IMPROVING COGNITION IN NORMALLY AGING OLDER ADULTS:
A RANDOMIZED CONTROLLED TRIAL OF MINDFULNESS MEDITATION (SAMATHA) AS A
TREATMENT FOR ATTENTIONAL INHIBITORY DEFICITS

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IMPROVING COGNITION IN NORMALLY AGING OLDER ADULTS:
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Dissertation

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According to Hasher and Zacks's (1988) Inhibitory Deficit Theory (IDT), a decline in the ability to inhibit task-irrelevant information from grabbing one's attention is the underlying cause for age-related differences in cognitive abilities. Unlike some other theories of cognitive aging, IDT provides a leverage point available to older adults for a low-cost, non-pharmaceutical intervention that could prevent or at least slow the decline in cognitive functioning with age: attentional functioning, or more specifically, inhibitory attentional functioning. This study investigated the efficacy of attentional process training in the form of meditation (samatha) on the neuropsychological functioning of cognitively intact older adults. Forty-two community dwelling adults (average age 73 years) participated in a 4-week, randomized wait-list-controlled clinical trial. Compliance with twice-weekly attendance and at-home practice, and a self-evaluation of achievement at the end of the training indicated that older adults can and will learn samatha. Objective efficacy measures consisted of participants' change scores on the Trail Making Test (TMT) and the Reading-with-Distraction Task (RwDT) from pretreatment baseline to assessment after completion of the experimental group's samatha training. The Attention-Related Cognitive Errors Scale (ARCES) and the Everyday Memory Failures Scale (MFS) were used as subjective measures. Improvement on the RwDT was statistically significant ($d = .75$), suggesting that the intervention had a beneficial effect on inhibitory attentional functioning. Improvement on TMT-B ($d = .40$) did not reach statistical significance. Hence the study failed to provide strong evidence that the 4-week intervention could effect improvement in cognitive functioning beyond attention. MFS and ARCES change scores had small, statistically non-significant improvements, indicating that, on average, participants did not perceive improvement in their memory and attentional functioning. Implications for practice and further research and the study's strengths and limitations are discussed.
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The population is aging all the world over, and the rates are higher in developed, industrialized countries (Prentice, 2006). In our own country at the beginning of the 20th century, only 4% of the population was 65 or older. By the end of the century it was 12.3%. By 2050, that age segment will make up more than 20% of the population of the United States (US; Profile of Older Americans, 2010). Dramatic increases in life expectancy are the primary cause worldwide, although in the US and other developed nations, decreasing birth rates also contribute to the increase in the median age. Between 1900 and 2003 in the US, average life expectancy increased from 49.2 to 77.5 years (Shrestha, 2006). Far more people now expect to reach old age. In 2005, a 65-year old man could expect to live to age 82, and a 65-year old woman could expect to live to 85. If they live to be 85 (and if the 2025 mortality rates are the same as those of 2005), the man can expect to live to age 91 and the woman to age 92 (US Census Bureau, 2010). While there are relatively few centenarians, the percentage of the population 100 years old and older is expected to more than quadruple between 2010 and 2050 (US Census Bureau, 2008).

The aging of the population is having a profound effect on society in many ways, in part due to the sheer number of older adults. In 2006 there were approximately 37.2 million people in the US over age 65; by 2050 there will be 88.5 million according to recent projections (US Census Bureau, 2009). As the proportion of the population older than 65 increases, the proportion of the population that is working age (18 to 64) declines. In terms of workers contributing toward the Old-Age, Survivors, and Disability Insurance (providing Social Security benefits), projections are that by the year 2030, when virtually all of the baby boomers (people born between 1946 and 1964) will be retired, each 100 workers will be supporting approximately
47 retirees (Korczyk, 2002). This is in contrast to the ratio in 2000 when 100 workers supported only 29 beneficiaries.

The increasing number of older adults is a cause for concern because advanced age is associated with both physical and cognitive changes which are usually perceived to be declines in comparison to the performance capabilities of younger adults. Some cognitive decline is considered normal cognitive aging. Studies conducted by Okura et al. (2008) and Plassman et al. (2008) have estimated the prevalence of cognitive impairment among older adults in the US as follows: An estimated 64% of adults over the age of 70 have normal cognitive functioning for their age. Of the 36% estimated to be impaired, 13.8% have diagnosable dementia. The remaining 22.2% have a measureable level of cognitive impairment that does not reach the threshold for a diagnosis of dementia, called "cognitive impairment, not dementia" or CINDS. In 2002, the 22.2% estimate translated into 5.4 million people older than 70 with CINDS. It is associated with progression to dementia (10% - 15% per year, compared to 1% to 2.5% for cognitively healthy older adults. CINDS is also associated with increased risk for disability and increased health care costs.

The causes of cognitive changes with age are not fully understood although some contributing factors have been identified. Recent views on the mechanisms underlying age-related declines in cognitive performance fall into two camps. One view is that there are changes in a variety of cognitive processes each with its own mechanisms; the other view is that there is a single underlying mechanism affecting a wide range of tasks and skills (e.g., Kramer & Kray, 2006; Rabbitt & Anderson, 2006). Buckner, Head, and Lustig (2006) claimed that the configuration of observed cognitive changes with advancing age precludes a simple, parsimonious explanation, but Rabbitt and Anderson claimed that the variance among test results associated with age is too small a proportion of the variance in abilities to abandon the parsimonious explanation. There are three main candidates for the general mechanism. One is a decline in processing capacity, proposed by Craik in 1983 (Anderson & Craik, 2000). The second candidate is slowing in the speed of processing with age, an idea strongly associated with Salthouse (1996a). Neither of these two mechanisms appear to provide a leverage point
available to older adults for interventions that could prevent or at least slow the decline. However, the third general mechanism proposed can possibly be affected by actions that older adults can take. Hasher and Zacks (1988) proposed that a decline in the ability to prevent, or inhibit, task-irrelevant information from grabbing one’s attention was the underlying cause for age-related differences in cognitive abilities. Distractors can originate either in the immediate environment or in the person’s own memory. Regardless of the source of the distracting information, older adults are less able than younger adults to inhibit them from pulling attention away from the task at hand, according to this theory.

Given that age-related deficits in the inhibitory processes of attentional functioning are a major cause of cognitive performance differences observed between younger and older adults (Lustig, Hasher & Zacks, 2007), there is the possibility that the capability can be trained and thereby prevent or at least decrement the differences. Conventional approaches for training attention, such as those used in rehabilitation after brain injury, effect performance improvements for the trained task but do not appear to improve attention per se, and do not show transfer effects to other cognitive areas (Michel & Mateer, 2006). Products to improve “brain fitness” have recently become available to consumers and at least one of these claims to be able to improve attentional functioning (Posit Science, n. d.). The products marketed directly to consumers and those used in rehabilitation clinics require computer implementation. Hence, for home use they require not only purchase of the software, but also maintenance of an underlying platform, and the expertise and expense may put them out of reach for some older adults. Only 38% of older adults were online as of December, 2009 (Pew Internet and American Life Project 2009, 2009), Internet usage prevalence has flattened since 2000, and most of those who are not currently online indicate that they have no future plans to ever go online, often citing the recurring costs and past problems with technology as major reasons (Raine et al., 2003).

An alternative to computer-based training of an individual’s attentional functioning that may well be at least as viable is meditation. Briefly, meditation is a process of mental training by which the usual “mental clutter”, the incessant internal dialogue of the mind, is slowed, allowing an awareness untainted by such thoughts to emerge (e.g., Rubia, 2009). It is a practice easy to
learn and challenging to do well. Once adopted by an older adult, the practice could be continued throughout the remaining lifetime (H. H. the Dali Lama, 2003/2004).

Evidence that meditation enhances attention exists in several areas. EEG studies indicate that it increases activation of brain wave frequencies ($\alpha$ and $\theta$) which are associated with increased attention focused on internal events, suggesting increased attentional control; and imaging techniques show greater activation in areas of the brain associated with attention (Cahn & Polich, 2006). Behavioral studies of the effects on attention comparing experienced meditators to people who do not meditate have found: Meditation is associated with improvements of attentional functions and cognitive flexibility (Moore & Malinowski, 2009). Attentional functioning in middle aged meditators ($M=48.5$, $SD = 5$) is superior to that of same aged non-meditators ($M = 50$, $SD = 5.4$) and in fact at the same level as that of younger non-meditators ($M=24.3$, $SD = 2.27$; van Leeuwen, Mueller, & Melloni, 2009). People who have been practicing meditation for more than 24 months have had superior performance on tests of attention compared to that of meditators whose practice began less than 25 months previously (Valentine & Sweet, 1999). Of course, these results found for experienced meditators in comparison to non-meditators may be confounded by baseline effects, that is, pre-existing psychological and biological differences between people who engage in meditation regularly, and those who do not.

There is also a small body of randomized controlled studies of the effects of meditation on attention and attention-related cognition (Alexander, Langer, Newman, Chandler, & Davies, 1989; Chambers, Lo, & Allen, 2008; Jain, Shapiro, Swanick, Roesch, Mills, Bell, et al., 2007; Tang, Ma, Wang, Fan, Feng, Liu, et al., 2007; Wenk-Sormaz, 2005; and others, reviewed below) which indicate that meditation has medium to large effects after training periods which range from just one day to twelve weeks. Of the randomized controlled studies, only one (Alexander et al.) focused on adults older than 65. None of the studies of either brain or behavior directly evaluated meditation as a means of improving the inhibitory functions of attention, although Rubia (2009) interpreted the EEG and neuroimaging evidence to have suggested the inhibition of task-irrelevant processes.
This study, then, seeks to add some of the missing data to the increasing body of knowledge concerning the effect of the meditation form of mental process training, specifically whether it can improve older adults’ ability to inhibit distractors from either the environment or memory from gaining control of attention. Given the centrality of attention to cognitive functioning, the growing number of older adults, and the incidence of cognitive impairment in that age group, a treatment that can delay, slow, or prevent decline will have a wide beneficial impact for all of society by improving their quality of life. Stated succinctly, the research question underlying the study is, What is the impact of mindfulness meditation training on attentional inhibitory deficits of older adults?
CHAPTER II
LITERATURE REVIEW

This chapter reviews the literature relevant to the hypothesis that meditation is a means to improving attentional capabilities in older adults and that improvement in attention will improve general cognitive functioning. The link between improving attention and improving general cognitive performance is provided by the Inhibitory Deficit Theory (Hasher & Zacks, 1988). To date, however, little published research exists regarding ways to improve attention in older adults and the transfer of those effects to other cognitive areas. Outcomes of meditation studies in terms of effects on the brain and cognitive processes suggest that meditation may have potential for improving attention capabilities with older adults.

The literature review has five sections. The first section seeks to convey an understanding of the concept of attention and two related concepts from cognitive psychology, working memory and executive function. The second section introduces the Inhibitory Deficit Theory (IDT) and reviews some of the supporting research. This section thus establishes attentional functioning as an important target of concern in the cognitive functioning of older adults. The third section takes up the question of how one goes about improving that central cognitive function and remediating the deficit identified in IDT; reviewing traditional methods of training and rehabilitating attention. Because these traditional methods fall short, meditation is pursued as a possible avenue to restoration of aging declines in attentional functioning, based on claims that long time meditators have superior cognitive abilities. Hence, the fourth section addresses meditation in its various meanings and some of its methods. In the fifth section the sparse literature on meditation's effects on cognition is reviewed. The chapter concludes with the
rationale for the current study of meditation as an intervention to improve attention in older adults, including specifications of the research hypotheses.

Attention

Attention is a complex and controversial construct (e.g., Cowan et al., 2005), and one of the most researched topics (Raz & Buhle 2006). On the one hand we all know what attention is and use the term confidently in everyday speech. On the other hand, it is difficult to precisely define and describe it. Conceptualizations of attention have been continuously evolving since the 1950s when cognitive scientists began their investigations in this area (Styles, 2006). There is no attempt to review even a small portion of the vast literature on attention; there is only the modest goal of conveying a basic understanding of the concept of attention so that the current study can be comprehended. The definition of attention can, and has, changed in response to new discoveries. William James (1890) offered a now-famous definition:

Every one knows what attention is. It is the taking possession by the mind, in clear and vivid form, of one out of what seem several simultaneously possible objects or trains of thought. Focalization, concentration, of consciousness are of its essence. It implies withdrawal from some things in order to deal effectively with others, and is a condition which has a real opposite in the confused, dazed, scatterbrained state which in French is called distraction, and Zerstreutheit in German.

In 1937, Spearmen, well known for his factor analysis of intelligence tests and subsequent conceptualization of 'g' as the general factor of mental ability, commented that the meanings of attention appeared to be even more anarchic than those of "intelligence" (Scholl, 2001). Scholl's definition of attention ("an extra processing capacity ..." p. 4) 110 years after James's indicated that cognitive psychology's conception had moved beyond the latter's close connection of attention to consciousness. Scholl included not just intentional selection of stimuli, but also acknowledged the possibility of attention automatically selecting and responding to stimuli, such as when one drives a familiar route and at the end cannot recall making the journey.
Currently, attention remains an incompletely understood mental process that is essential to most cognitive processing (Ashcraft, 2006). The formal definition that Ashcraft offered is simply "The mental energy or resource necessary for completing mental processes, believed to be limited in quantity" (p. 565). Cognitive scientists describe it as comprising several functions, and use the term "attention" and the phrase "attentional functions" interchangeably. For example, Lezak, Howieson, and Loring (2004) classified attentional functions as "mental activity variables" (p. 33), along with level of consciousness and activity rate. Attention acts as a catalyst that affects the efficiency of mental processes and is intimately involved in cognitive operations, but does not itself have an exclusive observable outcome. Rather, attentional functions are intertwined with other cognitive functions and maintain the activity of those other functions, taking the role of executive in that attention oversees other mental functions and assures their completion.

Attention can be parsed into several related but different processes that have to do with (a) receptivity to a stimulus (akin to noticing), (b) beginning to process the stimulus, and (c) assuring that the processing is appropriately maintained. This occurs for both stimuli that arise internally (i.e., from memory) and stimuli that originate externally (e.g., the siren of a fire truck). Hence, attention presides over the flow of information and its processing within the cognitive domains of memory, language, perception, judgment, decision making, et cetera.

