one is able to process the stimuli, and so faster RTs indicate more cognitive control and sustained attention. As such, greater sustained attention in this experiment is evidenced by faster RTs.

By comparing overall RTs across groups, the authors found that RTs decreased (i.e., became faster) for the mindfulness meditation group after training while they did not significantly decrease for the control group, ruling out possible practice effects and
suggesting an increase in sustained attention abilities in the mindfulness meditation group. In addition, the Mindful Attention Awareness Scale (MAAS; Brown & Ryan, 2003) was administered to determine the overall level of mindfulness experienced by each person, and it was found that the training group reported higher levels of mindfulness than the control group following training, and these increased mindfulness scores were negatively correlated with longer reaction times.

More recent research by Zeidan et al. (2010) has provided evidence of the short-term effects of mindfulness meditation in a sample of participants who received four days of training. Zeidan and colleagues (2010) attempted to see if short-term mindfulness meditation training would affect sustained attention by comparing undergraduate non-meditators who received the training to a control group of student non-meditators who listened to a book (The Hobbit) for the same period of time. Several tasks were administered to both groups, including a computer adaptive n-back task that assessed sustained attention among other processes. The n-back task is a commonly used measure of working memory, but in this study it was also used to measure sustained attention. For reference, the 2-back task consists of individual letters displayed on a screen, one after another, while participants are instructed to indicate via one of two keys whether or not the current letter is the same as or different from the letter that appeared two letters prior to that one (i.e., is the third letter the same as or different from the first letter). It was found that participants in the mindfulness meditation group had more consecutive trials wherein no mistake was made when compared to the control group, which was interpreted to indicate greater vigilance, or sustained attention, during the task.
Mindfulness Meditation and Inhibition

So far the literature has suggested there is an association between mindfulness meditation and increased sustained attention, but there also appears to be a link between mindfulness meditation and improved response inhibition. Chan and Woollacott (2007) identified an association between mindfulness meditation and response inhibition on the Stroop task in long- and short-term meditators (with individual experience ranging from 82 to 19,200 hours and daily frequency ranging from six to 150 minutes) who were experienced in mindfulness and/or concentrative meditation when compared to non-meditators. In the classic paper/pencil version of the Stroop task (Stroop, 1935), visual stimuli are presented in three conditions: “color patches,” “color words,” and “Stroop words.” In the “color patches” (neutral) condition, small, colored rectangles are ordered into multiple rows and columns and the participant is asked to name aloud the color of each rectangle as quickly as possible until all colored boxes have been named. In the “color words” (congruent) condition, words in black text are displayed in place of the colored boxes, and participants are asked to read each word aloud as quickly as possible. In the “Stroop words” (incongruent) condition, color words are displayed in colored text, such that the word ‘red’ might be written in green or, ‘blue’ might be written in red. Participants are asked to name aloud the color of each word while inhibiting the urge to read the word itself. For example, if the word ‘red’ is displayed in green, participants should state “green” as opposed to instinctually stating “red.” The act of reading the word reflects “Stroop Interference,” and the number of errors indicates how well the participant is able to inhibit their habitual response (fewer errors = better inhibition).
By comparing performance between meditators and non-meditators, Chan and Woollacott (2007) found that meditators made more correct responses for all three conditions (neutral, congruent and incongruent) than non-meditators. Interestingly, meditators who practiced solely concentrative meditation did not exhibit less Stroop Interference than non-meditators while practitioners of mindfulness meditations did do so, suggesting that the overall effect for meditation was driven by the mindfulness meditators. Further, the total amount of meditation experience did not correlate with Stroop Interference, possibly because all meditators were sufficiently adept at meditating with at least 82 hours of experience, and therefore all displayed enhanced response inhibition. Interestingly, greater frequency of daily meditation was associated with less Stroop Interference, suggesting a positive impact of meditation frequency on response inhibition. Frequency could have been found to impact response inhibition because of the greater range of reported daily meditating frequency in the participant sample, ranging from one-tenth of an hour to two and a half hours, such that meditation improves response inhibition only when practiced for a lengthy period each day (say, one hour). Similarly, had the participants included meditators with little overall experience with meditation, these subjects might have been worse at inhibiting responses than the more experienced meditators.

While there is evidence that long-term, frequently practicing mindfulness meditators may be better at inhibiting their responses than non-meditators (Chan & Woollacott, 2007), there is currently little published research addressing the effects of short-term mindfulness meditation training on response inhibition. However, Tang et al. (2007) investigated inhibitory processes in undergraduates who underwent Integrative
Body-Mind Training (IBMT; 20 minutes per day for five days), which consists of a variety of techniques that include relaxation, breathing modification, and mental imagery, in addition to mindfulness meditation (Tang et al., 2007, 2009). Participants were given the Attention Network Task (ANT; Fan, McCandliss, Sommer, Raz, & Posner, 2002) and Profile of Mood States Scale (POMS; Shacham, 1983) one week before the training and immediately after the last session. Briefly, the ANT involves making a choice about the direction of an arrow that is sometimes flanked by distractor errors that either point in the same direction, or the opposite direction. In addition, on some trials, cues are presented before the arrows are displayed to indicate either when or where (above or below a central fixation point) the arrows will appear.

In comparison to undergraduates who received relaxation training for the same period of time, the IBMT training group exhibited reduced flanker interference (distraction from the flanking arrows) compared to the control group, as evidenced by faster average reaction times in the incongruent flanker condition. Put another way, the IBMT group was better able to inhibit the urge to select the direction of the flanking arrows as a response, instead correctly choosing the direction of the center arrow more frequently than the relaxation group. Notably, the IBMT training did not have an effect on trials with cues revealing information that alerted or oriented participants to where the arrows would appear.

Wenk-Sormaz (2005) also found that non-meditators who underwent short-term mindfulness meditation training were better able to inhibit responses as necessary when compared to control participants. Participants in the meditation group completed either a Stroop task involving strings of Xs and color words, or a word production task designed
to assess habitual responding. Participants were assigned to one of three intervention groups: meditation (mindfulness training), learning (use of mnemonic devices to memorize a list), and rest (no concentration, mind-wandering encouraged), and assigned to receive one of two tests, either the Stroop task or a word production task (stem completion or category exemplar generation). For the stem completion task, participants had to complete 10 three-letter word stems with six different words per word stem. In the category exemplar generation task, participants were presented with a description of a category, and instructed to write down 20 items that belonged to each category within 30 seconds. Similar to the Stroop task, the word production tasks were meant to show deautomatization, such that “the distribution of responses elicited by category descriptions and word-stems after meditation should be more variable and less typical than the responses elicited in the control conditions,” reflecting less habitual responding (p. 45). Each group came in three times for 20 minutes within a two week time period, and was tested before and after meditating, learning, or relaxing on the third day. There were no baseline differences for the Stroop task, and the post-test results reflected decreased Stroop Interference in the meditation group when compared to both of the control groups. In contrast, performance on the word production tasks were similar between groups at both time points, such that, on average, participants generated a similar number of words (typical and atypical) for the word-stem completion test, and an equivalent number of typical and atypical words in the category production task suggesting no change in habitual responding due to meditation.

To better understand the contradiction between the Stroop and word-production results, Wenk-Sormaz (2005) conducted a second study. Undergraduates were assigned
to one of three groups, involving the same type of meditation and resting conditions as in Study 1, but participants only came in one time. The category production task was administered again, but participants were specifically asked to generate either typical or atypical words. At pre-testing, no differences were found among the groups for typical or atypical responses, meaning that no group responded more atypically than another group. However, at post-testing the meditation group responded more atypically when asked to do so as compared to both the cognitive control and resting groups. The authors suggest that meditation appeared to lead to more non-habitual responding when it was optimal to do so. This study therefore supports the notion that mindfulness meditation training, even when brief, can decrease habitual responding when it is not desired, and thus improve response inhibition.

The literature presented in this paper indicates that both long- and short-term training in mindfulness meditation can improve sustained attention and response inhibition. As seen through performance on tasks, such as the Wilkins’ Counting Test (Valentine & Sweet, 1999), the ANT (Tang et al., 2007), Stroop (Chan & Woollacott, 2007; Wenk-Sormaz, 2005) and word generation tasks (Wenk-Sormaz, 2005), it has been shown that mindfulness meditation can favorably impact habitual responses and lead to a deautomatization of behavior. This point is important because the evidence suggests that mind wandering is an automatic behavior (Smallwood & Schooler, 2006; Smallwood et al., 2007b), and it is feasible that methods which reduce automatic behaviors, such as mindfulness meditation, could conceivably reduce mind wandering. It follows then that mindfulness meditation may not only improve cognitive performance, but may also be a useful technique for reducing mind wandering. As such, the present study was designed
to determine whether short-term mindfulness meditation training can decrease mind wandering.

In addition, the current study was designed to assess the effects of two sessions of mindfulness meditation training. The relevant literature to date showing the effects of short-term mindfulness meditation training on sustained attention involves as few as four training visits (Zeidan et al., 2010), while effects of short-term mindfulness training on inhibition have been found in as few as three training visits (Wenk-Sormaz, 2005). No study has examined whether even fewer training visits can have an impact on sustained attention and response inhibition. It should be noted that Wenk-Sormaz’s (2005) second study, which involved a single training visit did produce a positive effect of meditation in the form of decreased habitual responding, but this task involved the creative generation of words within a specified time frame and thus it is difficult to assume that improved performance on the word generation task would mean better sustained attention and response inhibition, as these processes are not necessarily instrumental to success on the word generation task. In sum, no published study has looked at the effects of two training visits worth of short-term meditation on performance during a continuous performance test. Taking into account the varied benefits of mindfulness meditation, the ease with which training can be administered, and the low cost associated with mindfulness meditation practice, it would be valuable to know if very short-term mindfulness meditation training can lead to attentional improvement. Further, because mind wandering is a frequent phenomenon (Killingsworth & Gilbert, 2010; McVay et al., 2009) that can impair one’s performance on tasks (McVay et al., 2009), and is related to lower levels of happiness (Killingsworth & Gilbert, 2010), it would be beneficial to
determine if merely two sessions of training can reduce mind wandering. The current study was thus designed to add to the present knowledge base and offer research detailing the impact of just two sessions of mindfulness meditation training.