"Attentional processes facilitate, enhance, or inhibit other cognitive processes" (Cohen, Malloy, Jenkins, & Paul, 2006, p. 573). In describing their selective attention model (SLAM) Phaf, van der Heijden and Husdon (1990) stated, "Attention is the process whereby an abundance of stimuli is ordered and integrated within the framework of current tasks and activities; it integrates ongoing activity and newly arriving information. This integration results in the apparent selection of information" (p. 275).

Attention may be goal-directed or stimulus driven and these two types may interact in either a cooperative or competitive fashion (Kramer & Kray, 2006). Similar to Phaf et al. (1990), Styles (2006) emphasized the role of attention in maintaining coherent behavior, given the sea of stimuli, information from memory, and potential decisions in which the brain would otherwise be awash. Attention enables the person to keep a goal in mind and to make selections accordingly.
Information that is relevant to goal attainment needs to be composed into a response. Information which is irrelevant to the goal, needs to be ignored or inhibited. Without attention, a person's thoughts and behaviors would be scattered and disorderly. Styles identified the limited capacity of attention as instrumental in necessitating choices rather than trying to attend to every stimulus and possibility, or jumping from one line of behavior to another. Attention as a limited resource thus enables the coherence of behavior.

Related Concepts

Closely connected to the concept of attention are those of working memory (WM) and executive function. The former is short term memory (versus long term memory), a temporary holding area of active information so that it can be used or manipulated in real time (e.g., Lucas & Addeo, 2006). WM is often conceptualized as more than mere inert storage. For example, Ashcraft (2006) referred to WM as a "the mental workplace, the conscious attentional system where cognitive effort is expended" (p. 165). Similarly, Cowan et al. (2006) defined it as "the set of mental processes holding limited information in a temporarily accessible state in service of cognition" (p. 42).

Baddely and Hitch proposed the first model of WM in 1974, a model that continues to be influential (Baddely, 2000), though not the only model (Miyake & Shah, 1999). In addition to storage areas, this model postulated "a central executive for attentional control" (Baddeley, p. 83) as one of the three dissociable components of WM. That is, the central executive was conceptualized as wholly a part of WM and was cast as an attentional function. According to Lezak et al. (2004, p. 35), this controller consists of "those capabilities that enable a person to engage successfully in independent, purposive, self-serving behavior." Baddeley equated the central executive to executive control, and Ashcraft (2006) in describing the model defined it as "the mechanism responsible for assessing the attentional needs of the different subsystems [of WM] and furnishing attentional resources to those subsystems" (p. 566). In contrast, McDowd and Hoffman (2008) considered attention and executive function to be one factor. Others also
closely related attention and executive function, for example Carlson et al. (1999) combined the two and studied "executive attention."

In summary, these three concepts - attention, WM, and executive function - are very closely intertwined if not overlapping, and different researchers have parsed the roles and processes in different ways. As a result, there is no agreed-upon division into distinct, isolated functions for each of them. However, for the purposes of this project, one could consider WM primarily as a storage area whose contents are managed by attention; consider attention to be an action or process which entails execution as well as controlling and some types of decision making; and consider that executive function (also called executive or executive controller) controls the action and makes decisions. Attention manages the contents of WM by allowing or inhibiting information access to WM. As in the paragraph citing Styles (2006) above, attention selects information to store in WM that is relevant to goal attainment. Goals exist at different levels of magnitude and time. For example, while driving an immediate goal when one pulls up to a 4-way stop sign is to check for cars to the left. A goal that directs attention when walking in a parking garage might be "to seek safety" if one heard footsteps approaching. A goal that might operate at various levels is "to care for my child's needs." Setting the goal falls into the purview of the controller mentioned above, but whether that control is in the purview of attention or of a distinct executive function is not settled in the literature (e.g., Soto, Hodsoll, Rotshtein, & Humphreys, 2008), nor germane to the purposes of this paper.

Centrality of Attention

Positing that attention is the process whereby an abundance of stimuli is ordered and integrated as per the Phaf et al. (1990) definition above, along with its intertwined relationships to WM and executive function, all point to attention's centrality to higher order cognitive processing. Objective evidence is provided by the strong correlations of measures of working memory and overall measures of intelligence, especially fluid intelligence (e.g., Ashcraft, 2006). More evidence is offered by cases in which some areas of a person's cognitive function are intact but attention is impaired. In such cases, demonstration of the intact areas on neuropsychological tests is difficult
to obtain due to interference from the attention impairment. According to Howieson and Lezak (2002), the impairment causes lack of concentration and inattentiveness. Moreover, mental fatigue quickly sets in with even minimal cognitive exertion. The problem solving ability or concept formation ability (for example) of the intact regions in these cases cannot surface without the help of the missing attentional functions. Hence the true status of those intact areas and the potential for further cognitive function remains hidden.

Similarly, behaviors that some people may attribute to "memory problems" may in fact be impaired attention. Lezak et al. (2004) connected attentional disorder with slowed processing as the cause for a person's difficulty with, for example, misplacing items and being unable to recall what someone has told them. In a typical scenario, an older person arrives at the home of a grown daughter, entering the house with keys in hand. Immediately, the grandchildren eagerly blurt out greetings, invitations, and news. When it is time to return home, the grandparent has no recollection of where the keys were placed or memory that he'd carried an umbrella. Similarly, carefully picking her way down the steps to the basement, an older person cannot recall why the decent was made once she finds herself safely in the basement. The family may interpret these failures as evidence of a memory problem. However, assessment might more reliably point to inability to pay attention to multiple simultaneous stimuli, or indicate an inability to process a stream of information at an adequate rate of speed.

To summarize, attention's centrality to higher order cognitive processing has the effect that impairment in this function can interfere with accurate assessment of other cognitive functions, and may result in misattribution of where the problem lies. In the case of changes in cognitive functioning with age, the Inhibitory Deficit Theory (Hasher, Zacks, & May, 1999), identifies deficits in attentional functioning as the major underlying cause of observed deficits in higher order cognitive functioning. This theory is described in the next section.
Inhibitory Deficit Theory

Cognitive developmental change is an active area of research, especially with regard to the changes that become observable in adults age 60 and older. Researchers are not only interested in what the changes are, but also in the underlying mechanisms causing developmental changes. Inhibitory Deficit Theory (Hasher et al., 1999) offers an explanation for many of the age differences observed in cognitive function between young adults and older adults. As the name of the theory implies, it attributes those changes to deficits in the individual's attentional functioning, specifically a deficit in the ability to inhibit distractions from grabbing attention. Given the centrality of attention to cognition, that is, given that attentional functions are interwoven throughout the rest of the cognitive functions and maintain the activity of the other functions as explained above (Ashcraft, 2006), this theory that targets attention as the locus of the problem has immediate intuitive credibility.

Hasher and Zacks introduced the core ideas of Inhibitory Deficit Theory (IDT) as a new framework in 1988, positioning it to contrast with two other prominent, traditional views of the cause of older adults' cognitive deficits (Hasher & Zacks, 1988; Hasher, Tonev, Lustig, & Zacks, 2001). One perspective, advanced by Salthouse (e.g., 1996b) and others, postulated that aging brings about deficits in the speed of processing of basic cognitive functions, which in turn impact performance of more complex functions. The other perspective was Craik's limited capacity model of cognitive resources which hypothesized that capacity becomes more limited with age (Anderson & Craik, 2000). Hasher and Zacks specifically identified Kahneman's (1973) model of limited attention capacity as the foundation from which their own theory grew. Kahneman speculated that the capacity of attention is flexible in that motivation and increased arousal could increase attentional resources. Alternately, when the person is tired or not interested, fewer resources are allocated to attention. Moment to moment, the allocation policy can change with the circumstances, although there is an upper limit.

Hasher and Zacks's idea (1988) shared similarities with Craik's and Kahneman's, but switched the focus from capacity to the content of WM. They introduced the concept of inhibitory
functions to attention models, stating that the efficient operation of WM required that it contain only information that was directly useful in meeting goals. Information not useful ideally would not enter, and information no longer useful would be eliminated, expelled or overwritten. They conceptualized the denial of access and later elimination as being performed by inhibitory mechanisms. For example, looking to see how the construction of a new mall is coming along as one drives past is not relevant goals for safe driving and arriving on time. Recalling the face of a first love named Alice when seeing the name on a map is not relevant to the goal of finding the way. A 100% efficient operation would have denied access to WM by those thoughts of new stores and the past. Hasher and Zacks further hypothesized that when irrelevant information does gain access to WM, inhibitory mechanisms suppress that information so as to keep the focus on relevant material. In stark contrast to the limited capacity theories of cognitive deficits, Hasher et al. (1999) made the claim that limited capacity had a beneficial effect in that efficient use of a small WM capacity via inhibition provides for more rapid and more accurate cognitive processes. This is analogous to searching for a recalcitrant cat in a 2-bedroom compared to searching for it in a 14-room house.

Hasher and Zacks developed the framework which became the IDT to better explain their observations than the reduced capacity theories of cognitive ageing did (1988). They have since refined and expanded IDT based on the results of continuing research (Hasher et al., 1999; Hasher et al., 2001; Lustig et al., 2007). The theory now addresses not only age differences, but also performance differences due to fatigue, motivational level, stress, and circadian cycles, for both children and adults. However those extensions are not considered here, where the focus is on differences due to age.

Statement of the Theory

Hasher and Zacks' IDT (Hasher et al., 1999) postulates that goal-driven inhibition control mechanisms, when efficient, constrain the contents of WM to those facts, concepts, or perceptions that are most relevant at the current moment. Related to older adults, IDT states that this inhibitory control diminishes with age. That is, as a group, older adults (OAs) have less
inhibitory control over current contents of WM than young adults (YAs). The authors claimed that OAs do not have sufficient inhibitory control, which accounts not only for difficulty in retrieval from memory, but also difficulties in comprehending spoken or written material. This latter problem is an instance of attention's centrality in cognition as described in the above section on attention.

People who cannot effectively use inhibition to shut off the no-longer-relevant past create larger bundles of information in WM and are subsequently unable to quickly and accurately retrieve information needed to form inferences or to quickly resolve any initial misunderstandings or syntax or meaning. As a result of such on-line failures, comprehension will be compromised. (p. 665)

Further emphasizing the importance of inhibition control in IDT, Lustig et al. (2007) stated that: "Inhibitory processes are the major source of performance differences" in cognition (p. 152; italics added). Thus, the theory emphasizes that WM capacity does not decrease with age, nor do the excitatory attentions mechanisms change with age. Instead, the problems for OAs arise from decreasing efficiency of the inhibitory mechanisms. The major aspects of the IDT are presented in Figure 1 as a summary statement. Hasher and Zacks concretized their theory by specifying observable outcomes of the theorized constructs. These sequelae are described in the next section.

Sequelae of Deficits in Inhibitory Control of Attention

Having located the source of cognitive aging deficiencies in the inhibitory functioning of attention, the Hasher, Zacks research team identified the consequences of the deficits. Deficits in inhibition can disrupt learning, retrieval from memory, problem solving, and comprehension (Hasher et al., 2001, Lustig et al., 2007). Hasher et al. (1999) expansively described the intellectual sequelae of poor inhibitory control, and also acknowledged social/interpersonal consequences. According to these authors, people with poor inhibitory control are distractible and have difficulty retrieving the detailed data needed for real time inferences which are critical to
ATTENTION

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<th>source of stimulus</th>
<th>Excitatory Processes</th>
<th>Inhibitory Processes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>access</td>
<td>deletion</td>
</tr>
<tr>
<td>external</td>
<td>✓</td>
<td>↓</td>
</tr>
<tr>
<td>internal</td>
<td>✓</td>
<td>↓</td>
</tr>
</tbody>
</table>

Figure 1. The Inhibitory Deficit Theory (IDT) of Cognitive Differences with Aging. Stimuli from the environment, external to the person, and also stimuli from previously stored memories, internal to the person, may grab a person’s attention. These two sources contain significantly more stimuli than an organism can handle at any one time. Hence in order to not be overwhelmed with stimuli and unable to process the volume of material coherently, there must be not only excitatory attentional processes, but also inhibitory processes. The inhibitory processes act to reject or delete goal-irrelevant material from WM, thereby managing the demand load. IDT claims that with age, excitatory processes are preserved, but inhibitory processes work less well. ✓ indicates no change. ↓ indicates decrease.

comprehension. The authors used the term mental clutter to refer to WM content that is not relevant to goals. Mental clutter then has the consequence of interfering with rapid and accurate retrieval from memory. In turn, lapses in retrieval prevent coherency in thought. For example, the person would be unable to follow the story line in a TV show or book, or to grasp the points that a speaker is making. When one is unable to rapidly retrieve information from memory it becomes difficult to compose an adequate response to a situation. When the situation is novel or complex, one can only fall back onto highly practiced responses and belief systems, rather than adapting to the new aspects one is being confronted with. In the worst of circumstances, one will be reduced to having only overly practiced automatic behaviors in his response repertoire.

Inefficient inhibitory mechanisms can lead to dwelling on current personal concerns instead of attending to goal-relevant tasks. For example one may be unable to ignore the
discomfort of a tight waistband and miss the exit from the interstate highway. When external stimuli dominate attention, they make it difficult to refocus thinking on goal-relevant tasks. This explains why the older person would have misplaced the car keys in the scenario described above. Mental clutter explains why some OAs put the milk away in the pantry, cannot remember the reason for the trip to the basement once they arrive there, and are unable to locate the car in the mall parking lot once they have completed their shopping.