**Current Study**

The following questions were explored in the current study: Can brief training in mindfulness meditation reduce mind wandering? Can the same training improve response inhibition and sustained attention? Lastly, can mindfulness meditation improve recollection through stronger encoding of stimuli, due to better attentional processing, at the time of presentation?

For this study, participants were randomly assigned to one of two groups: Mindfulness Meditation or Focused Listening Control. The Meditation group listened to and followed a CD inducing mindfulness meditation, while the Listening group listened to a recording of ‘The Hobbit’ by J.R.R. Tolkien, which, as was described earlier, has been used for a control condition in work assessing the impact of meditation on attentional processes (Zeidan et al., 2010). Each subject came into the lab on two different days in order to ensure familiarity with the study procedure, and to see if only two days of meditation training could lead to improved sustained attention and response inhibition and decreased mind wandering.

Each group completed two continuous performance tasks designed to measure sustained attention and inhibition, both of which included intermittent thought probes asking about mind wandering to determine the nature and frequency of mind wandering. On the second day of testing, participants also completed a word retrieval task to assess how well they encoded, or paid attention to, the word stimuli.
On Day 1, participants completed a Number Go/No-Go task based on the measure used by Smallwood, McSpadden, Luus, and Schooler (2007), which included both short and long blocks of trials requiring a response to each digit that appeared except for ‘3.’ Following each block of trials, participants were presented with text thought probes asking if they were mind wandering, and whether they were aware of doing so. The varying block lengths were implemented so participants would not come to expect when the thought probes would appear. Errors of omission and commission were scored to provide a pre-test measure of sustained attention and inhibition, and participants’ responses to the thought probes provided a means of measuring mind wandering frequency.

Upon completing the go/no-go task, participants then listened to their assigned audio recording. One to three days later, each person came back into the lab at approximately the same time of day to complete a measure of affect (a baseline measure of how she/he was feeling at the time) before listening to his/her assigned audio recording again. The same affect questionnaire was then re-administered to determine if the recording had any impact on their positive/negative affect, attentiveness, and serenity.

Participants were then instructed to complete a Word Go/No-Go task similar to the one used in Smallwood et al.’s (2007b) study which provided a post meditation/listening measure of mind wandering, sustained attention, and response inhibition. Once again, block length was varied so participants would not anticipate when thought probes would appear on the screen. A subsequent word retrieval task was incorporated as another means of assessing attention in the go/no-go task by determining how well participants were able to keep track of the words they had already seen. In this
task, known as an exclusion test, subjects were instructed to complete word stems with words that they had not seen in the prior task; the use of old words indicated a lack of conscious recollection, and thus lower rates of word completion with old words suggests better recollection of those words.

Once finished with both cognitive tasks, participants completed a manipulation check that asked about perceived effort and included questions designed to assess their meditation experience.

**Hypotheses**

*Mind Wandering.* As mentioned above, mind wandering was measured through text thought probes presented during the go/no-go tasks that asked participants if they were on task, tuning out (mind wandering with awareness), or zoning out (mind wandering without awareness). Because participants were randomly assigned to groups there were no expected group differences in mind wandering frequency on Day 1. Mindfulness meditation though was expected to increase awareness and, given tune outs do not involve deficits in awareness, the frequency of tune outs was not expected to differ across groups on Day 2. However, because mindfulness meditation has been shown to reduce automatic behaviors, the meditation group was predicted to report fewer zone outs, or mind wandering without awareness on Day 2. As such, the meditation group was expected to experience less mind wandering overall on Day 2 when compared to the listening group. There was no reason to assume that a reduction in zoning out would lead to more tuning out, but instead that decreased mind wandering on the second day would be due to increased on-task responses.
In addition, previous research has shown that reaction times tend to be longer when more cognitive control is employed, such as when one is on task or mind wandering with awareness (Smallwood et al., 2007b), it was expected that participants would take longer to respond to trials occurring immediately before thought probes answered with “on-task” or “tune out” responses (mind wandering with awareness) than with “zone out” responses (mind wandering without awareness). However, there was no a priori reason to expect that reaction time differences between tune outs and zone outs found by Smallwood et al. (2007b) would differ as a function of meditation on Day 2.

A summary of the mind wandering hypotheses are listed below (Note: TO = tune outs; ZO = zone outs; OnT = on-task; MW = mind wandering).

- **Number Go/No-Go Task (Day 1):** 1) No group differences expected for MW frequency, 2) RTs for TO > RTs for ZO, and 3) RTs for OnT > RTs for ZO.
- **Word Go/No-Go Task (Day 2):** 1) Meditation group’s ZO frequency < Listening group’s ZO frequency, 2) Meditation group’s MW frequency < Listening group’s MW frequency, 3) Meditation group’s OnT frequency > Listening group’s OnT frequency, 4) Day 2 RT hypotheses same as Day 1 (see above), no group differences expected.

*Performance.* Again, because participants were randomly assigned to groups there were no expected group differences in performance on Day 1. As for the effects of mindfulness meditation on sustained attention, it was expected that the Meditation group would be more accurate when responding to the word stimuli on Day 2 by making fewer omission errors (in response to non-targets) than the Listening group. It was also
predicted that the Meditation group would exhibit improved response inhibition by making fewer commission errors (in response to targets) than the Listening group. Further, it was assumed that greater sustained attention in the Meditation group would lead to improved word recall, and thus the Meditation group would be better able to recall words than the Listening group.

A summary of the performance hypotheses are displayed below:

- **Number Go/No-Go Task (Day 1):** No group differences expected for omission or commission errors.

- **Word Go/No-Go Task (Day 2):** 1) Meditation group’s omission errors < Listening group’s omission errors, 2) Meditation group’s commission errors < Listening group’s commission errors.

- **Word Retrieval Task (Day 2):** Meditation group’s stem completion rate for old words < new words while the Listening group’s stem completion rate for old words > new words.

**Affect, Manipulation Checks and Block Length Effects.** If the brief mindfulness meditation training was effective, it was thought that the Meditation group would also exhibit improved positive affect, decreased negative affect, greater attentiveness, and an increase in serenity after the training. It was also predicted that the Meditation group would report higher scores on the experiential manipulation check items, such as “I felt my breathing slow down,” than the Listening group as the questionnaire was primarily designed to evaluate the meditation experience with the exception of two questions designed to measure participants’ engagement while listening (e.g., Did you fall asleep while listening?). Responses to those questions were not expected to differ across
groups. Further, it was anticipated that long blocks might encourage more tune outs than on task reports and more zone outs than on task reports relative to short blocks, which should show more on task reports than tune outs or zone outs. Lastly, it was thought that there would be more performance errors in long blocks than in short blocks.

A summary of these additional hypotheses is given below:

- **Affect (after the Meditation/Listening recording):**
  1) Positive affect: Meditation group > Listening group,
  2) Negative affect: Meditation group < Listening group,
  3) Attentiveness: Meditation group > Listening group,
  4) Serenity: Meditation group > Listening group.

- **Manipulation checks:** Meditation group > Listening group for all measures except for questions regarding engagement, which should not differ.

- **Block Length:** Same results for Number and Word Go/No-Go tasks.
  - Mind Wandering, Short Blocks:
    1) OnT > TO, 2) OnT > ZO, 3) TO > ZO, and 4) Same pattern for both groups.
  - Mind Wandering, Long Blocks:
    1) OnT < TO, 2) OnT < ZO, 3) TO < ZO, and 4) Same pattern for both groups.

- **Errors:**
  1) Omission errors in short blocks < omission errors in long blocks,
  2) Commission errors in short blocks < commission errors in long blocks,
  3) No interactions between block length and group.
METHOD

Participants

Participants were 79 (40 male, 39 female) undergraduates enrolled in Introductory Psychology courses at Wake Forest University. Although 87 students signed up for the experiment, data from four students were excluded due to current or extensive prior meditation experience, and four other students did not complete all of the tasks. Of the remaining subjects, 48 students had no prior experience with meditation, and 31 students reported meditating fewer than 11 times over their lifetime, as can be seen in Table 1. There were no significant differences between groups when comparing gender, prior meditation experience, age, and self-reported frequency of daily mind wandering (all $t$-values < 1.45; all $p$-values > .15).

Materials

Audio recordings. Meditation training was administered via a modified 19-minute mindfulness meditation CD created by Jon Kabat-Zinn. This modified version excluded 30 seconds of the recording where Kabat-Zinn suggested the listener congratulate him/herself, as it was thought that this excerpt might increase positive affect or motivation in the Meditation group. On both days, participants listened to the same recording and were instructed to close their eyes, relax, focus on their breathing and related sensations, stay in the moment, and monitor their attention as necessary so they could remain focused on the present moment.

Participants in the listening group listened to two 19-minute excerpts from J. R. R. Tolkien’s ‘The Hobbit’ (BBC Audiobooks Ltd., 1997) spread across both testing days to assess the effect of concentration without a meditative component on attentional
performance and mind wandering. Prior to listening, participants were told to close their eyes, listen to, and focus on the recording they were about to hear.

Table 1

*Demographic Information by Group*

<table>
<thead>
<tr>
<th>Measure</th>
<th>Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Meditation</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
</tr>
<tr>
<td>Females</td>
<td>21</td>
</tr>
<tr>
<td>Males</td>
<td>20</td>
</tr>
<tr>
<td>Prior Lifetime Meditation Experience</td>
<td></td>
</tr>
<tr>
<td>Never</td>
<td>25</td>
</tr>
<tr>
<td>1-2 times</td>
<td>8</td>
</tr>
<tr>
<td>3-5 times</td>
<td>3</td>
</tr>
<tr>
<td>6-10 times</td>
<td>5</td>
</tr>
<tr>
<td>Age</td>
<td>18.88 (.16)</td>
</tr>
<tr>
<td>Daily MW Frequency</td>
<td>3.39 (.13)</td>
</tr>
</tbody>
</table>

*Note:* MW = Mind Wandering, on a Likert scale of 1 to 5 (5 means extremely often).

**Self-report measures.** A general questionnaire was given that asked about demographic information and the extent of participants’ meditation experience to ensure that no students had extensive prior experience with any form of meditation (Appendix A). Mood was assessed via the Positive and Negative Affect Schedule (PANAS;
Appendix B; Watson, Clark, & Tellegen, 1988) in order to assess positive affect, negative affect, attentiveness, and serenity throughout the study. A subsequent manipulation check adapted from the meditation scale used by Reavley and Pallant (2009) determined the degree to which participants felt they focused on their assigned audio recording, the nature of their experience while listening, and whether or not they felt they had actually been concentrating/meditating (Appendix C). The Focused Listening participants also completed four short comprehension questions to ensure that they had paid attention to Day 2’s recording (Appendix C).