Attention Manages WM Content

As background for their theory, Hasher et al. (1999) conceptualized WM content to be under attentional control. They postulated that attentional control processes operate in the service of goals and expectancies; and that attentional control is exerted by both excitatory mechanisms and inhibitory mechanisms. Excitatory mechanisms enable the activation of goal-relevant information. For example, excitatory mechanisms draw into WM relevant information from long term memory stores and also enable one to notice the exit numbers on the highway signs as the destination draws near. Inhibitory mechanisms suppress the activation of extraneous, goal-irrelevant information. Both types of mechanisms are needed and must operate efficiently in order to keep the contents of WM free of extraneous information. Hasher et al. did not specify a set of excitatory mechanisms, but they did delineate three inhibitory functions: access inhibition; deletion or suppression; and restraint. Access inhibition prevents goal-irrelevant information from entering WM. An example is unrelated associations triggered by a familiar stimulus that could give rise to tangential thoughts, such as elaborate recall of what happened the last time one made chili as he is measuring out spoonfuls of chili powder into the soup pot. Deletion or suppression is the function which can remove marginally relevant or irrelevant information that is active in WM. This could be information that has served its purpose and is no longer needed. This function is called upon when, to continue the previous example, one has progressed forward in the chili recipe to the amount of cumin, and now needs to forget the amount of chili powder. By the actions of these first two inhibition functions, access inhibition
and deletion, the contents of WM are kept relevant to current goals. Irrelevant material does not enter and material that becomes irrelevant is deleted.

The restraining function operates at the output stage and restrains possible or potential responses from being executed until their appropriateness can be assessed. It is ideally used especially in cases where there is an automatic or habitual response that is not appropriate to the present goal. The restraint function allows one to keep response options open rather than delivering a sub-optimal or incorrect response impulsively. An example of restraint not operating appears in Styles (2006). This was the case of a man with severe bilateral frontal lesions who was asked to measure out a length of string so that it could be cut later. The man was unable to restrain himself from cutting the string immediately upon having measured it, even though he knew he was not to cut it then. In fact, he was able to state that he knew he was not to cut it, even as he wielded the scissors. The proverbial “jumping to conclusions” is an example of not being able to restrain oneself to continue processing the information in WM until all the relevant information can be fully considered. The Stroop color word interference test provides another example. In this test, names of colors (red, blue, green) are printed in colored ink (red, blue or green) on the protocol sheet; however, the color ink is not the same as the color connoted by the word. The challenge is to say the ink color and not the word. It takes longer to call out the color of ink than the color name, and this phenomenon has been given a variety of interpretations (Lezak et al., 2004). In the IDT paradigm, the examinee must use the restraint function to inhibit the incorrect response before the correct response is formulated and executed.

The three inhibitory functions are mere constructs, but they are conceptually useful. Hasher (2007) acknowledged that they may or may not prove to be separable at either the behavioral or the neural level. Figure 2 is a depiction of each of the three inhibitory functions as a gate through which material enters or exits the limited capacity of WM. The top panel shows the efficient operation of the inhibitory functions; the bottom panel shows imperfect operation of the inhibitory processes by which both goal relevant and goal irrelevant material occupy the limited capacity of WM. These inhibition failures result in the mentally cluttered state. Finally in this
scenario, some actions may be taken or decisions made impulsively before all options and relevant factors have been considered.

Support for IDT - Behavioral

Zacks, Hasher, and their colleagues conducted numerous behavioral studies to garner evidence for IDT. There is also support for IDT in imaging studies, which are reviewed below. The behavioral studies have been reviewed in Hasher et al. (1999, 2001) and Lustig et al. (2007). An overview of the literature and research paradigms that have been used to support IDT is provided next.

IDT had been positioned in opposition to the competing theory (e.g., Salthouse, 1996b) of slowed processing of cognitive resources at the neural level (e.g., perception, reasoning) as the explanation for observed performance changes with age. Hence IDT had to provide alternative explanations for the observations that had been previously been explained by the competing theory. Hasher et al. (1999, 2001) noted that several versions of tests used to assess speed of processing - oftentimes reading or a symbol cancellation task - used a cluttered display with many items per page. They reasoned that such a test protocol placed a demand on access inhibition that was greater than an OA's age-limited capacity. As a result, OA examinees were not able to limit attention to one item at a time; near-by items would distract them. They reasoned that if items were presented one at a time via computer, demand on access control would be greatly reduced, the phenomena of mental clutter would be avoided, and the measured result would be a more pure measure of cognitive processing speed. Changing the medium for the test in this manner speeded performance by over 15% indicating that defective access control in the original versions had interfered with performance as hypothesized (Lustig et al., 2007).

The theory was also supported in studies using categorization decisions or repetition tasks. In a simple categorization task, the examinee indicates whether or not a presented exemplar (e.g., a robin) is a member of a specific category (e.g., birds). A repetition task instructs the examinee to repeat back a verbal stimulus that gets longer at each trial. As examples, the stimulus might be a chain of numbers or letters. The instruction might be to repeat it just as it
Figure 2a. The content of WM is managed by attention. Efficient operation of inhibitory functions assures content of WM is goal relevant by denying access to goal irrelevant material and by deleting material from WM when it becomes irrelevant. The cognitive effort occurring in the efficient WM workspace outputs only optimal, fully considered decision material back into memory or takes only optimal, fully considered action in the environment.

Figure 2b. Imperfect inhibitory processes result in goal irrelevant as well as goal relevant material occupying the limited capacity of WM. Both types of material gain access, and both types may be deleted. Finally, some actions may be taken or decisions made impulsively before all options and relevant factors have been considered.
was presented, or in an altered order that requires simple cognitive functioning. An example of the second type of instruction is to first repeat back all numbers in numerical order and then all letters in alphabetical order so that for the stimulus "8-L-5-K-2" the correct response is "2-5-8-K-L." Such tasks use excitatory attentional functions, but do not require inhibitory attentional functions, so the finding of no age differences in the performance of these tasks supported the claim of preserved excitation in OAs and squarely pinned the attentional difficulties on inhibitory functions (Hasher et al., 1999).

Deficiencies in the deletion function were demonstrated in experiments using directed forgetting tasks (researchers direct study participants to forget some material) in which OAs later were able to produce irrelevant information at a high rate, especially in comparison to the rate of producing to-be-remembered information, and in comparison of YAs rate of producing irrelevant information. Performance on WM capacity tasks also demonstrated deficits in the deletion function. The traditional mode of testing WM capacity limits is to present lists of items that increase in length with each trial, and ask the study participant to recall them. The initial list might have four items, and if it is successfully recalled, the next stimulus has five items. Hasher et al. reasoned that in such tasks the shorter lists previously presented were interfering with recall of the subsequent longer lists because the old items had not been deleted from WM. When instead the study participants were presented with the longer lists first, and then shorter lists, the age differences disappeared (Hasher et al. 2001).

To examine the deletion function, several of Hasher, Zacks, and colleagues' studies used "the garden path" paradigm in which the study participant is mis-led to a "wrong" interpretation or answer that subsequently gets switched to a less probable, less expected one. That is, the participant is led down the proverbial garden path to a bad end. After giving an expected answer, participants are told to forget (i.e., delete) that answer and to substitute another answer in their memory for recall later. Both sentence items and narrative items are used in this paradigm. An example (Hasher et. al., 1999) of a garden path sentence item is to have the subject complete the sentence "Before you go to bed, be sure to turn off the ____.” After the participant responds with
the likely answer "light," he is informed he is wrong and that the less likely answer "stove" is the correct one.

Garden path story items use ambiguity in the narrative to lead to a wrong interpretation. An example is a story about hunters on safari in which taking a shot with a camera is the correct answer but subjects are led to think it would be taking a shot with a gun. To be successful in both sentence and story versions of such tasks, the study participant must delete from memory the original, expected ending he answered initially and produce only the new target word during the performance test phase. This phase occurs after a series of trials where expected and target words differ, and filler trials where the word the participant would naturally expect as the answer is also the researchers' target word. In the performance test phase, participants are asked to complete sentences with the first word that comes to mind. Efficient inhibition would result in the original, expected word (light and gun in the examples above) not being elicited and only the correct answers (stove and camera) being elicited. Hasher et al. made a case for ecological transference from this research paradigm to occasions in real life outside the laboratory in which there are shifts in discourse topics, protagonists, or settings, etc. Such shifts require the person to focus on the new topic, protagonist, etcetera; and that in turn requires the person to delete the old. Hasher et al. (1991) reported that in studies using this paradigm, YAs more often than OAs offered only the target word, not the initial, expected, "wrong" word, and that OAs still had access to both expected and target. That is, YAs had more often deleted the "wrong" word from WM but OAs had retained it along with - or without - the "correct" one.

There is less research on the third inhibitory function, restraint. One way it can be tested is by adding a stop signal paradigm to a categorization task already described above. In this add-on, participants are instructed to not make the categorization response on trials in which a tone has been sounded. For example, if the stimulus word "robin" is given at the same time the tone sounds, the participant should not respond with "bird." Here also, OAs performed less accurately than YAs, indicating deficits in the restraint function (Hasher et al., 1999). The studies conducted by the Hasher and Zacks research teams briefly reviewed above were targeted to one of the three inhibitory functions they had conceptualized as constituting inhibitory
control. As already noted, there are various ways that cognitive scientists parse cognitive functions, and another team could look at the same results and map it to another conceptualization of subfunctions. Such an alternate point of view was provided by Anderson and Craik (2000) who summarized the research supporting IDT as having produced four main findings: In comparison to YAs, OAs are (a) more susceptible to distraction from irrelevant information, (b) more likely to persever, i.e., to maintain no-longer-relevant information in memory, (c) more likely to recall information they were instructed to forget, and (d) more likely to demonstrate memory interference. Their summary indicates that IDT had been accepted as a mainstream explanation for some of the changes in cognitive functioning wrought by age. The next section explains a particular research paradigm used in several studies of IDT that is to be used in the current study.

**The Reading-with-Distraction Task**

Several studies of IDT are of particular interest in the current study not only for the support they provide for the theory, but also for the research paradigm used, the Reading with Distraction Task (RwDT). Connelly, Hasher, and Zacks (1991) compared YAs (mean age 19 yo) and OAs (mean age 69 yo) in ability to ignore irrelevant information on this reading task. This is an examination of the access/denial of access inhibitory function. Connelly et al. devised the RwDT for this study. Participants were required to read aloud a series of text passages, stories of approximately 125 words, and answer questions about the content. The target text was presented in Courier italic font. Some reading passages had distracting text discriminable by its standard Courier font interspersed with the target text; and other passages had target text only. For each story in the experimental condition, four distractor words or phrases that were meaningfully related to the story content appeared 15 times (60 appearances total) so that an interruption occurred every four to five target text words (See Appendix A for a similar example). Darowski, Helder, Zacks, Hasher, & Hambrick (2008) pointed out that this task can be easily administered using paper and pencil and a stop watch without need for a computer, and explicitly recommend this paradigm as a reliable test of the access function. Each story was printed in 10 point font on one 8 X 11 sheet of paper. Both reading time and comprehension were measured,
the latter by four straightforward multiple choice questions on content. Of the six possible answers, one was a foil based on the distractors, all were reasonable, and only one was correct. Older adults were expected to read the text with distractors more slowly than YAs and to have poorer comprehension.

Connelly et al. (1991) found that OAs read more slowly than YAs under both conditions but with much less difference under the control condition. Age differences in qualities of the reading other than speed, such as diction, phrasing, and expressiveness, were not noted. Both age groups read the passages with distractions more slowly, with OAs' time to read increasing by 138% and YAs' time increasing approximately 70%. Comprehension was negatively affected by the distractors for both age groups, without an age effect. Performance on a vocabulary test following the reading task was correlated with reading times; for OAs (but not YAs) lower verbal ability increased susceptibility to distraction (r = -.545).

In a second experiment, Connelly et al. (1991) tested the impact of the content of the distractors, keeping other aspects the same as above but now having three experimental distractor conditions: (a) story-related distractors as before; (b) meaningless distractors (strings of x's), and (c) words unrelated to the stories. Here it turned out that OAs were increasingly slowed as the distractors gained in meaning and relevance. YAs also were slowed by strings of x's and more slowed by text; however there was not a difference in slowing between related and unrelated words. The authors concluded from the two experiments that the disruptive effects of extraneous text is far greater for OAs than YAs. They suggested that OAs are more distractible than YAs, and claimed that similarity in meaning engages OAs in intellectual processing in a way that does not occur for YAs.

The reading-with-distraction task was also used by Carlson, Hasher, Connelly, and Zacks (1995), Darowski et al. (2008, below), and others. Carlson et al. found that when the location of distractors in the reading passages was predictable and fixed, the negative impact of the material on OAs' reading time was substantially reduced, and the differential slowing of meaningfully-related distractors was eliminated. The first of three experiments placed a line of distractors alternating with a line of target text. The second experiment placed them in fixed predictable
locations within a line of text: Target text was in columns 1, 3, and 5; distractor text appeared in columns 2 and 4. In this condition, both age groups' reading times were slowed and variations in the distraction from strings of x's, unrelated words, and related words, did not differentially disrupt reading times for OAs. The third experiment again used five columns but distractors could appear in any of the columns, making location unpredictable. In this third experiment, Connelly et al.'s (1991) results were replicated in that there were both condition and age effects with OAs being more slowed than YAs in each condition. YAs were slowed by x distractors and more slowed by words; whether the words were related or unrelated to the story made no difference. OAs were more slowed than YAs, and related words slowed them more than unrelated words.

The font manipulations in Carlson et al. (1995) are notable. For example in Experiment 1, the font was changed in size to 13 point compared to Connelly et al.'s (1991) 10 point Courier, and the font style for text was Bookman standard while the style for distractors was New Century Schoolbook italic, a denser font. Hence the text size made it much easier for OAs to see and read. Experiments 2 and 3 used Helvetica 16 point and as in Connelly et al., used italic for target text and standard for distractors. Although the authors took no note of it, Helvetica font, as a sans serif style, is significantly easier to read for OAs than the serif style (Nutt, 2004; Yager, Aquilante, & Plass, 1998).

Darowski et al. (2008) were interested in clarifying the role of inhibition in age-related differences in higher order cognition. In a path analysis, they used the reading-with distraction task as a measure of the ability to control the processing of irrelevant information. Specifically, they used Connelly et al.'s (1991) Experiment 2 paradigm, but with different fonts. Hypothesizing from IDT, they expected to find that distraction control would mediate age differences in performance of higher order cognition as measured by WM capacity and matrix reasoning. Matrix reasoning tests require examinees to complete a visual pattern (Lezak et al., 2004) and require reasoning by analogy (Groth-Marnat, 2003); they are often used as a single test measure of fluid intelligence (Darowski et al.) Darwoski et al. conducted a study of 229 adults aged 18 to 87. Age effects were found for reading with distraction, WM span, and matrix reasoning (age worsening performance). Reading with distraction performance was found to be a mediator.
Thus the study provided evidence of the role of distraction control in mediating the relationship between age and higher order cognition, providing further support for IDT. This study also provided evidence of the reliability and internal consistency of the reading-with-distraction task and suggested that the task could be shortened from the eight passages used previously to only four, and still be a reliable assessment of the access function across all age groups.