**Attention tasks.** The Number Go/No-Go task administered on Day 1 was based on the go/no-go task used in Smallwood, McSpadden, Luus, and Schooler’s (2007) study on mind-wandering. This task lasted approximately 20 minutes and provided a pre-test measure of sustained attention, mind wandering, and response inhibition. For each trial, a fixation cross appeared on the computer screen for 1250 msec followed by either a non-target (single digits, 0-9) or target stimulus (‘3’), which stayed on the screen for 1250 msec. Participants were instructed to press the spacebar every time a non-target was displayed, but inhibit their response when a target appeared. Because Smallwood et al. (2007b) were best able to distinguish between mind wandering with and without awareness in the low probability target condition, and participants in the low probability target condition showed that mind wandering is associated with decreased response inhibition and decreased recollection, we only made use of the low target probability condition, where the targets constituted 20% of the stimuli. Further, a textual ‘thought probe’ appeared on the screen every 30 or 60 seconds (varied randomly across trials) that requested each participant to press a key indicating whether they had been mind
wandering with awareness, defined as tuning out, mind wandering without awareness, defined as zoning out, or staying on task just before the probe appeared. Participants were given instructions explaining the differences between tuning out and zoning out so as to minimize confusion (Appendix D). In addition, the last four trials before each probe consisted solely of non-targets in order to provide a continuous measure of reaction time that could be associated with participants’ thought probe responses. Overall, the task was comprised of thirteen 30-second blocks and thirteen 60-second blocks for a total of 26 blocks, with a thought probe at the end of each block. The short blocks were included to ensure that subjects would not be able to anticipate when the thought probe would appear; likewise, the order of short and long blocks was randomly determined to further make it difficult for participants to know when they would be asked about their awareness level.

As in Smallwood et al.’s work (2007b), the stimuli for the continuous performance task used on Day 2 consisted of five-letter words with a target stimulus (XXXXX) presented intermittently during the task. Again, as on Day 1, target probability was set at 20%. In this 25-minute version, a fixation cross appeared for 500 msec before each stimulus was displayed for 2,000 msec. Again, participants were instructed to press the spacebar as quickly as possible when a non-target appeared, but withhold their response when a target appeared. The same thought probes used for the Day 1 task were presented randomly at the end of each block of trials (every 30 or 60 seconds), and the last four trials before each thought probe consisted solely of non-targets. The last three words before each thought probe came from Jacoby’s (1998) word list (Appendix E) and were used as stimuli in the subsequent word retrieval task. Overall,
the task consisted of fifteen 30-second blocks and fifteen 60-second blocks for a total of 30 blocks with a thought probe at the end of each block.

To further assess how much each participant paid attention during the Word Go/No-Go task, an exclusion memory task based on Smallwood et al.’s (2007b) word retrieval task was employed to determine the strength of encoding for the presented words. The stimuli included 120 word stems (the first three letters of a five letter word) presented individually in random order on the computer screen, 90 of which corresponded to old words seen in the Word Go/No-Go task, and 30 of which were new word stems that did not match any words seen in the prior task. Each word stem was displayed for 15 seconds, followed by 2 seconds wherein no word was displayed. Participants were instructed to complete each word stem with a word that was not seen during the go/no-go task, and if they could not do so, they were told to withhold their response.

Procedure

**Day One.** Participants were randomly assigned to groups before arriving at the lab, and completed both the Informed Consent and general demographics questionnaire before testing. Participants were then instructed to work through the Number Go/No-Go task, and then listen to, and focus on, the audio recording corresponding to the group to which they had been assigned.

**Day Two.** Participants were administered the PANAS before listening to, and focusing on, their audio recording. At this time they were informed that they would later be asked questions pertaining to what they heard. Once the recording finished, they filled out the PANAS to allow for a pre. vs. post-meditation/listening comparison of affective
state. Each participant then completed the Word Go/No-Go and exclusion memory task before filling out the manipulation check questionnaire that evaluated the extent to which he/she focused on the audio recording played earlier in the testing session.
RESULTS

Unless otherwise stated, all p-values reflect two-tailed hypothesis tests.

Number Go/No-Go Task

The number version of the go/no-go task was used on Day 1 to compare mind wandering frequency, reaction times, and performance in order to rule out group differences prior to the meditation/listening intervention.

Mind Wandering. Responses to thought probes assessing the frequency of mind wandering were analyzed using a 3-way mixed factors ANOVA with block length (short and long blocks) and mental state (on-task, tune outs, and zone outs) as within-subjects variables, group (Meditation and Listening) as the between-subjects variable, and percentage of responses as the dependent variable. Average self-reported mind wandering frequencies are listed in Table 2. The results reflected a main effect of mental state, $F(2, 154) = 4.63$, $MSe = .12$, $p = .01$ and a significant interaction between block length and mental state, $F(2, 154) = 35.42$, $MSe = .03$, $p < .001$, but no main effect of block length, $F(1, 77) = .18$, $MSe < .001$, $p = .68$. No group differences were found (all $ps > .10$), indicating that there were no differences in mind wandering across groups prior to the Meditation/Listening intervention.

To tease apart the interaction between mental state and block length, two one-way ANOVAs comparing the three mental states for each block length were performed. Significant main effects of mental state were found for both short, $F(2, 156) = 13.36$, $MSe = .08$, $p < .001$, and long blocks, $F(2, 156) = 7.75$, $MSe = .07$, $p = .001$. Subsequent paired samples t-tests using a Bonferroni corrected alpha of .008 and comparing between
mental states at each block length revealed that during short blocks, participants reported no significant difference in frequency for being on-task relative to tuning out, \( t(78) = 1.59, p = .12 \), but they tuned out significantly more than they zoned out, \( t(78) = 3.84, p < .001 \), and stayed on-task significantly more than they zoned out, \( t(78) = 4.84, p < .001 \). However, during long blocks, participants reported tuning out significantly more than they stayed on task, \( t(78) = -4.26, p < .001 \), and showed non-significant trends towards tuning out more than zoning out, \( t(78) = 2.02, p = .05 \), and zoning out more than being on-task, \( t(78) = -1.79, p = .08 \). Overall, these results suggest a greater degree of awareness during short blocks, and more mind wandering during long blocks.

### Table 2

*Mean (SE) Percentage Mind Wandering Frequency in the Number Go/No-Go Task*

<table>
<thead>
<tr>
<th>Mental State</th>
<th>Meditation</th>
<th>Listening</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Short Blocks</strong></td>
<td>[</td>
<td>[</td>
</tr>
<tr>
<td>On Task</td>
<td>43.7% (3.9%)</td>
<td>42.7% (4.1%)</td>
</tr>
<tr>
<td>Tune Outs</td>
<td>34.1% (3.4%)</td>
<td>37.6% (3.5%)</td>
</tr>
<tr>
<td>Zone Outs</td>
<td>22.1% (3.3%)</td>
<td>19.6% (3.5%)</td>
</tr>
<tr>
<td><strong>Long Blocks</strong></td>
<td>[</td>
<td>[</td>
</tr>
<tr>
<td>On Task</td>
<td>24.0% (3.4%)</td>
<td>26.1% (3.5%)</td>
</tr>
<tr>
<td>Tune Outs</td>
<td>42.8% (3.2%)</td>
<td>40.9% (3.4%)</td>
</tr>
<tr>
<td>Zone Outs</td>
<td>33.2% (3.7%)</td>
<td>33.0% (3.8%)</td>
</tr>
</tbody>
</table>
**Reaction Times.** The time participants took to respond to trials immediately preceding thought probes was intended to be analyzed using a 3-way mixed factors ANOVA with block length and mental state as within-subjects variables, and group as the between-subjects variable. The dependent variable was the median reaction time obtained from the last four trials before thought probes, which can be found in Table 3. However, not all participants reported experiencing each mental state at each block length leading to a reduced sample size when making within-condition comparisons (n = 37). As such, block length was collapsed to yield a larger sample size of n = 64 in order to increase the statistical power of the analyses and a 2-way mixed factors ANOVA was conducted.

Results showed that there was not a significant main effect of mental state, $F(2, 124) = 2.06, MSe = 1540.57, p = .13$, which contradicts Smallwood et al.’s (2007b) finding that reaction times corresponding to tune outs/on-task responses, or just before self-reported tune outs and on-task experiences, are slower than those before zone outs. The 2-way ANOVA also did not yield a main effect of group, $F(1, 62) = 1.79, MSe = 14861.40, p = .19$, nor was there a mental state by group interaction, $F(2, 124) = .16, MSe = 1540.57, p = .85$, indicating that reaction times in response to non-targets, and associated with each mental state, did not vary as a function of group.

**Accuracy.** Errors of omission, or failures to press a key in response to non-targets, were assessed by measuring the percentage of key presses in response to non-targets across groups (see Table 4). A 2-way mixed factors ANOVA was employed with block length as the within-subjects variable and group as the between-subjects variable. The results showed that there was no main effect of block length, $F(1, 77) = .007, MSe <$
### Table 3

*Median (SE) Reaction Times (msec) for the Four Trials Preceding Thought Probe Responses in the Number Go/No-Go Task*

<table>
<thead>
<tr>
<th>Mental State</th>
<th>Group</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Short Blocks</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>On Task</td>
<td>Meditation</td>
<td>426.03 (18.35)</td>
<td>425.27 (19.90)</td>
</tr>
<tr>
<td>Tune Outs</td>
<td>Meditation</td>
<td>419.23 (17.45)</td>
<td>421.32 (18.93)</td>
</tr>
<tr>
<td>Zone Outs</td>
<td>Meditation</td>
<td>440.65 (18.22)</td>
<td>407.27 (19.76)</td>
</tr>
<tr>
<td>Long Blocks</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>On Task</td>
<td>Listening</td>
<td>428.10 (17.94)</td>
<td>434.91 (19.46)</td>
</tr>
<tr>
<td>Tune Outs</td>
<td>Listening</td>
<td>447.65 (20.13)</td>
<td>446.82 (21.83)</td>
</tr>
<tr>
<td>Zone Outs</td>
<td>Listening</td>
<td>433.68 (18.81)</td>
<td>440.15 (20.41)</td>
</tr>
</tbody>
</table>

### Table 4

*Mean (SE) Percentage Key Presses in Response to Non-Targets in the Number Go/No-Go Task*

<table>
<thead>
<tr>
<th>Mental State</th>
<th>Group</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Short Blocks</td>
<td></td>
<td>96.9% (1.6%)</td>
<td>98.1% (1.7%)</td>
</tr>
<tr>
<td>Long Blocks</td>
<td></td>
<td>96.7% (1.8%)</td>
<td>98.2% (1.9%)</td>
</tr>
</tbody>
</table>
.001, \( p = .93 \), or group, \( F(1, 77) = .28, \text{MSe} = .02, p = .56 \), nor was there an interaction between block length and group, \( F(1, 77) = .26, \text{MSe} < .001, p = .61 \).