**Recent Support from Other Research Teams**

The Hasher and Zacks research teams began to garner evidence in favor of IDT beginning in the 1980s. As evidence that the theory continues to be well regarded in the field, several recent studies by other researchers are reviewed below.

Andrés, Van der Linden, and Parmentier (2004) studied directed forgetting, a process requiring the deletion function of inhibition, in older (mean 66 yo) and younger (mean 24 yo) adults. Zacks, Radvansky, and Hasher (1996) had also used a directed forgetting paradigm to study the deletion function, but Andrés et al.'s study increased the cognitive demands made on participants. In their paradigm, recall of to-be-remembered (TBR) and to-be-forgotten (TBF) items presented together, was compared to recall when only TBR items had been presented (the control condition). Participants did not know at the time of presentation whether an item was TBR or TBF, and hence had to encode all items. The items were 3-letter trigrams (determined not to be acronyms) that were presented on a card. There were two experimental conditions. In the interference condition, two trigrams were presented, one card after the other. Next, the participant read aloud strings of digits for 10 seconds, followed by recall of both trigrams with the letters in order. For the directed forgetting condition, presentation of the second trigram was immediately followed by a card that said, 'to be forgotten,' and after digit reading participants were asked to recall only the first trigram. The control condition presented a single trigram to be recalled after digit reading. Hence, in all conditions the information had to be held during a digit-reading task, requiring dual maintenance and processing of information. Inhibitory capacity was measured by the difference in recall between the control condition and directed forgetting. Sensitivity to interference was measured by the difference in recall between the control condition and the interference condition. OAs recalled fewer items than YAs across all three conditions,
but did not differ from YAs in the control (single trigram) condition. Both groups performed better under directed forgetting than interference, although OAs' performance was poorer than YAs'. OAs had more intrusions of TBF material under directed forgetting than YAs did. Andrés et al. concluded that, as predicted by IDT, the OAs inhibited the no-longer-relevant information less efficiently.

In addition to the above study of the deletion function, Andrés and her colleagues found support for IDT in a later cross-modal task in which sounds were used to distract attention from a categorical task. Andrés, Parmentier, and Escera (2006) compared older (mean 68 yo) and younger (mean 23 yo) participants' performance on a task in which sounds were used either as an alert to an impending visual stimulus, or as a potential distractor to visual stimuli. Digits were presented visually by computer to participants, who were to categorize them as either odd or even as quickly as possible by a key press. Response time (RT) was the dependent variable of interest. This categorization task would have required attention but not inhibition, according to Hasher et al. (1999). However, this study required participants to also filter irrelevant auditory information. Shortly before each digit was presented, a sound was presented that participants were told was a distractor and instructed to ignore (i.e., they were informed that the sound was task-irrelevant). For most of the distractor tone instances (90%) a sine wave was used, but randomly a novel sound was used – telephone ring, drill, door shutting, etc. According to Carlson et al. (1995), older as well as younger participants can learn to inhibit a frequent, regular distractor stimulus. In fact, participants learned to use the standard sound as a warning to prepare for the upcoming target stimulus. Hence this research paradigm allowed Andrés et al. to focus on performance comparisons for the instances of novel sounds compared to a standard tone preceding the presentation of the digit. As expected, accuracy of the digit categorization was near the ceiling limit for both young and old groups, but researchers expected a delay by all participants when the digit presentation was preceded by a novel sound compared to the RT when the standard tone was sounded. In comparison to trials of visual stimuli only and no sounds, the consequent speeding of responses (lower RTs) in the digit task preceded by the standard sound was defined by Andrés et al. as alertness. The slowing after a novel sound was...
defined as distraction. Significant effects of distraction thus defined were observed for both age
groups, however older participants showed significantly greater sensitivity to distraction from
novel irrelevant sounds, with an age effect size of 1.03 as measured by Cohen's d. The
researchers found no age difference in the alert effect. These are the findings IDT would predict,
that excitatory processes are preserved with age, but inhibitory processes decline, and the study
extends the support beyond the visual attention deficits reported here, to auditory attentional
systems.

Similar to the Andrés et al. (2006) objective of distinguishing between alertness and
distraction and the finding that the former are preserved and the latter decline with age, Collette,
Germain, Hogge and Van der Linden (2009) were interested in distinguishing between
unintentional and intentional inhibition, and similarly found the first to be preserved and the latter
to decline with age. They compared 40 OAs (mean 67 yo) and 40 YAs (mean 24 yo) in ability to
intentionally or unintentionally inhibit memory content. Unintentional inhibition occurs prior to
conscious awareness, an automatic, gating function of attention. Intentional inhibition is
deliberately invoked to deal with irrelevant stimuli. Participants were explicitly warned on tasks
requiring intentional inhibitory processes that they did not have to recall certain information.
Tasks calling for unintentional inhibition did not warrant such a warning. Researchers assessed
several inhibition processes. To assess intentional inhibition in WM they used a directed
forgetting task similar to that used by Andrés et al. (2004). To assess intentional inhibition in long
term episodic memory, they used a long term directed forgetting task. The material for this task
was 36 six-letter words categorized either as TBR or TBF and presented one at a time on a
screen followed by the cue to remember or forget. To assess capacity to suppress a habitual
response the researchers used a task in which there were thirty sentences with the last word
omitted; participants were to supply the last word and then were given another, different last
word to remember which was unrelated to the sentence, similar to the garden path paradigms
described above. Unintentional inhibitory memory control was tested by three different tasks, one
each for WM, long term, and semantic memory. Performance on tasks assessing unintentional
inhibition indicated age-preserved functioning - there was no significant interaction effect for age
and condition on any of the tasks, although there were group effects with OAs' RTs being slower than YAs' for most tasks. The results affirmed the IDT prediction that some of the memory deficits associated with age are related to less efficient inhibitory control. The authors concluded that only aspects of intentional inhibitory memory control were less efficient among OAs compared to the YAs. A median split of the OAs on response times and comparison of the two resulting groups enabled the authors to express confidence that poorer performance by OAs on tasks requiring intentional inhibitory control of memory content was not due to less efficient memory functioning in normal aging. These researchers emphasized that although intentional inhibitory control processes are less efficient in OAs than in YAs, OAs do continue to have access to them.

Support for IDT - Neuroimaging

In addition to experimental behavioral studies, support for IDT has been found in at least one series of neuroimaging studies. Gazzaley and D'Esposito (2007) reviewed findings of Gazzaley's laboratory on the effect of age on the neural mechanism of top down modulation. Top down modulation is the mechanism by which brain activity associated with task-relevant information is enhanced (i.e., increased) and by which brain activity in regard to task-irrelevant information is suppressed. It is called "top down" to indicate that a higher order cognitive function or brain area is controlling a lower level cognitive function or neural area. In this paper, it refers more specifically to directing attention according to goals or tasks, and also ignoring stimuli that are not useful to attaining goals. Gazzaley and D'Esposito reported use of functional magnetic resonance imaging (fMRI) and electroencephalography (EEG) to detect location and timing of brain activity when participants reacted to stimuli. In a major study, 16 OAs (60 – 77 yo) and 17 YAs (19 – 30 yo) were shown block trials of pictures of faces and of scenes, and given one of three instructions: (a) remember the scenes and ignore the faces, (b) remember the faces and ignore the scenes, or (c) passively view without attempting to remember anything. The researchers recorded neural activity in the brain area known as the Visual Association Cortex. When the activity was greater in magnitude for the attention tasks compared to the passive
baseline, enhancement (an excitatory function) was indicated. When the activity measures were below passive baseline, then suppression (an inhibitory function) was indicated. The researchers were able to locate specific regions of the brain for either the face-stimuli processing or scene-stimuli processing, and used them as regions of interest where they could best study activity modulation based on the goals of the task given to participants.

In YAs, top-down modulation activity magnitude (shown via fMRI) occurred above and below the passive baseline depending on task instruction. All YAs had greater fMRI activity during the encoding period when attempting to remember scenes compared to ignoring scenes. Eighty-two percent of YAs enhanced activity above the passive view baseline when remembering scenes and 88% suppressed activity below the passive view baseline when ignoring scenes. OAs also had greater activity in the scene-selective region when attempting to remember scenes versus ignore scenes. However, only 44% of OAs suppressed activity, indicating the absence of significant suppression of task-irrelevant information in the other 56%. The researchers determined that those OAs whose recall during the test phase was significantly inaccurate (about 1/3 of the group) were the same participants whose suppression was deficient; these same people had a higher incidence of rating scenes as familiar that would correctly have been ignored. Behavioral and neuroimaging data were consistent in these cases. WM performance and suppression were significantly correlated in OAs. This indicated that the extent of top-down suppression during encoding predicted WM recognition accuracy. According to Gazzaley and D’Esposito, this correlation established the relationship between age-related deficits in suppression of task-irrelevant information, incidental long-term memory encoding, and interference during the WM task.

There was a subgroup of six OAs in their sample with preserved suppression abilities and these individuals also had intact WM performance. Gazzaley and D’Esposito viewed this as evidence that inhibitory deficits are not an inevitable, universal characteristic of aging and also as further evidence of the importance of top-down suppression to cognition. Hence this study offered strong support for IDT in that it established the specificity of an attention deficit to inhibition, specifically a deficit in the suppression of task-irrelevant information, and directly linked
this deficit to WM impairment. It further supported IDT by finding no significant age difference in enhancement activity (excitatory function) -- OAs are able to enhance sensory neural activity for relevant information, but most are unable to sufficiently suppress neural activity for irrelevant information.

Conclusion

In conclusion, IDT appears to be a highly viable and well-supported explanation for the cognitive difficulties, especially short term memory difficulties, that many OAs experience. Given that many OAs can be expected to have attentional control deficits as predicted by IDT, the question of interest is, how can this explanation be used to help them improve cognition, which in turn may enable them to live independently longer, with a higher quality of life and less anxiety about their capabilities? Improving attention appears to be a worthwhile endeavor. The next section reviews research on clinical methods of improving attention.

Conventional Approaches To Improving Attention

Two major ideas presented above are that attention is central to cognition, and that the cause of age-related cognitive difficulties is a deficit in inhibitory functioning of attention. Together they point to the desirability of improving attention in older adults (OAs). However, the published research indicates that to date, there has been very little effort expended to find effective, efficient, and economic ways to do so. Most cognitive training for OAs has been targeted to improving memory; processing speed has recently been added as a second target. Given that memory impairment is the prominent feature of the dementias, and that older adults are highly concerned about memory loss (e.g., Mol et al., 2007; Reese, Cherry, & Norris, 1999), this concentration on memory training to the exclusion of other cognitive functions is not unexpected. In other populations (primarily brain injured patients), however, attention training is a common focus for cognitive rehabilitation, and the methods there would seem to have potential for transfer to use by OAs. This section reviews the sparse literature on methods of attention.
training in OAs and also the literature on attention rehabilitation with the objective of identifying and evaluating established means to improving OA cognition in accordance with the IDT.

The earliest study (Willis, Cornelius, Blow, and Baltes, 1983) located for this review grew out of the information processing paradigm that cognitive psychologists were applying to intellectual processing. It was motivated by observations that OAs performed at lower levels than younger adults YAs on measures of attention; and by new speculation that attentional processes were associated with age differences in fluid intelligence. Fluid intelligence (Gf) is the component of intelligence that has to do with problem solving, reasoning, and understanding novel situations, in contrast to crystallized intelligence (Gc), which has to do with knowledge of facts and vocabulary. Willis et al. investigated whether training could improve OA's performance on various attention process dimensions, and additionally whether the improvements (if any) wrought by the training in the area of attention would transfer to other areas of cognition, that is, to processing speed, memory span, and both Gf and Gc. The training consisted of five 1-hour sessions. Each of the first four sessions focused on one of four attention dimensions (discrimination, selective attention, attention switching, and concentration). The fifth session was a review of the previous four sessions. Each session included two practice sessions on training problems that had been developed to focus on the cognitive process demands of the attention dimensions. Each session also included group exercises offering more practice, and the trainers also related the attentional dimensions to activities in the participants' daily lives. Practice problems were similar to test items, but differed in content.

In addition to the experimental group, Willis et al. (1983) had an active control group with similar meeting schedules, and a no contact control group. Seventy-three OAs aged 62 - 84 years (M = 70.5, SD = 5.4) with 5 to 22 years of education (M = 11.9, SD = 3.2) completed the study. Three post tests were administered at one week, one month, and six months after training. The dependent variables were gain scores (the difference of post-test scores from the pre-test scores) as the direct measures of change. A significant treatment main effect was found on the attention measures and maintained for the 6-month span. However, no significant effects were found for the transfer effects to Gc and Gf, or for processing speed or memory span. In
interpreting the lack of a transfer effect, the authors noted that the attention tasks were distinctly different from the Gf tasks in the tests. They also commented that the information processing field (perhaps they meant cognitive science), being at the stage of development where it described processes and strategies people use, had not yet grappled with issues of modifiability or training optimization. The implication was that the training would have to be different to garner a transfer to other dimensions of intelligence or cognition.

This was a well designed and executed study. Looking at the outcomes through the lens of the IDT, one could conclude that the training did not adequately address deficits in the inhibitory functions of attention since it did not result in an improvement in cognition.

It appears that Willis et al. (1983) put to rest all curiosity about training OAs' attention ability for over a decade. Only Yesavage and Jacob (1984) published a study of a training effect for attention in OAs, although their objective was not to train attention per se. They hypothesized that by training participants in two disparate areas, their anxious ruminations would decrease and they would also have better attention skills. They further hypothesized that these changes in turn would increase available working memory. The two training areas were a face-name memory technique, and relaxation techniques. They found that after the training, participants with the greatest increase in attention scores and the greatest reduction in anxiety and cognitive interference, also had the best post-test recall for names. They concluded that anxiety in OAs interferes with attentional and memory tasks, and that the effect could be reduced through relaxation training. The interest in the study for the present study is that attention scores did increase after training in areas other than attention per se. However, there were no follow-on studies of attention training building on this result among the 29 publications that cited it, nor among the 15 publications that cited Willis et al. (1983). Instead, these two studies apparently only generated interest in memory and relaxation training.