Errors of commission were analyzed by comparing the percentage of key presses in response to targets (Table 5) across groups and blocks, which reflects failures in response inhibition. Data were analyzed with a 2-way mixed factors ANOVA, and as with the data for omission errors, there was no main effect of block length, \( F(10 ,77) = 1.41, \text{MSe} = .004, p = .24 \), or group, \( F(1, 77) = .82, \text{MSe} = .04, p = .34 \), nor was there an interaction between block length and group, \( F(1, 77) = .10, \text{MSe} = .004, p = .75 \). The findings for errors of omission and commission thus indicate that there were no group differences in performance prior to the meditation/listening intervention.

Table 5

<table>
<thead>
<tr>
<th>Mental State</th>
<th>Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Meditation</td>
</tr>
<tr>
<td>Short Blocks</td>
<td>17.9% (2.2%)</td>
</tr>
<tr>
<td>Long Blocks</td>
<td>16.4% (2.2%)</td>
</tr>
</tbody>
</table>

**Word Go/No-Go Task**

The lexical version of the go/no-go task was employed to determine if there were any group differences in mind wandering frequency, reaction times, and performance due to the meditation/listening intervention.

**Mind Wandering**. The frequency of participants’ reported mind wandering following the meditation/listening manipulation (Day 2) on the Word Go/No-Go Task was measured via a 3-way mixed factors ANOVA with block length and mental state as
within-subjects variables and group as the between-subjects variable. The percentage of thought probe responses was the dependent variable, and the average values for each group and mental state are presented in Table 6. The data did not reveal a significant main effect of block length, $F(1, 77) = .76, \text{MSe} < .001, p = .39$, or mental state, $F(2, 154) = 2.13, \text{MSe} = .19, p = .12$, but there was a significant interaction between block length and mental state, $F(2, 154) = 14.50, \text{MSe} = .02, p < .001$. Further, there was no main effect of group, $F(1, 77) = .04, \text{MSe} < .001, p = .85$, or any group-related interactions (all $Fs < .69$, all $ps > .50$), showing that the frequency of on-task reports, tune outs and zone outs did not vary as a function of group. This finding suggests that meditation did not lead to fewer zone outs and less mind wandering than the listening manipulation.

In order to explore the significant interaction between block length and mental state, two follow-up one-way ANOVAs were conducted with mental state as the independent variable and mind wandering frequency as the dependent variable for each block length. For short blocks, there was a main effect of mental state, $F(2, 156) = 7.01, \text{MSe} = .09, p = .001$, but this effect did not hold up during long blocks, $F(2, 156) = .16, \text{MSe} = .11, p = .85$. Further paired samples t-tests using a Bonferroni corrected alpha of .017 with the short block data revealed that participants reported significantly more on-task experiences relative to tune outs, $t(78) = 2.50, p = .015$, and zone outs, $t(78) = 3.61, p = .001$, but a similar number of tune outs as zone outs, $t(78) = 1.01, p = .32$. These results indicate more awareness during short blocks, consistent with the Number Go/No-Go data, but there was no difference in mind wandering frequency during long blocks,
contrary to the greater amount of mind wandering found during long blocks in the Number Go/No-Go task.

Table 6

*Mean (SE) Percentage Mind Wandering Frequency in the Word Go/No-Go Task*

<table>
<thead>
<tr>
<th>Mental State</th>
<th>Group</th>
<th>Meditation</th>
<th>Listening</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Short Blocks</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>On Task</td>
<td></td>
<td>45.4% (4.2%)</td>
<td>41.6% (4.4%)</td>
</tr>
<tr>
<td>Tune Outs</td>
<td></td>
<td>28.9% (3.9%)</td>
<td>32.3% (4.1%)</td>
</tr>
<tr>
<td>Zone Outs</td>
<td></td>
<td>25.7% (3.6%)</td>
<td>26.2% (3.8%)</td>
</tr>
<tr>
<td><strong>Long Blocks</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>On Task</td>
<td></td>
<td>37.1% (4.3%)</td>
<td>31.0% (4.4%)</td>
</tr>
<tr>
<td>Tune Outs</td>
<td></td>
<td>33.5% (4.3%)</td>
<td>35.0% (4.5%)</td>
</tr>
<tr>
<td>Zone Outs</td>
<td></td>
<td>29.4% (4.2%)</td>
<td>34.0% (4.3%)</td>
</tr>
</tbody>
</table>

**Reaction Times.** As with the Number Go/No-Go data, the time participants took to respond to trials immediately preceding thought probes was to be analyzed via a 3-way mixed factors ANOVA with block length and mental state as within-subjects variables, and group as the between-subjects variable. The dependent variable was the median reaction time obtained from the last four trials before thought probes. Median reaction times for each group and mental state can be found in Table 7. As was found with the Number task, not all participants experienced each mental state at each block length leading to a reduced sample size for within-condition comparisons (n = 40), so block
length was collapsed and a 2-way mixed factors ANOVA was used to analyze the data (n = 62). Results showed that there was a main effect of mental state, $F(2, 120) = 3.00$, MSe = 3924.94, $p = .05$, but no main effect of group, $F(1, 60) = 1.61$, MSe = 31723.36, $p = .21$. In addition, there was no interaction between mental state and group, $F(2, 120) = .69$, MSe = 3924.94, $p = .51$.

Table 7

Median (SE) Reaction Times (msec) for the Four Trials Preceding Thought Probe Responses in the Word Go/No-Go Task

<table>
<thead>
<tr>
<th>Group</th>
<th>Mental State</th>
<th>Meditation</th>
<th>Listening</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Short Blocks</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>On Task</td>
<td>446.09 (20.20)</td>
<td>443.94 (22.34)</td>
<td></td>
</tr>
<tr>
<td>Tune Outs</td>
<td>468.55 (27.41)</td>
<td>455.56 (30.30)</td>
<td></td>
</tr>
<tr>
<td>Zone Outs</td>
<td>444.05 (20.02)</td>
<td>443.97 (22.14)</td>
<td></td>
</tr>
<tr>
<td><strong>Long Blocks</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>On Task</td>
<td>470.21 (24.18)</td>
<td>480.92 (26.73)</td>
<td></td>
</tr>
<tr>
<td>Tune Outs</td>
<td>463.68 (22.96)</td>
<td>461.72 (25.38)</td>
<td></td>
</tr>
<tr>
<td>Zone Outs</td>
<td>431.75 (20.17)</td>
<td>444.28 (22.30)</td>
<td></td>
</tr>
</tbody>
</table>

To further understand the main effect of mental state, paired samples t-tests collapsed across group with a Bonferroni corrected alpha of .016 were conducted. The results showed that participants responded about as quickly before on-task reports as they did before tune outs, $t(69) = .55$, $p = .58$, but took significantly longer before on-task reports than zone outs, $t(65) = 2.17$, one-tailed $p = .015$, as predicted. There was also a
trend in line with the hypothesis that participants would take longer to respond before tune outs than zone outs, \( t(64) = 1.33 \), one-tailed \( p = .09 \). Unlike the Number Go/No-Go task, these findings are in accord with this study’s predictions and the results from Smallwood et al. (2007b).

**Accuracy.** Errors of omission were measured by comparing the percentage of key presses in response to non-targets, the absence of which reflects an error of omission. A 2-way mixed factors ANOVA with block length as the within-subjects variable and group as the between-subjects variable was used. Mean percentage key presses in response to non-targets for each group and block length are displayed in Table 8. Data analysis did not reveal any significant main effects for block length, \( F(1, 77) = 1.78, \text{MSe} < .001, p = .19 \), or group, \( F(1, 77) = .02, \text{MSe} = .003, p = .88 \), the latter of which was contrary to the prediction that the Meditation group would make significantly more non-target key presses (or fewer errors of omission) than the Listening group. Lastly, there was no interaction between block length and group, \( F(1, 77) = 1.10, \text{MSe} < .001, p = .30 \).

| Table 8 |

| **Mean (SE) Percentage Key Presses in Response to Non-Targets in the Word Go/No-Go Task** |
|----------------------------------|------------------|------------------|
| **Mental State**                 | **Group**        |                  |
| Short Blocks                     | Meditation       | Listening        |
| 98.9% (.5%)                      | 98.6% (.5%)      |                  |
| Long Blocks                      | 98.5% (.7%)      | 98.6% (.7%)      |
Errors of commission were analyzed by comparing the percentage of key presses in response to targets, which indicates failures in response inhibition. A 2-way mixed factors ANOVA with block length as the within-subjects variable and group as the between-subjects variable was carried out. Mean percentage of key presses following target stimuli for each group and block length can be found in Table 9. The results indicated that there was a main effect of block length, $F(1, 77) = 4.73$, MSe = .002, $p = .03$, such that participants made significantly more errors of commission during short blocks than long blocks, which was unexpected. As with the omission results, there was no main effect of group, $F(1, 77) = .07$, MSe = .02, $p = .80$, contrary to the hypothesis that the Meditation participants would make fewer errors of commission than the Listening participants. Lastly, there was no interaction between block length and group, $F(1, 77) = .08$, MSe = .002, $p = .77$.