OAs can get better on specific tests of attention with practice, and there is some generalizability to other attentional tasks with different stimuli and task combinations, as demonstrated by Rockstroh, Dietrich, and Pokorny (1995) and Bherer et al. (2005, 2006, 2008). Both research teams were interested in age differences and compared OAs to YAs in ability to
improve on attentional tasks. In all these studies, OAs were found to be slower at pre-test but just as accurate as YAs, indicating that OAs might prefer a correct response to a fast response, and that YAs had the opposite preference. Rockstroh et al. used computerized tests of visual attention with random audible warnings or distractors and found improvements in speed. Behere et al. used visual discrimination and auditory discrimination tasks and found improvements in both speed and accuracy (2005); and that both age groups benefitted from getting continuous individualized adaptive feedback to enhance performance (2008). Rockstroh et al. further concluded that OAs could reach greater improvements than YAs in response times with practice, perhaps because YAs were either at their maximal ability at pre-test or were unmotivated to improve. Bherer et al. concluded that there was substantial cognitive plasticity in attentional control in OAs. However, there was not an attempt to discover any transfer effects to broader cognitive functions.

The handful of studies reviewed above were the only ones published in the late Twentieth Century. Although there was a dearth of interest in training OAs' attention to compensate for normal aging effects for nearly two decades following the 1983 Willis et al. study, there have been on-going efforts to find ways to rehabilitate brain-injured and seizure patients whose attentional abilities have been compromised. Methods fall into one of two approaches (Engelberts et al., 2002): (a) retraining impaired cognitive functions, which assumes there is at least a modicum of neuroplasticity to aid recovery; and (b) teaching strategies to compensate for immutable neuronal loss, which assumes insufficient neuroplasticity to recover. Neuroplasticity refers to the brain's ability both to generate new cells and to reorganize existing cells for new purposes. Engelberts et al. found that for attention deficits attributable to focal seizures in epilepsy, both approaches provided improvement relative to wait-list controls, with retraining showing greater effect for objective measures and with compensation being more effective for self-reported outcomes.

One of the attention rehabilitation practices that potentially could be helpful to OAs experiencing normal aging is Attention Process Training (APT, Sohlberg & Mateer, 1987). This well-regarded program has become a rehabilitation practice standard for remediation of attention deficits in brain-injured persons (Michel & Mateer, 2006). APT is based on theories in cognitive
science and on outcomes of experiment studies of attention. The patient practices attentional skills by performing tasks related to visual and auditory stimuli, by using mental control to perform other tasks, and finally by completing attentional tasks similar to those that arise in daily living. The exercises increase in difficulty by way of both complexity of the task and processing speed requirements. Progression through one module builds skills that are thought to be necessary for performing in subsequent modules. However Michel and Mateer reported that even this theoretically well-grounded practice standard has not been shown to generalize to new situations and to other functional capacities. Hence, this would not likely be more helpful to OAs than to rehabilitation patients as a way to improve their attention.

It might seem that rehabilitation approaches used for stroke and brain injury patients would provide methods that would work for OAs experiencing normal aging and the attendant deficits in inhibitory attentional functioning. After all, the most common sequelae of stroke and brain injury in both children and adults are deficits in attention, memory, and executive function. This phenomenon is consistent with the intertwined relationships of these three functions and their centrality to all of cognition, as described above. In fact, a long-standing, generative idea in the field of rehabilitation is that deficits in attention impede the recovery of other cognitive and behavioral abilities (Michel & Mateer, 2006). Michel and Mateer reported that training attentional processes uses a series of repetitive drills with increasing demand as the patient progresses. This is based on the theory that repeated activation and stimulation of attentional brain systems result in increases in cognitive capacity and thus in attentional improvement. The training begins with laboratory tasks such as detecting a target in the presence of a distractor. With successful execution of laboratory tasks, the focus of treatment shifts to functional tasks and onward to practice of real life tasks in naturalistic environments. In their review, Michel and Mateer reported that improvements are consistently shown in performance on the training task, even in severe brain injury; but that improvement seems to be attributable to acquisition of a specific skill rather than improvement in attention per se. Instead of training specific processes such as attention, another approach is to focus on performing a specific functional skill that requires attention, such as driving or other activities of daily living. They reported that this approach has found significant
results in a few small studies. Hence, from Michel and Mateer's review of the research, the
evidence for direct practice of attention-related skills does not allow for a conclusion that there are
transfer effects, and therefore one can conclude that the inhibitory functional defects were not
addressed by the training.

The direct training methods and findings from the cognitive aging and rehabilitation
literatures reviewed here can be simply summarized: Practice to improve the skill, although the
practice only improves that skill. Hence these practice methods are not promising as a way for
OAs to overcome the deficits foretold in IDT. However, Kaiser and Othmer (2000) and Levy,
Jennings, and Langer (2001) sought long lasting improvement in attention by methods other than
practice. Kaiser and Othmer used neurofeedback to improve attention in adults and children with
attentional complaints. Through neurofeedback, an individual is trained to modify the amplitude,
frequency, or coherence of his/her brainwaves. In their sample of over a thousand participants,
only 186 had been formally diagnosed with ADHD or ADD; and a "handful" had been diagnosed
with more severe co-morbid conditions or more severe behavioral disorders such as
Oppositional-Defiant Disorder, Tourette's Syndrome, minor traumatic brain injury, epilepsy,
anxiety disorders, or depression. None of the participants were on stimulant or antidepressant
medications during the test administration. They were tested prior to training in a continuous
attention task lasting 22.5 minutes during which they were required to respond to targets and not
respond to non-targets generated by computer; response was by key press. The pre-testing
revealed that the majority had moderate attention deficits; that is, their scores on the test were
one-to-two standard deviations below the age-and-gender-normed means. (The balance of the
sample is inadequately described, although it was noted that a part of the sample had scored
below two standard deviations). A training session consisted of thirty minutes of visual and
auditory feedback within a forty-five minute contact hour; the course of treatment was 20
sessions. Testing of attention was again conducted after the last session using the same
computerized stimuli. Kaiser and Othmer claimed an 85% treatment response rate among those
with moderate pre-training deficits; these participants improved their scores by at least a half
standard deviation in the age-and-gender-normed standard scores, and 73% improved by at least
a full standard deviation. A subset of 157 participants with more severe pre-training deficits had extended training (40 sessions or more) and improved further with the additional 20 sessions. The authors noted that their 85% response rate is a sizable improvement over the 70% response rate for psycho-stimulants such as methylphenidate, which are often prescribed as treatment for diagnoses of ADD and ADHD. The authors concluded that neurofeedback training is effective for treating attentional deficiencies. Criticisms of this report are that incomplete statistics were provided both to describe the sample and to measure the results; that effects for ADD and ADHD-diagnosed participants were not distinguished from those with subjective complaints but no objective diagnosis; and that it used extant data rather than conducting a randomized control trial.

Levy, Jennings, and Langer (2001) also devised a strategy for improving attention other than direct skill practice. They investigated the effects of a mindful intervention (noticing distinctions) on the attentional ability of OAs (60 to 89 years old) who were shown a set of pictures and subsequently asked to recall and describe the pictures. There were two experimental conditions: instruction to notice three distinctions or instruction to notice five distinctions. The two control groups were either told simply to pay attention or were not given any directions related to attention to the set of pictures. Results were that those who viewed the stimuli in terms of distinctions were able to remember significantly more pictures than did those in the control groups. The authors suggested that if older individuals wanted to increase attention and recall, they should find ways to vary their attention (i.e., notice distinctions about the object), rather than pay attention in a static way as though one were focusing a camera. The suggestion emerging from this well-conducted study appears to be a helpful one for OAs. However it cannot be concluded that improvements would generalize beyond the strategy. It is not clear that attention per se as a cognitive function was improved by mindfulness as described here. Nor could one expect that mindfulness affects the specific inhibition sub-functions of attention so as to make the implied predictions of IDT, that improving the deficits in those functions would improve cognition, operative.

This sparse literature indicates how little work has been done on improving attention in normally aging OAs. However, in the last four years, cognitive training for OAs has become a
hotbed of research (e.g., Potkanowicz, Hartman-Stein, & Biermann, 2009; Smith et al., 2009; Willis et al., 2006) and entrepreneurial endeavor (e.g., Bakalar, 2008; Doraiswamy, 2010; Greene, 2007; International Herald, 2006; Shapiro, 2007; Vedantam, 2006). The explosion in the popular press occurred on the heels of the announcement that particular mental exercises enable OAs to maintain cognitive ability instead of succumbing to the expected decline in their thinking skills; and that the training effect could last for five years or longer. These were the results of an NIH-funded randomized controlled study, Advanced Cognitive Training for Independent and Vital Elderly (ACTIVE) of 2802 OAs older than 64 (National Institute on Aging, 2002). This randomized controlled study consisted of training interventions in three areas: memory, reasoning, and speed of information processing.

Participants in the experimental conditions had ten training sessions in one of the three areas. Sessions lasted 60 to 75 minutes and took place over five- to six-weeks. The speed-of-processing group was taught strategies to identify an object on a computer screen at increasingly brief exposures, while quickly noting where another object was located on the screen - a task that would develop attentional skills as well as speed. Practice for this intervention used an interactive software program that manipulated task difficulty at an individualized level for each participant, providing increasingly complex practice tasks. Here, task difficulty increased each time the participant achieved a criterion level of performance on a task. The design of this training intervention appears to have followed the principles outlined above by Michel and Mateer (2006) for cognitive rehabilitation programs. The other interventions were less rigorous, less demanding, and not individualized. Participants in the memory and reasoning interventions were taught strategies for their respective cognitive function, and then had both individual and group practice time during the session. Immediately after the initial training was complete, 87% of the speed-training group, 74% of the reasoning group and 26% of the memory group showed improvement in the skills taught. Benefits persisted for five years; effect size for memory training was .23; effect size for reasoning training was .26; and effect size for speed of processing training was .76. However, the training did not show improvements on measures of everyday functioning.
(Willis et al.), an outcome similar to that of the rehabilitation training of attention not finding improvements to daily life abilities (Michel & Mateer, 2006).

As the media reports cited above indicate, there are currently several electronic products available to consumers which claim to improve cognitive ability; and the results of the ACTIVE study form the basis of the claims. Some in the health care industry have called for more rigorous investigation of the effect the products can have (e.g., Butcher, 2008). There is some evidence that one of the products, "The Brain Fitness Program" offered by Posit Science, is an effective attention training program. Posit Science, a privately held corporation, acquired ownership of the speed of processing intervention used in the ACTIVE Cognitive Training Trial in October, 2007 (www.positscience.com) and incorporated it into their products. As described above, the ACTIVE speed of processing training used visual stimuli. Posit subsequently developed a battery of six computerized exercises of increasing difficulty that were designed to improve speed and accuracy of processing auditory information (Smith et al., 2009; another software product is available for improvement of the visual system.). One of the promises made on the website for this product is, "Follow and participate in conversations more fluidly" (Posit Science, n. d.) indicating that the software will remedy one of the problems that Hasher and Zacks (Hasher et al., 1999) had identified as a sequela of a deficit in inhibitory functioning. Smith et al. stated that the theoretical foundation for the Brain Fitness Program was that "age related reductions in the quality of neural information flowing through peripheral and central sensory systems to cognitive systems contribute to age decline" (p. 595). The principles used to design the training programs, as reported on the website, are very similar to those for programs to rehabilitate attention outlined by Michel and Mateer (2006) and reviewed above.

To evaluate the efficacy of the Brain Fitness Program, Posit Science sponsored a multisite randomized controlled double-blind trial with 487 OAs aged 65 and older (mean 75) called the IMPACT study (Smith et al., 2009). Training was an hour a day, five days a week for eight weeks. The active control group had a program that engaged learning processes but was not designed to improve auditory system function. They watched educational DVDs on history, art, and literature and were quizzed afterward. The primary objective of the study was to evaluate
the efficacy of the experimental treatment on untrained measures of memory and attention. The primary outcome was a composite score of auditory memory and attention tests; measures of processing speed, and participant self-reports were also included. The effect size in the primary measure was 0.23 in favor of the experimental group. Effect sizes ranged from .20 to .30 on other standard neuropsychological measures of attention and memory; effect size was .87 on the directly trained skill. Participants’ self-reports were also favorable.

Criticisms of the IMPACT study included a lack of transparency into the experimental intervention, unless one purchases the product; and questionable bias introduced by the presence of a Posit Science principal on the research team and his authorship, as well as the sponsorship of the corporation for its own product. Considering the recent guidelines issued by the Institute of Medicine (Committee on Conflict of Interest in Medical Research, Education, and Practice, Board on Health Sciences Policy, 2009) after numerous high-profile medical ethics breaches were reported in the media, mere disclosure of relationship is not adequate to guard against bias. As Dana (2009) explained, psychological research has shown that unconsciously and unintentionally a researcher tends to bias the evidence when he stands to gain from a particular outcome, and that this occurs beneath the individual’s level of awareness.

Of the all the programs to train attention described above the one that appears to have the most credibility as a means to overcome aging deficits in inhibitory functioning of attention and enable OAs to retain cognitive abilities as they age is The Brain Fitness Program. The price for the product is currently $395; the program for training visual information processing is also priced at $395 (www.positscience.com). In addition to the software, the user needs the supporting hardware (a computer with audio capabilities) and computer support for installation, trouble shooting, and related incidents. OAs whose hearing or vision have been compromised beyond the minimal level needed to use the programs would not be able to avail themselves of the potential benefits.

There is some evidence of a more cost-effective approach that could be more widely available and useable even by those OAs with hearing and vision limitations. Meditation has been suggested as a means of improving attention (Buell, 2009; Lutz, Dunne, & Davidson, 2007;
Morone, Lynch, Greco, Tindle, & Weiner, 2008). Before presenting the clinical studies that provide some support for this conjecture, meditation itself is defined and described.