Table 9

Mean (SE) Percentage Key Presses in Response to Targets in the Word Go/No-Go Task

<table>
<thead>
<tr>
<th>Mental State</th>
<th>Group</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Meditation</td>
<td>Listening</td>
<td></td>
</tr>
<tr>
<td>Short Blocks</td>
<td>12.3% (1.6%)</td>
<td>12.6% (1.7%)</td>
<td></td>
</tr>
<tr>
<td>Long Blocks</td>
<td>10.6% (1.2%)</td>
<td>11.3% (1.3%)</td>
<td></td>
</tr>
</tbody>
</table>

Word Retrieval Task

To compare the rate of word-stem completion in the word retrieval exclusion task across groups, a 2-way mixed factors ANOVA was applied with word type as the within-subjects variable and group as the between-subjects variable. Accurate recall is
evidenced by lower stem completion rates for previously seen words (old) relative to baseline (new) as participants were told to avoid completing the stems with words shown to them during the Go/No-Go Task. Average word-stem completion rates for old and new words for each group are shown in Table 10. The data analysis did not yield main effects of word type, $F(1, 77) = .25, MSe = .01, p = .62$, or group, $F(1, 77) = .001, MSe = .02, p = .97$, but there was a marginally significant interaction between word type and group, $F(1, 77) = 2.81, MSe < .01, p = .10$, such that the Meditation group completed fewer stems with old words than new words, while the Listening group completed more stems with old relative to new words. These findings suggest that the Meditation participants were slightly better able to recall and thus exclude old words than the Listening group.

Table 10

<table>
<thead>
<tr>
<th>Word Type</th>
<th>Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Meditation</td>
</tr>
<tr>
<td>Old</td>
<td>28.2% (1.6%)</td>
</tr>
<tr>
<td>New</td>
<td>31.1% (1.8%)</td>
</tr>
</tbody>
</table>

Positive Affect and Negative Affect Schedule (PANAS)

The following four subscales obtained from the PANAS (see Appendix B) were compared across groups: a) positive affect (active, alert, attentive, determined, enthusiastic, excited, inspired, interested, proud, and strong), b) negative affect (afraid, scared, nervous, jittery, irritable, hostile, guilty, ashamed, upset, and distressed),
c) attentiveness (alert, attentive, and determined), and d) serenity (calm and relaxed).

Scores for each subscale were calculated by adding the Likert rating responses for each emotion comprising a given subscale. Each subscale was then analyzed using a 2-way mixed factors ANOVA with time (before meditation/listening and after meditation/listening) as the within-subjects variable, and group as the between-subjects variable to determine if meditation/listening changed participants’ affect. Mean subscale scores before and after the meditation intervention or listening task are listed in Table 11.

For positive affect, the results showed a main effect of time, $F(1, 77) = 17.79$, $MSe = 12.74$, $p < .001$, such that, on average, participants experienced a decline in positive affect at Time 2 when compared to Time 1. There was no main effect of group, and there was no significant interaction between time and group, $F(1, 77) = 1.92$, $MSe = 12.74$, $p = .17$.

Table 11  

<table>
<thead>
<tr>
<th>Measure</th>
<th>Meditation Pre</th>
<th>Meditation Post</th>
<th>Listening Pre</th>
<th>Listening Post</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive Affect</td>
<td>25.49 (7.02)</td>
<td>23.88 (7.91)</td>
<td>24.24 (6.85)</td>
<td>21.05 (8.10)</td>
</tr>
<tr>
<td>Negative Affect</td>
<td>13.83 (3.66)</td>
<td>11.85 (2.78)</td>
<td>14.39 (4.06)</td>
<td>12.26 (2.70)</td>
</tr>
<tr>
<td>Attentiveness</td>
<td>8.78 (2.54)</td>
<td>8.63 (2.95)</td>
<td>8.08 (2.62)</td>
<td>6.74 (2.83)</td>
</tr>
<tr>
<td>Serenity</td>
<td>6.29 (1.97)</td>
<td>8.05 (1.50)</td>
<td>7.18 (1.69)</td>
<td>7.00 (2.12)</td>
</tr>
</tbody>
</table>
The data analyses for negative affect also indicated a main effect of time, $F(1, 77) = 50.10$, $MSe = 3.32$, $p < .001$, such that there was a general decrease in negative affect over time. There was no main effect of group, $F(1, 77) = .49$, $MSe = 19.06$, $p = .49$, nor was there an interaction between time and group, $F(1, 77) = .07$, $MSe = 3.32$, $p = .79$.

A main effect of time was similarly found for the attentiveness subscale, $F(1, 77) = 9.05$, $MSe = 2.41$, $p = .004$, reflecting a decrease in attentiveness over time. There was also a main effect of group, $F(1, 77) = 5.29$, $MSe = 12.58$, $p = .02$, such that the Meditation group reported being more attentive overall. Lastly, a significant time by group interaction was found, $F(1, 77) = 5.84$, $MSe = 2.41$, $p = .02$. To examine this interaction, independent samples t-tests were analyzed for both time points. At Time 1, group membership did not appear to affect one’s level of attentiveness, $t(77) = -1.21$, $p = .23$, but at Time 2, the Meditation group was significantly more attentive than the Listening group, $t(77) = -2.92$, $p < .01$, due to the Listening group becoming less attentive over time. It is possible then that the meditation training protected against the reduction in attentiveness that the Listening group experienced.

For the serenity subscale, results showed that there was a main effect of time, $F(1, 77) = 14.70$, $MSe = 1.66$, $p < .001$, wherein participants were generally calmer at Time 2 than at Time 1. There was no main effect of group, $F(1, 77) = .05$, $MSe = 5.05$, $p = .83$, but there was a significant interaction between time and group, $F(1, 77) = 22.40$, $MSe = 1.66$, $p < .001$. Follow-up independent samples t-tests revealed that the Listening group was significantly calmer at Time 1 than the Meditation group, $t(77) = 2.15$, $p = .03$, but, at Time 2, the Meditation group was significantly calmer than the Listening group, $t(77)$.
These findings provide support for the hypothesis that the meditation training may have led to an increase in feelings of calmness.

**Manipulation Checks**

Chi-square tests for independence were conducted comparing the frequency of responses to the two yes/no questions that were used to assess participants’ focus during the Listening and Meditation tasks (i.e., ‘Did you fall asleep during the audio recording?’ and ‘Did you feel that you were truly concentrating on ‘The Hobbit’ [or meditating]?’) to determine if there were any group differences. The number of participants who answered yes or no to each question can be found in Table 12. The results did not show a group difference in the number of people who fell asleep during the meditation/listening task, $\chi^2(1, N = 78) = .01, p = .91$. However, there was a marginally significant trend in which more Listening participants reported feeling they were truly concentrating than the number of Meditation participants who felt they were truly meditating, $\chi^2 (1, N = 78) = 3.24, p = .07$.

Further independent samples t-tests were carried out to compare the amount of effort participants in the two groups put into listening to their assigned audio recording and to examine the extent to which they endorsed the occurrence of different experiences, such as impartially observing their thoughts or feeling their heart rate slow down (see Appendix C), during their audio recording. Mean rating scores for effort (on a scale of 1 to 10) and for each experiential measure (scale of 1-5) are displayed in Table 13.

Both groups reported the same amount of effort when questioned after the tasks on Day 2, $t(77) = .181, p = .857$. Results also indicated that the Meditation group reported significantly more feelings of gratitude/contentment, $t(77) = -3.60$, one-tailed $p$
Table 12

*Number of Participants in each Group Responding Yes or No to Manipulation Checks*

<table>
<thead>
<tr>
<th>Manipulation Checks</th>
<th>Meditation*</th>
<th>Listening</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall Asleep</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>No</td>
<td>32</td>
<td>30</td>
</tr>
<tr>
<td>Truly Meditating/Concentrating</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>13</td>
<td>20</td>
</tr>
<tr>
<td>No</td>
<td>27</td>
<td>18</td>
</tr>
</tbody>
</table>

* One Meditation participant did not respond to the question about falling asleep, and another Meditation participant did not respond to the question about truly meditating.

< .001, awareness of slowed breathing, $t(77) = -2.05$, one-tailed $p = .02$, and awareness of body sensations and responses, $t(77) = -3.79$, one-tailed $p < .001$, than the Listening group. Further, the Meditation group observed marginally more positive thoughts and emotions [$t(77) = -1.28$, one-tailed $p = .10$], clear perceptions [$t(77) = -1.35$, one-tailed $p = .09$], and a sense of one’s body feeling heavier [$t(77) = -1.43$, one-tailed $p = .08$] than the Listening group. No other group-based differences were found (all $t$’s $< 1.24$, all $ps > .11$). In sum, the Meditation participants recorded higher Likert ratings on several of the manipulation checks, indicating greater awareness of one’s self and one’s thoughts than the Listening participants.
Table 13

*Mean (SE) Group Scores in Response to Manipulation Check Questions*

<table>
<thead>
<tr>
<th>Mental State</th>
<th>Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Meditation</td>
</tr>
<tr>
<td>Effort</td>
<td>5.68 (.28)</td>
</tr>
<tr>
<td>Observed positive thoughts/emotions</td>
<td>2.98 (.15)</td>
</tr>
<tr>
<td>Observed negative thoughts/emotions</td>
<td>2.56 (.18)</td>
</tr>
<tr>
<td>Impartial observer of thoughts</td>
<td>2.27 (.15)</td>
</tr>
<tr>
<td>Felt gratitude/contentment</td>
<td>3.02 (.18)</td>
</tr>
<tr>
<td>Let thoughts go</td>
<td>2.68 (.19)</td>
</tr>
<tr>
<td>Mind alert but still</td>
<td>2.80 (.17)</td>
</tr>
<tr>
<td>Perceptions clearer</td>
<td>2.78 (.16)</td>
</tr>
<tr>
<td>Better mental focus</td>
<td>2.73 (.18)</td>
</tr>
<tr>
<td>Able to think clearly</td>
<td>2.73 (.17)</td>
</tr>
<tr>
<td>Breathing slowed</td>
<td>3.44 (.20)</td>
</tr>
<tr>
<td>Body felt heavy</td>
<td>3.12 (.18)</td>
</tr>
<tr>
<td>Heart rate slowed</td>
<td>2.95 (.18)</td>
</tr>
<tr>
<td>Body felt soft/loose</td>
<td>2.88 (.15)</td>
</tr>
<tr>
<td>Sense of physical wellbeing</td>
<td>2.88 (.17)</td>
</tr>
<tr>
<td>Aware of body sensations</td>
<td>3.34 (.16)</td>
</tr>
<tr>
<td>Fewer stress symptoms</td>
<td>3.15 (.15)</td>
</tr>
</tbody>
</table>
Lastly, the four short comprehension questions about the Hobbit story that the Focused Listening participants were given were not analyzed as most participants had difficulty remembering the answers to the questions.
DISCUSSION

The current study was designed to investigate two major questions: can mindfulness meditation influence the rate at which one’s mind wanders, and can two training sessions of mindfulness meditation impact sustained attention or inhibition? Participants were randomly assigned to groups where they either listened to and followed a mindfulness meditation recording, or listened to and concentrated on an excerpt from The Hobbit over the course of two days. A different continuous performance test was administered each day to assess both sustained attention and inhibition. Thought probes within each test measured the frequency of mind wandering and whether or not participants were mind wandering with or without awareness. A subsequent word retrieval task provided another measure of attention as participants were instructed to recall words they had seen during the continuous performance task, and refrain from using old words to complete word-stems. Data analyses revealed that there were no group differences when comparing sustained attention and response inhibition performance and the frequency of mind wandering on either day. Results from the word retrieval task yielded a marginally significant group difference whereby Meditation participants were better able to recall old words than Listening participants. A breakdown of the major findings and implications of each are described below.