Meditation As Mental Process Training

Meditation is generally understood to be a contemplative spiritual practice and as such, many religions, including Christianity, Islam, and Native American traditions, claim to have ways to meditate. This section addresses the definitions of the term meditation and describes several methods of meditation that are encountered most often in the literature. Meditation has been studied in the West as a health therapy since 1956 (Ospina et al., 2007) or possibly earlier; and specifically as a psychotherapy from the 1970s or possibly earlier (e.g., Goleman & Schwartz, 1976; Smith, 1976). Beginning in 1992, the nature of the research into the effects of meditation changed significantly and the Western scientific community's understanding of the term meditation became far more nuanced. That was the year that cognitive psychologists and neuroscientists began to investigate the exceptional mental abilities in advanced Tibetan monks by using such tools as EEG, fMRI, and other neuroimaging techniques (Mind and Life Institute, n. d.). In defining meditation, this section bridges that pre-and post-1992 divide (or rather a pre- and post neuroscience involvement) in precision. Hence, the section first offers the broad definition suitable for the behavioral observations of the first period. It presents the taxonomy that Ospina et al. developed to organize the 813 studies included in their meta-analysis of research from 1956 to 2005 on meditation very broadly defined. This way of perceiving meditation is helpful to understand the body of non-neuroscience literature. Next the section presents the definition of meditation as it is used by Tibetan Buddhists and applied by a major network of neuroscientists collaborating with the monks to investigate its effects on the brain. The Buddhist/neuroscience definition presented here is broadened by brief descriptions of three major forms of meditation within the Buddhist tradition. This definition and expansion is appropriated to the present investigation into possible improvement of OAs' ability to inhibit distractions, albeit a behavioral and not a neuroscience study.
Meditation Broadly Defined

There are a great many activities and behaviors that come under the umbrella term meditation. For their US-government funded report on the state of the research of meditation practices for health, Ospina et al. (2007) used over fifty different search terms denoting various forms meditation (e.g., kinationa, lectio divina, guided imagery, progressive relaxation, vipassana) to identify studies in several research databases. There is also great deal of imprecision in the way various researchers have used this generic term and related ones such as mindfulness. For many Westerners, especially in earlier research conducted in the 1970s and 1980s, meditation was viewed as a form of relaxation and "emptying" the mind. More recently and more precisely, Perez de Albenz and Holmes (2000) offered the psychophysiological perspective that it is "intentional self-regulation of attention in the service of self-inquiry, in the here and now" (p. 49). They also asserted that meditation is distinguishable from daydreaming, hypnosis, praying, biofeedback, and relaxation.

Ospina et al. (2007) concluded from a review of the literature that most investigators could support a definition of meditation as "a form of mental training that requires either stilling or emptying the mind, and that has as its goal a state of 'detached observation' in which practitioners are aware of their environment, but do not become involved in thinking about it." They further observed that most forms of meditation practice involve "self-observation of immediate psychic activity, training one's level of awareness, and cultivating an attitude of acceptance of process rather than content" (p. 9, both quotes). To form an operational definition, they enrolled seven academic experts in meditation practices to engage in a Delphi inquiry technique. The panel agreed that the essential criteria for designating a practice meditation were that it use a defined technique that the individual is able to practice alone without the presence of an instructor, and that it involve suspension of logical or rational thought, analysis and judgment. The panel of seven was split 3-4 on whether reaching a state of mental calmness and physical relaxation was essential, but all did agree it was an important feature. They further agreed that important but not essential features were (a) use of a self-focus skill or an anchor to avoid
undesirable thinking, torpor and sleep; (b) involvement of mental silence or psychophysical relaxation; (c) entering an altered state of consciousness that is neither normal wakefulness nor sleep; and (d) a philosophical, spiritual, or religious context. The panel agreed that guided imagery and visualization practices are not meditation, nor is progressive muscle relaxation nor dialectical behavior therapy. However, at least five of the seven agreed that tai chi, qi gong, and any form of yoga were. These three forms are characterized by coordination of breathing pattern with physical postures and movements. They are three of the six categories of meditation into which Ospina et al. sorted the 813 studies they analyzed. The other categories were mantra meditation, mindfulness meditation, and miscellaneous/combined practices. Practices having the repetition of a word or phrase - the mantra - formed the first category. The mantra is used to focus attention.

Of the type of meditations that Ospina et al. (2007) categorized as mantra, Transcendental Meditation® (TM®) stands out for its claims of broad usage around the world and for the scientific research its devotees have conducted on its benefits. Twenty-eight percent of the studies included by Ospina et al. were of TM®. It calls for twice-daily, 20-minute sitting meditation with eyes closed and attention focused on a mantra. A key characteristic of this style is that the mantra, a Sanskrit word, is personalized and unique to the person. Learning TM® initially requires a seven-step course of instruction by a certified teacher (cost: $1500), and then monthly sessions in which the student’s technique is evaluated and corrected if necessary to ensure conformity (Maharishi Vedic Education Development Corporation, n. d.). Advanced forms are also available for additional fees. It is considered by some to be commercialized and to be a cult (Cowan & Bromley, 2008), and has been the subject of controversy and lawsuits (e.g., Conant, 2008).

The "mindfulness" category used by Ospina et al. (2007) comprised meditation practices that emphasize attention to the present moment and acceptance of whatever the current experience is, without interpretation or judgment. Such practices seek to cultivate awareness, curiosity, and openness in everyday life; equanimity; reflective instead of impulsive reaction; and the formation of considered, intentional responses instead of automatic and habitual responses.
Ospina et al.'s mindfulness meditation category included forms from the Buddhist tradition, including Zen Buddhist meditation (Bishop et al., 2004; Shapiro, Carlson, Astin, & Freedman, 2006). Ospina et al.'s inclusion criteria required that the study be published in English through September, 2005 and perhaps that language requirement eliminated some research that had been done on, for example, the Sufi tradition. Yet that review demonstrates not only the breadth of practices but also the imprecision with which researchers have used the term. Notably, in addition to the six categories mentioned above, there was a seventh for those studies that provided so little detail about the subject form of meditation that

MBSR was developed in the late 1970s as a therapy for chronic illness. It has a number of components: sitting meditation, walking meditation, body scan, breathing exercises, yoga exercises, and mindfulness in daily life. During body scan, the practitioner places attention non-judgmentally on each area of the body in a toes-to-head sequence. During sitting practice, attention is focused on breathing. During walking meditation, attention is focused on body sensation and breathing (Morone et al., 2008). It is taught in a group format over eight weeks of weekly meetings two to three hours in duration, and participants are expected to practice daily for 45 minutes or more. Instructors must be credentialed. However, in 1990 its originator made MBSR available as a self-directed training program via a popular press book (now in its special 15th anniversary edition) that fully describes all the components, exercises, and background information (Kabat-Zinn, 1990). Currently, the program is applied to a wide spectrum of clinical populations as treatment for chronic pain, anxiety, well being, psoriasis, depression, heart disease, and cancer (Grossma, Niemann, Schmidt, & Walach, 2004) and is the reason for an international gathering of clinicians, researchers and educators for the past eight years (Center for Mindfulness, n. d.).
they could not be placed in one of the other six categories (3% of the included 813). The authors pointed out that meditation, as a complex and multifaceted intervention, is "difficult to standardize" (p. 199), and called for future investigations to more clearly define and report the procedures being studied. Lutz et al. (2007) similarly pointed out the necessity for more precision in the definition of technique being used by the meditator participating in the study, and the terminology being used. The next section focuses on the meaning, and some terms in use and forms of meditation in the modern Indo-Tibetan Buddhist tradition.

Meditation Trains the Mind: the Buddhist / Neuroscience Definition

Ospina et al. (2007) were very inclusive of meditation forms, although there has been little research published on many of those extant. As it is most often studied in neuroscience and as it is most often used in psychotherapy, the term meditation denotes more specifically one or more techniques drawn from traditional Buddhist practices (Lutz et al., 2007). Moreover, in these contexts meditation is secular and not given religious or spiritual overtones, as is appropriate to a scientific usage. In fact, the earliest Buddhist writings refute the existence of a divine creator (Wallace, 1999a). Rather than pursue reconciliation to a supernatural being, Buddhism’s primary activity is to investigate the nature of human experience. It is concerned with the mental processes (including emotions, which are not distinguished from other mental processes) that are conducive to affecting the individual's and others' well being (Ekman, Davidson, Ricard, & Wallace, 2005). It is widely considered the most psychological of all spiritual traditions (Wallace & Shapiro, 2006). Buddhist conceptualizations of meditation are useful to science because they are precisely described and supported by extensively detailed theories (Lutz et al., 2007). Its structured model of perception and cognition are viewed as facilitative of Western scientific study of meditation effects (Rapgay & Bystrisky, 2009).

In this view, then, meditation is a rigorous system of mental training and observation of mental processes. Tibetan Buddhists consider meditation to be the "science of the mind" (Barinaga, 2003). They use a wide variety of methods, each with a specific, different objective towards accomplishing this science, including focusing attention on the breath, visualization of
energy flowing in the body, visualization of the universe, recitation of a mantra, and analytical review of narratives and argument - all these within the Tibetan Buddhist tradition (Lutz et al., 2007). Meditation is clearly a generic term and not a specific one. The cognitive psychologists and neuroscientists working with the monks defined it as "a family of complex emotional and attentional regulator strategies developed for various ends, including well being and emotional balance" (Lutz, Slagter, Dunne, & Davidson, 2008, p. 163). It is a form of relaxed alertness, verified in studies of brainwaves (Lutz, Greischar, Rawlings, Ricard, & Davidson, 2004).

In the three main Buddhist traditions that are most likely to be practiced by Westerners (Tibetan; Zen, originating in Japan; and Theravadin originating in India), there are two major classes of meditation (Lutz et al., 2008). Practices in these two classes are considered to be somewhat modern in that there are simple and standard instructions and the practice is not limited to those who practice as a vocation (i.e., monks). One of these two classes is characterized by focusing attention on a fixed object, which can be tangible or intangible, concrete or abstract. This class is referred to as Fixed Attention. The other, considered a more advanced form, calls for open monitoring of experience and does not use a concrete object; in its advanced stages it does not use any object. It is called, Open Monitoring. Each of these classes comprises multiple, diverse techniques and forms having specific objective to be accomplished (Lutz et al., 2008; Rapgay & Bystrisky, 2009). The form of meditation, or mental training, used in the present study is in the first class and is called, in the Tibetan tradition, samatha. Wallace (1999b) pointed out that this form of meditation is not unique to Buddhism, and is found to varying extents in many contemplative traditions including Christianity, Taoism, Hinduism, and Sufism.

Samatha Practice

Samatha practice is aimed at developing the ability to focus the attention single-pointedly for a theoretically unlimited period of time. Thus trained, attention becomes a more reliable and precise instrument of observation for the investigations of mind and nature that are of interest in Buddhism. Traditionally, the object on which attention is focused is the breath, the sensation
made by the breath as it flows in and out of nostrils. The breath is not the only object which can be used in samatha, and objects may be concrete or a mental image. The task is to keep attention focused on, for example, the breath, without distraction and without attention wandering. If it attention does wander, the practitioner merely returns to focusing attention back on the breath without further mental involvement with the distractor, and especially without emotional investment such as berating oneself for having wandered (Wallace, 2006). One “releases” the distraction. Hence this mental training uses and further develops three abilities: ability to sustain a focus on the object; a monitoring ability that can notice that attention has wandered; and ability to re-direct attention back to the object without delay (Lutz et al., 2007). The analogy of the first two abilities to the concepts of attention and executive control described above in this literature review is remarkable.

The term samatha not only refers to the mental training of attention; it also refers to the state obtained via that practice, the state in which one can focus on an object for an unlimited period of time without wavering. (Wallace, 1999b, Lutz et al., 2007). This is a serene state in which attention becomes neither so excited that one is distracted, nor so lax that the object is forgotten in a torpor. The state is reached by progressing through ten stages, described by Wallace both in an academic journal (1999b) and in a practical manual published in the popular press (2006).

As an overview of the progression of the training in samatha (the practice) to reach the state of samatha, Wallace and Shapiro (2006) explained that in Buddhist attentional practice, the first emphasis is cultivation of mental and physical relaxation. Once sufficiently accomplished, attentional stability then comes to the fore, and once that is sufficiently achieved, development of attentional vividness becomes primary. The end result is attentional balance. When attention is balanced, one maintains a high level of attentional arousal and at the same time continues to be deeply relaxed and composed. Hence samatha translated into English is “quiescence.” In the state of samatha, the mind is free of laxity or dullness, and excitation or agitation or hyperactivity, and can then be used effectively for any task to which it is put.
Mindfulness and Introspection

As training progresses and as stability increases, there are fewer and fewer moments focused on anything else besides the intended object. Another dimension of the training is that one first attends to a physical object, and then proceeds to construct a mental image of it which becomes the focus. The vividness that is developed subsequent to stability is akin to having a very clear picture of the object; the term "clarity" is also used to denote a goal of the training and an aspect of the state. The way one sustains attention on the object without distraction is "mindfulness," a usage of this word that is notably different from its use in the type of meditation called "mindfulness meditation" and MBSR as described above. In the Buddhist usage, mindfulness has to do with being fixed steadily on the object (Rapgay & Bystirisky, 2009). Mindfulness is the mental faculty of maintaining attention without distraction; its function is non-distraction (Wallace, 2006).

Mindfulness is the principal means of accomplishing samatha, but it must be accompanied by the mental faculty of introspection. This has the function of monitoring the meditative process. It is a meta-cognition, and detects laxity or excitation to distraction. This is the same monitoring that is referred to in the class of meditative or mental training practices described above, Open Monitoring. Vipassana, which is translated as "awareness," is the primary style in this second class. At a more nuanced understanding of Tibetan meditative practices, samatha (mindfulness) and vipassana (awareness) are thought of as two aspects of the same meditative state, and both must be integrated into a single practice. For novices, the two aspects are understood to work at odds (Wallace, 1999b).

Samatha in the Current Study

The stated intention of Wallace's practice manual (2006) is to provide tools for anyone who is interested in training their capacity for attention. Of the ten stages of development of samatha, he indicated that one need not complete all ten stages to benefit from the training. Even achieving the first two stages would lead to dramatic improvements in the quality of all endeavors. Going beyond stage 2 requires a commitment of time of at least two hours daily, and the more advanced stages of attentional development are accessible only by dedicating weeks or
months to retreat from normal life. Progress beyond stage 4 requires a vocational commitment involving full time practice for months or years at a time. Hence the present study targets only the first two stages of attentional development, which use the technique of mindfulness of breathing, already described.