Mind Wandering

There were no group differences for the frequency of self-reported mind wandering on the first day (Number Go/No-Go task), indicating that the two groups did not differ in how frequently they mind wandered. However, there were also no group differences on the second Day (Word Go/No-Go task), contrary to expectations that the
meditation intervention would lead to decreased zoning out and therefore less mind wandering in the Meditation group than the Listening group. It is feasible that only two sessions of meditation training was insufficient to significantly decrease mind wandering, and that more extensive training is necessary to lower the rate at which one’s mind wanders. This point will be discussed in further detail below.

On both days, participants reported about the same amount of mind wandering (55% with tune outs and zone outs combined) during short blocks, and more on-task reports than zone outs during short blocks, in agreement with prior research (Smallwood et al., 2007a). In contrast, participants’ reports differed between the two days when long blocks were considered. Throughout the long blocks in the Number Go/No-Go task (Day 1), participants indicated that they tuned out more than they stayed on task, tuned out more than they zoned out, and zoned out more than they stayed on task. However, no differences in the frequency of each mental state emerged during long blocks in the Word Go/No-Go task (Day 2). This appears to be primarily due to a smaller drop in the frequency of on-task responses during long blocks compared to short blocks, combined with a smaller increase in the frequency of tune outs during long blocks when compared to short blocks in the Word Go/No-Go task relative to the Number task. Considering that participants reported more overall mind wandering (tune outs plus zone outs) during long blocks in the Number Go/No-Go task (75%) than the Word Go/No-Go task (65%), it is possible that the word stimuli led to more engagement with the task than the single digits present during the Number task, thus keeping participants “on-task” more.

Reaction times in response to trials immediately preceding thought probes did not differ significantly by mental state prior to the meditation/listening intervention in the
Number Go/No-Go task (Day 1), contrary to Smallwood et al.’s (2007b) finding that reaction times are slower before tune outs and on-task responses than zone outs. However, in line with expectations, reaction times corresponding to on-task reports were significantly longer than zone outs in the Word Go/No-Go task (Day 2), suggesting that participants were responding more automatically to stimuli preceding zone outs as compared to on-task reports, in accord with Smallwood et al.’s (2007b) results. Further, reaction times corresponding to tune outs were longer than zone outs in the Word Go/No-Go task, also in agreement with this study’s predictions. This difference across tasks is unlikely due to the meditation intervention as there was no reason to expect that meditation would influence reaction times in response to stimuli. It is thus unclear why the reaction time data would mimic Smallwood et al.’s (2007b) findings in the Word Go/No-Go task but not the Number Go/No-Go task. One possible explanation is that participants were not fully accustomed to recognizing their mental state when queried by the thought probes during the Number Go/No-Go task as it was administered on Day 1, and thus their self-reported mental states did not necessarily coincide with their true mental state. As such, reaction times corresponding to a participant’s self-reported mental state might not accurately reflect his/her actual mental state. This idea seems plausible as other studies that have found longer reaction times associated with on-task reports and tune outs compared to zone outs have consisted of tasks lasting twice as long (40 minutes; Smallwood et al., 2007a) as the current one. It is also possible that the stimulus type used in each task influenced reaction times, considering that prior research examining reaction times associated with mental states have only included word stimuli (Smallwood et al., 2007b). As such, supporting results may not have been found in this
study on the first day because the task made use of numerical stimuli only. It could be
that participants do not need to pay as much attention in order to process single digits as
five-letter words, and thus when they were “on-task” during the Number Go/No-Go task,
they were not investing as many attentional resources as when they were “on-task”
during the Word Go/No-Go task. This would imply that participants respond more
automatically to numerical stimuli, which would be reflected in faster reaction times
overall when compared to reaction times in response to word stimuli. In line with such
reasoning, participants were in fact faster in this study when responding to non-targets in
the Number Go/No-Go task than the Word Go/No-Go task for both short and long
blocks.

**Sustained Attention**

Errors of omission were analyzed in order to compare sustained attention across
groups, and no group differences were found before the meditation/listening intervention
during the Number Go/No-Go task on Day 1, as was expected. Furthermore, no group
differences were found after the meditation/listening intervention during the Word
Go/No-Go task (Day 2), indicating that the meditation intervention did not lead to an
increase in sustained attention. As with the mind wandering data, it is possible that the
two sessions of meditation training were not adequate enough to improve the Meditation
participants’ ability to sustain attention, and that further training could have led to
increased performance. This notion is supported by prior research that has found long-
term mindfulness meditators to be better at sustaining their attention than short-term
mindfulness meditators (Lutz et al., 2009; Valentine & Sweet, 1999).
It should also be noted that the number of key presses in response to non-targets (the lack of which indicates an error of omission) was very high across groups for both days. This pattern indicates a ceiling effect that makes it difficult to determine whether there were any real differences in sustained attention ability across groups. It is possible that a more demanding task could have led to more performance errors which would allow noticeable group differences to appear if they existed.

Attention was also measured through performance on the word retrieval exclusion task, and the Meditation group was found to exhibit greater memory for previously seen words than the Listening group, as evidenced through a lower word-stem completion rate for old words compared to new words. Put another way, the results from this test suggest that the Meditation participants were somewhat better able to attend to and encode the word stimuli than the Listening participants. However, these results seem to contradict the lack of a group difference in the omission error rate. It is possible that the word retrieval task was tapping into a greater level of attentional engagement in terms of processing individual stimuli in the Word Go/No-Go task, while omission errors simply measured the degree to which participants were able to maintain vigilance over time. Such a distinction could mean that the meditation intervention had some effect on deeper aspects of attentional processing. Supporting this notion was the finding that the meditation intervention appeared to protect against the reduction in attentiveness that the Listening group experienced as reflected by the PANAS data.
Inhibition

Errors of commission were measured to compare response inhibition across groups, and, as predicted, no group differences were found on Day 1 (Number Go/No-Go task) before the meditation/listening intervention. Contrary to predictions, but in agreement with the omission error data, there were no group differences on Day 2 (Word Go/No-Go task) either, indicating that the meditation intervention did not improve response inhibition in the Meditation group. Unlike the omission error data, there were no concerns regarding ceiling effects with commission error rates, suggesting that sustained attention (as measured through errors of omission) might not have shown improvement even in the absence of a ceiling effect. It is important to note as well that the percentage of commission errors in this study were in accord with previous research that has found participants demonstrate failures in response inhibition for approximately 12% of target stimuli (Smallwood et al., 2007b).

Interestingly, participants made significantly more commission errors during short blocks than long blocks on the Word Go/No-Go task, indicating that, regardless of experimental condition, participants were less able to inhibit their responses during short blocks when compared to long blocks. Previous research has shown that increased target probability can lead to increased response inhibition (Smallwood et al., 2007b), but targets appeared 20% of the time for both block lengths, effectively ruling that out as a potential explanation. Further, the order of block lengths was randomly determined so even if participants improved over time, their response inhibition should not vary according to block length due to practice effects. Moreover, target probability was constant and block length order was randomized in the Number Go/No-Go task as well,
but block length did not affect the commission error rate in the Number Go/No-Go task. It is therefore unclear why response inhibition differed as a function of block length during the Word Go/No-Go task.

Affect

The PANAS data revealed that the participants experienced a decline in both positive and negative affect over time, regardless of experimental condition. There were no group differences for either positive or negative affect, failing to support results from prior studies indicating that meditation training leads to an increase in positive affect (Baer, 2003; Chambers et al., 2008) and a decrease in negative affect (Baer, 2003; Chambers et al., 2008). However, the Meditation group was found to be calmer at Time 2 than the Listening group, as predicted.

Effectiveness of the Meditation Intervention

The two sessions of mindfulness meditation training appeared to improve participants’ ability to attend to and encode stimuli as seen through results on the word retrieval task, and help protect participants from a decline in self-reported attentiveness over time as per the PANAS data. The PANAS findings also revealed that participants were calmer over time when compared to the Listening group in line with expectations. However, this study suggests that the meditation training may not have been sufficient to improve attentional performance, at least in the form of sustained attention or response inhibition, as measured by omission and commission errors, respectively. The PANAS data also indicated that the Meditation participants did not experience an increase in positive affect or a decrease in negative affect, contrary to predictions and prior research (Baer, 2003; Chambers et al., 2008).
As for the manipulation checks, the Meditation group experienced more feelings of gratitude and contentment, slowed breathing, clear perceptions, had a greater awareness of both body sensations/responses and a feeling that their body was heavier, and were better able to observe positive thoughts and emotions. However, the Listening group reported more impartial observation of thoughts, and no group differences were found on the other nine experiential measures, contrary to expectations. It is possible that group differences were not found on the other measures, or for performance on the Go/No-Go tasks, because the Meditation participants were not sufficiently experienced with meditation and thus were not yet able to notice increased mental focus, or a sense of physical wellbeing, for example. Supporting this idea is the fact that the majority of the Meditation participants admitted feeling that they were not truly meditating, while Listening participants were more evenly split over whether they felt they were truly concentrating or not.

**Limitations and Future Directions**

The current study showed that two days of mindfulness meditation training had some effect on participants, but not in the form of improvements in attentional performance. It is possible that two sessions are simply not adequate to provide participants with the ability to be more vigilant over time or more able to withhold a response when necessary; instead, more training sessions may be needed to enhance performance on a Go/No-Go task. This idea seems plausible as prior research has shown that individuals who have had four sessions of mindfulness meditation training are better at sustaining their attention than a non-meditating control group (Zeidan et al., 2010). Similarly, it has been found that three sessions of mindfulness meditation training can
improve one’s ability to inhibit a response (Wenk-Sormaz, 2005), and so it could be the case that an additional session or two may be sufficient to provide an individual with the skills necessary to increase sustained attention and response inhibition. Given these considerations, it would be valuable for future studies to focus on training participants over the course of three sessions or more to examine whether there any improvements in sustained attention, response inhibition, and mind wandering frequency.

Alternatively, two sessions of training might be sufficient if participants are more fully engaged in the meditation intervention and report feeling like they are truly meditating. In the current study, both groups invested a similar amount of effort in following their audio-recording, but this level was around the midpoint of the rating scale (approximately ’5’ on a scale of 1-10), and thus did not reflect a high degree of engagement with either the Meditation or Listening intervention. Since participants were left alone while their audio-recording was playing, it is feasible that they might not have been compelled to expend much effort following along with it because they did not feel they were being actively monitored and needed to take the task seriously. Previous studies addressing the effects of short-term meditation on attention have involved an experienced mindfulness meditation facilitator who leads the training (Wenk-Sormaz, 2005; Zeidan et al., 2010), and thus it might help in future studies to make participants more aware of the experimenter’s presence or to discover other ways to ensure they are more fully engaged in the meditation/listening intervention.

It could also be the case that the continuous performance tasks used in this study were simply too short, and while they were sufficient for inducing mind wandering, participants may not have been disengaged enough to hurt their performance accuracy.
Longer tasks have been shown to produce more errors in response inhibition than shorter tasks (Manly et al., 1999), and thus utilizing a longer continuous performance task might better reveal group differences if the short-term meditation training is having any effect. Similarly, longer blocks within each task, such as those used in Smallwood et al. (2007b; 60 and 90 seconds), might induce a decrease in sustained attention and help eliminate the ceiling effects found in this study. Prior research has also shown that mind wandering increases as block length gets longer when using three different block lengths (Smallwood et al., 2007a), and that increased mind wandering is associated with more performance errors in both sustained attention (Christoff et al., 2009) and response inhibition (Smallwood et al., 2004). Taking these findings into account, employing a greater variation in block length (i.e., 3 different block lengths) could provide another means of increasing performance errors thus making it easier to observe group differences.

An additional weakness of the current study is that limited statistical power may have decreased the ability to identify significant effects of mindfulness meditation. This point is particularly relevant when considering the reaction time data associated with each mental state, as so few data points made it impossible to separate the data by block length to infer useful conclusions. As such, the reaction time data had to be collapsed across block length for both the Number Go/No-Go task and the Word Go/No-Go task, which yielded differing results from one another and from those of Smallwood et al. (2007b). Perhaps more importantly though, an examination of the means in Table 6 show the Meditation group indicated a higher level of on-task responses relative to the Listening group, along with fewer reports of both tune outs and zone outs. It is therefore possible
that larger sample sizes in each group may have yielded significant results following the meditation intervention. Thus taking statistical power into consideration, future studies might consider including more subjects so as to increase power. In addition, increasing effect sizes by improving the strength of the mindfulness meditation manipulation (as discussed above in this section) could further increase the power of the study.

In sum, future studies might benefit from including more participants and using more than two sessions of meditation training or increasing the level of effort that participants invest into that training in order to adequately reflect any effects of meditation on attentional performance. In addition, using a Go/No-Go task with longer and more varied block lengths, or that is a longer duration overall (i.e., more trials) would likely induce more mind wandering and decrease participants’ performance, which could subsequently allow any group differences as a result of the Meditation intervention, assuming they exist, to be more readily observable.
REFERENCES


Appendix A:
General Questionnaire

1. What is your gender (circle one)?  F   M
2. How old are you? ________
3. What is your race? ____________________________
4. How often does your mind wander in a given day (circle one)?
   
<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
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<th>5</th>
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<tbody>
<tr>
<td>very slightly or not at all</td>
<td>a little</td>
<td>moderately</td>
<td>quite a bit</td>
<td>extremely often</td>
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</table>

5. Do you meditate currently (circle one)?  Yes  No
   
   If YES:
   1. What type of meditation do you practice? ___________________________
   2. How often do you practice per week? ___________________________
   3. How long have you been practicing? ___________________________
   
   If NO:
   Have you ever meditated in the past (circle one)?  Yes  No
   
   If YES:
   Did you practice meditation regularly or only a few times?
   ___________________________

   • If you tried meditation only a few times, please answer the following:
     1. What type of meditation did you try? ___________________________
     2. How many times did you try meditation? ___________________

   • If you practiced meditation regularly, please answer the following:
     1. What type of meditation did you practice? ___________________________
     2. How often did you practice per week? ___________________
     3. How long did you practice meditation? ___________________
**Appendix B:**
Positive Affect Negative Affect Schedule (PANAS)

This scale consists of a number of words that describe different feelings and emotions. Read each item and then mark the appropriate answer in the space next to that word. Indicate to what extent you feel this way **right now**, that is, at the present moment. Use the following scale to record your answers.

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<tbody>
<tr>
<td>very slightly or not</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>or not at all</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

____ interested       ___ attentive
____ distressed       ___ jittery
____ excited         ___ active
____ upset           ___ afraid
____ strong          ___ calm
____ guilty          ___ relaxed
____ disappointed    ___ curious
____ scared          ___ blue
____ hostile         ___ amused
____ enthusiastic    ___ angry
____ proud           ___ discouraged
____ irritable       ___ anxious
____ alert           ___ content
____ ashamed         ___ disgusted
____ inspired        ___ happy
____ nervous         ___ relieved
____ determined      ___ sad
____ depressed       ___ surprised
____ satisfied       ___ tired
Appendix C: Manipulation Checks

**Meditation**

1. Did you fall asleep during the audio recording (circle one)? Yes No

2. On a scale of 1 to 10, with 1 being very little and 10 being a great deal, how much effort did you put into following the audio recording? __________

3. Did you feel that you were truly meditating (circle one)? Yes No

On a scale of 1-5, please indicate to what extent you experienced each of the following when listening to the audio recording earlier in the testing session:

1
very slightly 2 a little 3 somewhat 4 quite a bit 5 extremely
or not at all often

1. I observed, without judgment, any positive thoughts or emotions that arose. ______

2. I observed, without judgment, any negative thoughts or emotions that arose. ______

3. I observed my thoughts as an impartial observer. ______

4. I experienced feelings of gratitude and/or contentment. ______

5. I was able to let my thoughts go and not get caught up in them. ______

6. My mind was alert but still. ______

7. My perceptions were clearer. ______

8. I had better mental focus and concentration. ______

9. I was able to think more clearly. ______

10. I felt my breathing slow down. ______

11. I felt my body become heavy. ______
12. I felt my heart rate slow down. ______

13. My body became soft and loose. ______

14. I felt a sense of physical wellbeing. ______

15. I was more aware of body sensations and responses. ______

16. I experienced fewer physical symptoms of stress. ______

**Concentration**

1. Did you fall asleep during the audio recording (circle one)?     Yes     No

2. On a scale of 1 to 10, with 1 being very little and 10 being a great deal, how much effort did you put into following the audio recording? __________

3. Did you feel that you were truly concentrating on ‘The Hobbit’ (circle one)?

   Yes      No

On a scale of 1-5, please indicate to what degree you experienced each of the following when listening to the audio recording earlier in the testing session:

1. I observed, without judgment, any positive thoughts or emotions that arose.  
   ______

2. I observed, without judgment, any negative thoughts or emotions that arose.  
   ______

3. I observed my thoughts as an impartial observer. ______

4. I experienced feelings of gratitude and/or contentment. ______

5. I was able to let my thoughts go and not get caught up in them. ______

6. My mind was alert but still. ______
7. My perceptions were clearer. ______
8. I had better mental focus and concentration. ______
9. I was able to think more clearly. ______
10. I felt my breathing slow down. ______
11. I felt my body become heavy. ______
12. I felt my heart rate slow down. ______
13. My body became soft and loose. ______
14. I felt a sense of physical wellbeing. ______
15. I was more aware of body sensations and responses. ______
16. I experienced fewer physical symptoms of stress. ______

Comprehension Questions

• What makes the secret entrance into the lonely mountain? ___________________
• What does Gandalf give Thorin from his father? ___________________
• Is Bilbo early, late, or on time for his meeting with the dwarves when they embark on their adventure? ___________________
• What does daylight do to the trolls? ___________________
Appendix D: Thought Probe

Were you just mind wandering?

Press ‘T’ if you were tuning out, or mind wandering with awareness. Press ‘Z’ if you were zoning out, or mind wandering without awareness. Press ‘O’ if you were NOT mind wandering.

Please respond by pressing the appropriate key to continue with more trials.

Instructions Given to Participants (Adapted from Smallwood et al., 2007):

At various times during this experiment, you will be asked whether you are focused on the task or are aware of other things than just the task. For example, you may find that you are reading the text and you begin to think about something that is unrelated to what you are reading – this is what we have termed ‘mind-wandering.’ There are two types of mind-wandering:

Tune-outs refer to when your mind wanders and you are aware of it. For example, you become aware that your mind has drifted off to think about things other than what you are reading, but you still continue to read.