The first stage is embarked upon with a mind dominated by excitation. One can bring the object to mind, but almost immediately the mind flits to another thought or sensory impression; attention is scattered. Wallace (1999b) cites scientific evidence that the duration of focused attention is one to three seconds. The first stage is achieved when attention can exceed that and be focused for several seconds. Hence the recommendation is for many short practice sessions for this first stage. As training progresses through the stages, session durations are elongated and frequencies are decreased. (Wallace, 2006).

Wallace recommends 24-minute twice daily practice sessions for the second stage. In this stage, attention can occasionally be sustained for a full minute or so at a time. The actual stability in this stage is not so long as it may seem. Experientially, it seems to the practitioner that attention is still fixed on the object while other thoughts and sensory impressions come to mind. This is analogous to the false belief that one can multi-task. The more likely explanation, according to Buddhist psychology, is that attention is disengaged from the intended object but disengaged so briefly before it returns to the object that it appears to be unbroken. At stage 2 a gross level of stability is achieved, along with ongoing gross excitability. This accomplishment is enabled by thinking about the tactile sensations of the breath around the nostrils and the expansion and contraction of the abdomen; and also by counting the breaths. Counting the number of breaths is done as a form of monitoring attention; the focus is not supposed to shift to the numbers per se. In stage 3, attention is on the meditative object most of the time during the sessions which elongate from 24 minutes up to 48 minutes; only periodically during this time does attention need to be returned to the intended object. In this stage, one begins to cultivate vividness (Wallace, 2006).

In addition to direct training of samatha, Wallace (2006) also recommended training in Loving Kindness as an ancillary practice. This is considered as a complement to the training in
attention because it is a means to balancing emotions. In the manual, this practice is introduced in two parts, after the first stage and after the second stage. Briefly, Loving Kindness is accomplished by focusing first on the self or a beloved other, and then expanding the feelings of love and compassion for this initial object outward to ever widening circles of known to unknown personages. Such a practice is advisable because emotions can otherwise create obstacles to the stable focus of attention. Loving Kindness meditation is a widespread practice in Buddhism that cultivates a sense of love and compassion toward all living things. It is said to inhibit anger and jealousy between meditative sessions (Lutz et al., 2007).

Engaging in samatha practice, even if only to the second stage (Wallace, 2006) has a high level of a priori validity as a method for training attentional abilities because it entails holding attention on one object for increasing periods of time, monitoring the hold, and pulling focus back to the intended object quickly when it has strayed. It also has face validity as a method of improving the inhibition functions as well ability because to increase stability, the time of steady unperturbed focus, the practitioner must learn, perhaps unconsciously, to inhibit distractions. The traditional effects expected to arise from Focused Attention meditations are greater ability to concentrate and a decrease in susceptibility to being perturbed or distracted; and these accrue prior to reaching the highest levels of practice. Lutz et al. (2007) concluded from two brain imaging studies that Focused Attention meditation enhances processing in regions of the brain associated with attention. Based on evidence of neuroplasticity in response to meditative practice, they further concluded that many mental processes including attention should be conceptualized as trainable skills similar to music, math, and mah jong.

To summarize this section, meditation in the Buddhist tradition is a means of training mental processes. A particular type of meditation which specifically trains the mental process of attention is samatha. Although complete training in samatha leads the trainee through ten stages and can likely be accomplished only if meditation becomes one's vocation, benefits accrue from practice at the level of the first two stages. With the exposition of meditation provided in this section as a foundation, the next section reviews research into the cognitive effects of that practice.
Evidence That Meditation Affects Cognition

A great deal of research has been conducted on the benefits of meditation, as evidenced by the abundance of studies available to Ospina et al. (2007). However, most of these looked at physical health outcomes and some looked at mental health and well-being. Support for the proposition that meditation could improve cognitive function and especially attention in older adults (OAs) is sparse; only two clinical studies have looked exclusively at OAs. The greater portion of what little is known about cognitive effects of meditation comes from interventions that investigated younger adults (YAs). The clinical interventions that have been published to date are described below, beginning with the two studies that did investigate the effects of meditation on OAs. Only the first of these is a qualitative study. Following the study reviews is a summary of effects and the study methods that hold promise for the current study.

Morone et al. (2008) provided qualitative evidence of subjective improved attention emerging from MBSR. There were 27 community-dwelling adults (M= 74, SD = 5.3) who had chronic low back pain of at least moderate severity and of at least 3 months duration. They participated in an 8-week MBSR training program and during that time kept daily diaries of their experiences, which they turned in weekly. The diary was one page per week with space each day to record time spent meditating, comments about the day's meditation, and general comments about the MBSR experience. Over the 8-week period the average number of participants turning in the diary (the week's single page) was 18. At the conclusion of the training, the diaries were qualitatively analyzed via a grounded theory approach. The second of six themes that emerged was the improvement of attention skills. Other themes concerned pain, sleep, and well-being. Specifically, participants noted improvement in their ability to pay attention. Diary comments included, “My concentration and awareness improved so much. My mind does not wander anymore as much as it used to. I am more focused” (p. 845); and “Benefits of clearer thinking/focusing continue” (p. 844). One participant associated increased attention to an improved sense of well-being. The study authors speculated that mindfulness meditation had
permitted greater attention regulation, resulting in ability to choose how to direct their attention. At a 3-month follow-up on the effects of the training, 64% responded affirmatively that they could concentrate better after learning mindfulness meditation. Other findings useful to the present study were that it was feasible to train the OAs in MBSR and that they were compliant with the homework to the extent of practicing an average of four days per week for 30 minutes a session in response to a directive to meditate six or seven days per week for 45 minutes.

One weakness of the study for the present purpose is that few comments regarding attention were reported, and it is unclear whether the two direct comments provided were from different participants. Although attention emerged as the second theme (assuming the themes are ordered by volume of related text), there is no indication of the portion of participants who made such comments. This study suggests that MBSR affected attention skills beyond training focused attention during the meditations, to an improvement in attention in the conduct of everyday life. However, it is unknown whether the trainers made everyday attention improvements salient as a possible outcome. If so, then the spontaneous comments might only be evidence of demand characteristics of the training. Yet even in that case, of only imagined subjective improvement, the study indicates that OAs valued the improvements. This is useful to the current study as an indicator that at the recruitment stage, something of value is being offered to potential participants in exchange for their participation.

Alexander, Langer, Newman, Chandler, and Davies (1989) recruited participants from retirement homes, a senior living apartment complex, and a nursing home to compare the effects of three treatments and no-treatment on subsequent adaptability and alertness. One treatment was meditation, specifically Transcendental Meditation® (TM®) that used a mantra to facilitate focusing attention. Another treatment was non-meditation mindfulness training of the sort described above in the Levy et al. (2001). This was a mental training program for actively directed thinking practiced via verbal and creative tasks. The third treatment was mental relaxation. The objectives were to determine whether a change in consciousness brought about by the first two treatments would reverse age-related declines and whether the changes would extend life over the next three years. The sort of consciousness that TM® and the mindfulness
training were expected to induce has been referred to as a fourth major state of consciousness in addition to the three ordinary states of waking, dreaming, and sleep. The authors explained that this is consistent with William James's position that waking consciousness itself is not a homogeneous state. The fourth type is a restful alertness of greater awareness than is typical of normal wakefulness and results in the individual directing attention to new contextual cues that may be consciously controlled as appropriate.

The authors’ intention was to test their hypotheses on an "advanced elderly population." Average age of the 73 participants was 81. Some of them had dementia. Only those who were clearly unable to remember instructions from day to day were excluded. A stratified random assignment was used so that each group included participants with dementia. For all treatments, the 12-week training program included weekly classes, twenty minutes of practice in the technique two times a day at home, and weekly half-hour individual meetings with the instructor to verify and correct the technique.

Four different measures of cognitive functioning were administered before and after the 12 weeks, as well as measures of health, mood, and personality. The cognitive measures were verbal pairs, a test of learning and memory; word fluency, regarded as a test of cognitive flexibility; Overlearned Verbal Task (OVT) which the authors created for the study as a test of mindfulness and attention, specifically ability to adjust from overlearned to more adaptive responses; and the Stroop color word interference test, a test of attention and response inhibition (Lezak et al., 2004). Posttest scores were adjusted after covarying for pretest scores. Computing effect size (ES) for TM® compared to no treatment from the scores reported by Alexander et al. (1989) yielded .90 on verbal pairs and .97 on OVT. Because pairwise differences did not reach statistical significance, the authors did not report sufficient data to allow ESs to be computed for word fluency or color word interference. However, the means on the latter test for the TM® and no treatment groups were 20.74 and 25.90 respectively, a 20% decrease in response time for TM®. On word fluency the means were 36.87 and 31.79, a 16% increase in the number of words generated for TM®.
More TM® group members than those in mindfulness or relaxation groups were found to practice regularly (i.e., at least once a day; 80% compared to 48% and 47%). In a subjective evaluation of program effectiveness at posttest, the TM® group members reported feeling better and more interested during each practice than the mindfulness and relaxation groups' members. More TM® group members (75%; Z = 2.40, p<.01 for n = 39) reported that overall their technique was "valuable" to them than did participants in the mindfulness (38%) and relaxation groups (40%) when participants were asked to describe their program in their own words at posttest. Alexander et al. (1989) speculated that the minimal TM® group dropout rate was attributable to the group members perceiving a greater benefit from this practice. Three years (i.e., 36 months) after the training ended, all of the members of the TM® group were still alive, a survival rate of 100%. Survival rate was 87.5% for mindfulness training, 65% for relaxation, 77.3% for no treatment, and 62.6% for remaining populations in the same institutions who had not been study participants.

This study controlled for salient differences in treatments, participant expectations of benefit, and instructors. Drop-out analysis was reported. Hence, the results can be assumed to be more valid than studies not controlling for these possible confounds. It clearly demonstrated both objective and subjective benefits of meditation to older adults, including what the authors referred to as the ultimate test of increased adaption, extension of life. For the purpose of the present study, it demonstrates that OAs can learn TM®, a mantra form of meditation according to Ospina et al.'s (2007) taxonomy, and that the participants found it to be interesting and valuable. Moreover there was an acceptable rate of compliance with the homework requirement for daily practice over the entire 12-week period. The study would have been more informative in regard to the present study had the measures of attention and inhibition via the Stroop test been better discriminated among groups. Yet the study did demonstrate that meditation can have a large improvement effect on learning and memory, attention, and cognitive flexibility with strong to moderate effect sizes. Moreover, these results were achieved with a sample that included OAs whose cognition was compromised by dementia.
Wenk-Sormaz (2005) noted that the focus of research on meditation in Western cultures had been on medical and psychological symptoms with little if any research into its cognitive consequences. She also noted that there was no empirical evidence demonstrating how much meditation is necessary in order to produce a desired effect. She conducted a study on 120 undergraduate students (mean age 19.5, SD = 1.92) to test the hypothesis that the practice could reduce habitual responding. According to the author, habitual responding arises from biases and from fixed mental sets that organize and interpret perceptual stimuli. Habitual responding can be undone by allocating attentional resources to actions and experiences. This author’s explanation of habitual responding is consistent with some of the outcomes of a deficit in inhibition functioning of attention described by Hasher and Zacks (Hasher et al., 1999), specifically that in a novel or complex situation, a person with poor inhibitory control can only fall back onto highly practiced responses and belief systems, responding automatically rather than composing a more adaptive response. Poor inhibitory control in the IDT sense might not be the only cause of habitual responding, but it could well be a contributing factor, according to IDT.

Wenk-Sormaz's (2005) study participants were meditation-naive and randomly assigned to one of three conditions: the experimental condition, an active control group, or a rest group serving as the passive control group. All three conditions consisted of three 20-minute sessions that were accomplished within two weeks on different days and as close together as participants’ schedules allowed. That is, some participants may have accomplished all three sessions including testing in as little as three days, and none took longer than 14 days to complete their participation tasks. At the first two sessions, an instructor taught the technique for ten minutes before the participants’ 20-minute practice. The experimental intervention belonged in the Fixed Attention class (Lutz et al., 2008). The author stated it was modeled on Zen Buddhist meditation with focus on the breath, based on Kabat-Zinn (1990). Participants practiced while listening to an audiotape of the instructions for the twenty minutes. The active control group learned the ancient Greeks’ mnemonic, Method of Loci, and then applied it to a learning task for twenty minutes. Wenk-Sormaz considered this a "concentrated attention" task. Participants in the rest group were told to sit, rest, and let their minds wander.
The first two sessions could be considered learning sessions. Pre-and post-testing occurred on the day of the third session, immediately before and after practicing the technique for twenty minutes. Similar to Alexander et al. (1989), Wenk-Sormaz (2005) used the Stroop color word interference test (SCWIT) to measure ability to inhibit habitual responding. She also used a word production task in which the variables of interest were the number of atypical categories and the number of word stem completions. The effect size (ES) of the SCWIT scores at post-test for the meditation group compared to the combined control groups at post test was .59 based on average ratio scores (interference response time divided by baseline response time; the author noted that using the ratio measure did not change the statistical significance level of the reported effects). When a measure of arousal (galvanic skin conductance) was added in as a covariate, ES of SCWIT based on the t statistic of a planned contrast was .64. Accounting for arousal allowed Wenk-Sormaz to conclude that the cognitive effect of meditation was not mediated by physiological relaxation.

No effect was observed for the other dependent variable, the word production task. The author interpreted that lack of effect to be caused by unclear task instructions to participants. Hence, she conducted a second study with altered instructions for that test. Ninety undergraduates were randomized to the same three conditions. However, the second experiment differed from the first in that there were no learning sessions. Instead, participants were pre-tested, instructed in how to do the intervention for the group they had been assigned to, performed the technique (meditation, Method of Loci, or rest) for 20 minutes, and then were post-tested. The ES for the word production task (specifically, the average frequency of producing an atypical response) based on the means of the meditation group vs. pooled means of the two control conditions was .71, computed from the t test statistic of a planned contrast.