Zone-outs refer to when your mind wanders and you do not realize that your thoughts have drifted away until you catch yourself. For example, you were reading but then you suddenly realize that you have been thinking about something else and have not been reading after all.
### Appendix E:
Jacob’y’s (1998) Completion Stems

<table>
<thead>
<tr>
<th>act - actor</th>
<th>fai - faith</th>
<th>ran - ranch</th>
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</thead>
<tbody>
<tr>
<td>ali - alien</td>
<td>fau - fault</td>
<td>reb - rebel</td>
</tr>
<tr>
<td>ang - angle</td>
<td>fli - flick</td>
<td>riv - rebel</td>
</tr>
<tr>
<td>arg - argue</td>
<td>for - forge</td>
<td>roa - roach</td>
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<tr>
<td>arr - arrow</td>
<td>fre - freak</td>
<td>rou - route</td>
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<tr>
<td>bat - batch</td>
<td>fro - frost</td>
<td>sau - sauce</td>
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<tr>
<td>ber - berry</td>
<td>gla - glaze</td>
<td>ser - serve</td>
</tr>
<tr>
<td>bir - birch</td>
<td>gli - glide</td>
<td>shi - shift</td>
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<tr>
<td>bla - black</td>
<td>glo - glory</td>
<td>sku - skunk</td>
</tr>
<tr>
<td>bli - blind</td>
<td>goo - goose</td>
<td>slu - lump</td>
</tr>
<tr>
<td>blo - block</td>
<td>gri - grind</td>
<td>sme - small</td>
</tr>
<tr>
<td>boa - boast</td>
<td>gui - guide</td>
<td>sna - snack</td>
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<tr>
<td>bre - breed</td>
<td>gul - gully</td>
<td>spo - spoke</td>
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<tr>
<td>bri - bride</td>
<td>hat - hatch</td>
<td>squ - squaw</td>
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<tr>
<td>bro - broke</td>
<td>hav - haven</td>
<td>sta - stand</td>
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<tr>
<td>bud - buddy</td>
<td>hea - heavy</td>
<td>sti - stick</td>
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<tr>
<td>bul - bully</td>
<td>hon - honey</td>
<td>stu - study</td>
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<td>cab - cabin</td>
<td>hor - horse</td>
<td>swa - swamp</td>
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<tr>
<td>cam - camel</td>
<td>hou - house</td>
<td>swi - swing</td>
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<tr>
<td>cau - cause</td>
<td>hum - human</td>
<td>tal - tally</td>
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<td>cho - choke</td>
<td>inl - inlet</td>
<td>thi - thick</td>
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<td>chu - chunk</td>
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<td>cla - clamp</td>
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<td>tra - tramp</td>
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<td>cle - clerk</td>
<td>kno - knock</td>
<td>tre - treat</td>
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<td>cli - click</td>
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<td>clo - cloth</td>
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<td>clu - clump</td>
<td>lev - level</td>
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<td>wri - write</td>
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<td>div - diver</td>
<td>pan - panic</td>
<td>yea - yeast</td>
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<td>dou - doubt</td>
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<tr>
<td>dre - dream</td>
<td>per - perch</td>
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Aasha I. Hoogland  
Curriculum Vitae

**EDUCATION**

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<tr>
<td>2011-</td>
<td>University of Kentucky</td>
<td>Lexington, KY</td>
<td>Ph.D. in Gerontology</td>
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<tr>
<td>2009-2011</td>
<td>Wake Forest University</td>
<td>Winston-Salem, NC</td>
<td>M.A. in Psychology</td>
<td>Expected graduation in Fall 2011</td>
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<tr>
<td>2007-2008</td>
<td>Georgia State University</td>
<td>Atlanta, GA</td>
<td>B.A. in Psychology</td>
<td>Magna Cum Laude, Overall UGPA: 3.82</td>
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<tr>
<td>2004-2006</td>
<td>Florida International University</td>
<td>Miami, FL</td>
<td></td>
<td>Honors College member, Assistant Editor of the FIU Alumni Newsletter</td>
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**GRADUATE RESEARCH EXPERIENCE**

<table>
<thead>
<tr>
<th>Year</th>
<th>Institution</th>
<th>Details</th>
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</table>
| 2011 | Wake Forest University| Advisor: Janine Jennings, Ph.D.  
Project (Thesis): Mindfulness Meditation and Mind Wandering.  
- Managed a team of five undergraduate assistants.  
- Programmed two stop signal tasks, one word retrieval task, and all analysis programs via E-Prime software.  
- Study design examined the effects of mindfulness meditation vs. focused listening on mind wandering, sustained attention, and response inhibition. |
| 2010 | Wake Forest University| Advisor: Janine Jennings, Ph.D.  
Major Area Paper (MAP): The Effects of Meditation on Attention: A Review.  
- Reviewed by three tenured psychology professors.  
- Passed with no revisions necessary before official departmental submission.  
- Led to thesis proposal which was passed with no revisions. |

January 2010-Present  
Wake Forest University  
Research Coordinator  
Advisor: Janine Jennings, Ph.D.  
**Project:** Determine the effects of time of day on attention and memory in older adults.  
- Manage and train two undergraduate assistants (one each semester).  

- Recruit older adults via phone screening.
- Administer the Morningness/Eveningness Inventory (MEQ), Mini-Mental Status Exam (MMSE), ANT (Attention Network Task), Nback, Trails, and Stroop tasks to participants.
- Data entry and analysis via SPSS, E-Prime, and Microsoft Excel.

2009-2010 Wake Forest University

Research Assistant
Advisor: Janine Jennings, Ph.D.

Project: Examine the effects of a high-nitrate diet on blood flow in the brain and on cognitive functioning in older adults.
- Recruited older adults via phone screening.
- Collected data by administering the CVLT (California Verbal Learning Task), Digit Substitution Task, SOPT (Self Ordered Pointing Task), and Flanker Task to older adults.

2009-2010 Wake Forest University

Research Assistant
Advisor: Christy Buchanan, Ph.D.

Project: A focus group study assessing attitudes and motivations regarding civic engagement requirements in various middle schools in the Piedmont Triad region of North Carolina.
- Qualitatively coded textual responses to pre-determined questions to determine students’ attitudes about civic engagement.

GRADUATE TEACHING ASSISTANT EXPERIENCE

2009 Wake Forest University
Teaching Assistant
Advisors: Janine Jennings, Ph.D., and Christy Buchanan, Ph.D.
- Cognition: Graded essay portions of exams.
- Effective Parent-Child Relations: Graded essay portions of exams.
Advisors: Heath Greene, Ph.D.
- Introductory Psychology: Proctored exams, and graded Scantron exams via a test scoring machine.

UNDERGRADUATE RESEARCH EXPERIENCE

2008-2009 Emory Medical Center, Emory University
Research Assistant
Advisor: Chaundrissa Smith, Ph.D.

Project: Implement the PPP Parenting Program to assist low-income African American parents with small children who exhibit extreme behavior problems.
- Reformatted and revised protocols for initial assessments and follow-up sessions.
- Crafted pamphlets to be distributed during recruitment efforts.
- Recruited and screened study participants at Children’s Healthcare of Atlanta at Hughes Spalding and Grady Memorial Hospital.

2008-2009  
Cognitive Psychology Lab, Georgia State University

Research Assistant  
Advisor: Heather Kleider, Ph.D.

Project: Explore the effect that physiological arousal has on memory of episodic events.
- Collected pilot data by administering studies to undergraduates utilizing E-Prime software, and briefing and debriefing students.
- Found relevant stimulus videos as needed.
- Conducted literature searches.

Miscellaneous: Bi-weekly assignments for team meetings.
- Completed the CITI Basic/Refresher Human Subjects Protection course
- Read and discussed related research articles.
- Assisted in preparing a poster on the effects of working memory capacity and negative emotionality on police officers’ shoot/don’t shoot decisions.
- Assisted in preparing a poster that explores the perception that African Americans are linked with criminality through looking at participants’ recollection of crime related events for Black and White perpetrators.
- Presented at the 2009 Georgia State University Undergraduate Research Conference.
- Co-authored an undergraduate Honor’s thesis on lie detection titled *Somatic Markers of Lie Detection*.

2008-2009  
Clinical Psychology Lab, Georgia State University

Research Assistant  
Advisor: Lisa Armistead, Ph.D.

Project: Explore the nature of persuasive appeals used on YouTube by motivated voluntary participants in response to political candidate videos posted early on in the primaries.
- Reviewed an accepted thesis proposal.
- Coded textual group interactions for persuasive appeals utilizing NVivo 8 software.
- Read and discussed related research articles.

Project: Examine the impact of maternal history of child sexual abuse on the mother-daughter relationship.
- Completed data entry and data checking.

Miscellaneous: Assigned as needed.
- Completed the CITI Basic/Refresher Human Subjects Research course.
- Conducted literature searches utilizing PsycINFO and Google Scholar.
CLINICAL EXPERIENCE

2008-2009 Clinical Psychology Lab, Georgia State University
Clinical Interviewer
Advisor: Alana Clayton, M.A. (under supervision of Lisa Armistead, Ph.D.)

**Project:** Explore the coping skills and mother-daughter relationship between low income women and their teenage daughters who have experienced sexual abuse.

- Conducted structured interviews with the teenage girls concerning their history of abuse, coping skills, and relationship with the individual members of their social support system.
- Assessed whether or not the participant required additional psychological assistance during debriefing period.

PUBLICATIONS


POSTER PRESENTATIONS

**Anderson, A.**, & Jennings, J. (2010). *The effects of aging and time of day on alerting, orienting, and executive function.* Poster presentation at the 2010 Wake Forest University Psychology Department’s Graduate Student Colloquium; Wake Forest University: NC.


PROFESSIONAL DEVELOPMENT
North Carolina Cognition Group, Annual Meeting ................................. 2010-2011
Mindfulness-Based Stress Reduction Course ........................................ 2010
Applied Suicide Intervention Skills Training (ASIST) Certification ........... 2010
Cognitive Aging, 13th Biennial Conference ........................................... 2010
WFU Psychology Department’s 2009-2010 Colloquium Series ................. 2010
- Submitted written evaluations of prospective candidates for tenure-track
  professor positions in affect/cognition and self/regulation, and
  self/regulation/personality.

ACADEMIC AWARDS
Kentucky Opportunity Fellowship ..................................................... 2011-2012
Summer Research Grant at Wake Forest U ........................................ 2010
William Randolph Hearst Assistantship at Wake Forest U .................... 2010-2011
William Randolph Hearst Minority Scholarship at Wake Forest U .......... 2009-2010
Outstanding Undergraduate Psychology Student (Elizabeth A. Kenny Scholarship
  in Psychology) at Georgia State U ........................................................ 2009
Dean’s List at Georgia State U ............................................................... Spring & Fall, 2008
Faculty Scholar at Georgia State U ....................................................... Spring & Summer, 2007
Florida Medallion Scholar Scholarship ................................................. 2004-2006
Florida International University Presidential Scholarship .................... 2004-2006

PROFESSIONAL MEMBERSHIPS
Gerontological Society of America ..................................................... 2011-
American Psychological Association Student Affiliate .......................... 2007-present
National Society for Collegiate Scholars Member .................................. 2005-present

REFERENCES
Available upon request.