This second study additionally attempted to control for the possible inherent capacity that some people might possess for intentional control of attention. The author speculated that some participants' meditation performance might be attributable to a natural proclivity for attentional control. In order to control for this possible individual difference beyond the control offered by randomization, at the pre-test participants completed a questionnaire that measures the degree to
which individuals become involved in perceptual and imaginary experiences. This was used as a measure of what the author called “absorption.” On this measure the mean score of the meditation group was .34 standard deviations higher than the overall mean, and an ANOVA revealed a trend toward differences between groups on this variable in spite of random assignment. When scores on this questionnaire were added as a covariate in a planned contrast, the ES for the word production task based on the t test statistic decreased to .59, a medium effect size. The author concluded from both studies that meditation does affect cognition, specifically that it can disrupt habitual patterns of behavior and that it gives an individual the flexibility to respond in a non-habitual way. She pointed out that the effects were found immediately after engaging in meditative practice and presumed that effects are sustained over time and may become more pronounced with longer practice.

Wenk-Sormaz’s (2005) studies found strong effects with minimal treatment: just two 10-minute instructions from a human and three 20-minute practices with a tape in the first experiment, and only one 10-minute instruction and one 20-minute practice in the second. This seems too good to be true, warranting further consideration of the validity of the methods. Here I consider the sampled population, the treatments, the testing timeframe, and the data analysis. The rapidity with which participants presumably learned to meditate sufficient to alter their attentional control may be typical only of young college students, or perhaps of an even more restricted population, young college students admitted to very exclusive universities (Yale, in this study) from which it can be inferred the cognitive and other abilities are in the upper percentiles of the population rather than more broadly representative. The treatment in Study 1 was fairly brief; it was even more brief in Study 2. For the second study, the procedure was altered to eliminate two practice sessions because Study 1 participants across all three conditions reported during debriefing that the extra sessions were of little value. It is understandable that practice sessions had little value to the rest and learning groups because there was less to practice. A more complex treatment for the active control group and longer involvement of a human instructor might have made the active control intervention more congruent with the experimental condition and hence a better control. Longer involvement of the instructor would also have been more
valuable to the studies in that the trainer could have observed outward signs of the quality of the meditation, as was done in the Alexander et al. (1989) study and in others described below. In this study, habitual responding was measured immediately after a 20-minute meditation period. Hence the results are only informative about the immediate effect of meditation, and not longer term benefits to participants and practitioners. This could also be the reason for finding of a strong effect. Another concern is that the author did not discuss practice effects on the tests, and for Study 2 the retest was within an hour. This is perhaps a minor concern in a controlled study such as this because practice effects would be a factor for all groups. Thus, results for the experimental group cannot be attributed to this factor. Conceptually related to the practice effect is the possibility of de-motivation in the control groups, which would have been evidenced by post test scores that were worse than pre-test scores. The author did not indicate how pre- and post-test scores compared in either study, although for Study 1 the reader was informed there were no group differences in pre-test performance. Both studies conducted analyses only on post-test scores, justified by the author on the basis of random assignment; this is the most important criticism of the studies because it obscures the improvement if any wrought by the technique. If the meditation group did not improve, and the control groups did worse because, for example, they were bored by their experimental task or entered torpor because of it, the effect size might be impressive, but it is the negative effect of the control condition rather than an indication about a benefit arising from meditation. Lastly, there is concern about controlling for participants’ innate ability to intentionally control attention (Study 2). The theoretical motivation was not discussed and thus the appropriateness of the variable chosen to measure it was unclear, as was the true meaning of the effect found. Controlling for this variable seems to have been an attempt to elevate results unreasonably far beyond reproach. It is unique to this study among the ones reported here, and does not appear to be necessary in controlled studies with random assignment.

Tang et al. (2007) conducted a 5-day study on meditation-naive undergraduate students in a Chinese university (mean age 21.8, SD=.55). The 80 participants were randomly assigned to experimental or control conditions. Each group had daily, 20-minute practice sessions at the
same time every day. Instructions for both conditions were provided by CD. The control group was given training and time to practice a relaxation technique. The experimental group's practice was supported by the recorded instruction on posture, breathing, guided imagery, and mindfulness; by recorded music; and by a coach (the first author). The experimental technique, Integrative Body-Mind Training (IBMT), had been developed by the first author based on traditional Chinese medicine and other meditation techniques. His objective in developing IBMT was to introduce a technique with reduced reliance on control of thoughts as compared to other methods of meditation, and thus to be easier for novices to learn. The coach observed facial and body cues of the participants during the practice via closed circuit television (CCTV). Immediately after each session he helped any individuals who had appeared to be struggling with the method and answered any questions.

Pre-testing was conducted one week prior to the start of training; post-testing was conducted immediately after the final session. The Attentional Network Test (ANT; Fan, McCandliss, Sommer, Raz, & Posner, 2002), a computerized test of attention that calls for responses to competing stimuli; and Raven's Progressive Matrices (RPM; Raven, Raven, & Court, 2003), a culture fair test of intelligence (Lezak et al., 2004), were used to measure cognitive functioning (stress and mood were also assessed, but not of interest to the current study). The ANT indicated post test improvement in executive attention functioning for the experimental group compared to controls with an effect size of .44. In regard to RPM, t tests on group means indicated significant improvement in post-test scores for the experimental group and no significant improvement for the control group; ANOVA results were statistically significant of the group X session interaction at p = .085. Effect size for IBMT on the measure of intelligence was .40. The authors concluded that IBMT was an effective way to improve self-regulation in cognition and that the study supported the idea that attention is a flexible skill that can be trained.

One source of the strength of this study is that the treatment, IBMT, is apparently well defined. The description of IBMT was necessarily brief in Tang et al. (2007), but more detail is available at the website of the first author. Moreover the developer of the technique was involved in the study providing initial training, then observing participants via CCTV, and making
corrections in participants’ execution after each session. Given the sample and setting, the authors increased the generalizability as well as reliability of results by using measures that had been developed in the West but non-verbal and culture fair. Using people blind to experimental condition to conduct the assessments further enhanced reliability. The authors addressed the question of generalizing from China to the West by informing readers of preliminary studies conducted in the United States and published in China that showed similarly strong effects. They also dismissed the concern that participants would be biased by culture-based belief in the benefits of meditation, by informing readers that undergraduates in modern China do not highly value meditation or traditional medicine. However the authors did acknowledge the possibility of subtle differences in cognition between Chinese and Americans due to culture specific experience in language and mathematics. It is helpful to the present study that the authors identified aspects of the treatment that likely contributed to the results: conducting training at the same time of day for five consecutive days and having coaches who are skilled in interacting with students and in creating group harmony. One weakness arises from the use of RPM at both pre- and post-test, just two weeks apart; and in fact a “training” effect was found on this measure. This likely is the cause of the p value at .085 for the group X session effect. This might be more of a concern with a small effect, but here the medium-size effect makes a larger-than-usual p value adequate.

Jain et al. (2007) studied the effects of meditation on students who were experiencing psychological distress. The reduction of ruminative and distractive thoughts are of interest here. Eighty-one medical and nursing graduate students and undergraduates (aged 18 - 61, mean 25) were randomized into one of three conditions: mindfulness meditation, somatic relaxation, or a no treatment wait list. The meditation intervention was modeled on MBSR and included sitting and walking meditations, yoga stretching, body scanning, and a loving kindness meditation in which one seeks to cultivate compassionate awareness. Each of the two treatment groups were given didactic materials and tapes. Over the course of one month, each of the first two groups met weekly for classes that lasted 1.5 hours, four classes in all. Both treatment groups also met for a 6-hour retreat on the Saturday after the third week. Hence the total contact time for each of
the treatment groups was 12 hours. Treatment group participants reported an average of 5.3 hours practice at home (range .5 to 15 hours, SD = 5 hrs). Pre-testing was conducted ten days prior to the start of training and post testing was conducted within two weeks of the end of the month-long intervention. The study period was the last month of the semester. A self-report questionnaire was administered both pre- and post- to assess distractive and ruminative thoughts and behaviors.

At post-test, the meditation group showed significantly less ruminative thought than the control group and significantly less distractive thought than both relaxation and control groups, with pre-test scores used as covariates. I calculated effect sizes (ESs) to be .82 for rumination and .83 for distraction at post-intervention for the meditation group compared to the control group. Within the meditation group, the effect of the intervention was ES = .57 and .25 for rumination and distraction, respectively. Hence the large effect sizes observed in comparison to the other groups were partly due to increasing rumination and distraction in the relaxation and control groups. The increases in these groups may have been due to the timing of the study near the end of a university semester. Hence the effect of meditation compared to relaxation training and no treatment at post treatment was a combination of intervention effect and historical effect. The authors concluded that meditation was unique in reducing rumination and distraction compared with relaxation, and that it was effective even in times of high stress. While participants in the other two conditions were having difficulty maintaining efficient cognitive functioning and deteriorated, the meditation group not only maintained, but improved functioning.

This study was thorough in that there were checks for social desirable responding and checks on instructor or class setting differences - instructor and setting differences were not found. This study can be criticized for choosing the month prior to exams as the study period (although it was possibly better for motivating attendance) because it conflates effects of the experimental conditions with individual responses to semester end and exam stress. However, the objective was to study effects on distress, and in that respect the study period was well-chosen. Group differences on initial levels of distress were not controlled in analyzing the changes in rumination and distraction, which would have been useful for the present study.
Instead, the authors conducted mediation analysis of the latter variables on stress. The implied model is that change in rumination and distraction are the direct result of treatment, with change in distress as an outcome of those intermediate change. This study should not be faulted for using self-reports on ruminative and distressing thoughts instead of more objective measures for cognitive effect, given the authors' objective. However, the measure used is intended for assessing rumination and distraction specifically in response to depressed mood, so measures of those constructs as more global response styles would have been more informative for the purposes of the present study. Finally, the question that could more appropriately be asked is whether the study has relevance for the present study. Given that rumination and distressing thoughts are examples of internal stimuli that ideally are inhibited, the study does indeed seem to inform the present undertaking, although the cause of rumination and distraction in the students studied by Jain et al. (2007) is very likely different than the cause of the age-related inhibitory deficits and follow-on rumination and distraction that have been observed in OAs.

In order to study the effect of meditation and meditation x age on attention, Jha, Krompinger, and Baime (2007) recruited 34 medical and nursing students who were meditation naive. Half were already enrolled in an 8-week mindfulness training course (mean age 24, SD = 2.5); the other half served as controls (mean age 22, SD = 2.3). They also recruited experienced meditators who were about to take part in a month-long meditation retreat (n unspecified; age range 22 - 57, average 35). Attention was measured by the ANT (Fan et al., 2002) which was briefly described previously as used by Tang et al. (2007). This computerized test was administered immediately before the start of the retreat and the course, and again shortly after the training courses ended; controls were tested in the same time frame as the mindfulness training course. Response times and accuracy did not differ for older vs. younger experienced meditators at either pre-test or post test. At pre-test, the experienced meditators had significantly better response time and accuracy in executive attention than the other two groups. At post test, there were no group differences in executive attention; the control group’s scores had improved without the benefit of any meditation training. The authors speculated that the ANT as they used it was subject to practice effects or floor effects, and that the retreat had taught the experienced
meditators to use a type of meditation other than a concentrative, fixed attention type. This is the sort of situation that Lutz et al. (2007) had cautioned against: confusion or insufficient delineation of the type of meditation that was being used by experienced meditators who have agreed to be experimental participants, and consequential mixed results that are unexpected. Regardless of the lack of results, the authors asserted a provocative demonstration of meditation as an attention training protocol.

Provocative or not, the study did not use random assignment, and the authors did not have control over training protocols. An interesting possibility that the authors raised is that the advanced training provided by the retreat qualitatively changed the meditation performed in ways that confounded measurement. This is not inconsistent with Lutz et al.’s (2008) 2-class taxonomy of FA and OM meditation styles. Jha et al. (2007) can be criticized for not being sufficiently apprised of the goals of the retreat (e.g., was it to qualitatively advance the meditative practice from FA to OM?). The lack of effect of meditation training among the novices permits speculation of undetected individual differences between those who had self-selected enrollment in the 8-week training and the control group. The authors themselves as already noted questioned the power of the instruments to detect difference. It was not reported that a power analysis had been performed to determine sample size; perhaps the sample was too small to detect effects for the variables of interest by the measurements used.

Chambers, Lo, and Allen (2008) conjectured that mindfulness meditation practice enhances development of the ability to focus attentional resources in a sustained manner, and promotes development of the ability to switch that focus at will. These are abilities that bridge mindfulness and enhanced cognitive performance. They evaluated the impact of an intensive 10-day training in mindfulness meditation (up to 110 hours of actual practice) on cognition in comparison to no-treatment controls. Measures of interest were the Digit Span Backwards (DSB) from the WAIS III (The Psychological Corporation, 1997), a widely used test of attention and working memory; and an ad hoc measure of attention switching devised by the second and third authors. All participants were novices. Twenty enrollees in the training course (aged 21 to 55, average 34) formed the experimental group; 19 psychology students and others (age range 22 -
63, average 32) served as controls. Pre-testing took place immediately before the course began; post testing was delayed for 7 - 10 days after its completion to allow experimental condition participants to readjust to their normal lives and to allow for a better measure of enduring effects of the training without contamination by possible transient effects. Both groups were tested in this timeframe. Participants were tested individually at the same time of the day both times. The meditation group significantly improved on the DSB from pre- to post-test, whereas the control group did not. The related effect size (ES) for the meditation group was .71 and .02 for the control group. Comparing the two groups' mean DSB scores at post test, ES = .53. ES at pre-test had been .12 in favor of the control group. On the ad hoc switching task, the meditation group significantly improved their overall response times (ES = .27) whereas the control group did not (ES = .15). Comparison across groups' means showed minimal effect at both times. The authors stated the results indicated that mindfulness training may significantly benefit working memory capacity and sustained attention.

The hypotheses tested are highly congruent with those of the present study. The authors did not use random assignment but did recruit from the training course wait list a 25% portion of the control group so that inherent individual differences between people interested in learning meditation and others would have been mitigated. This study used a very strong treatment paradigm in respect to duration, intensity, and purity (meditation only, no yoga or relaxation, in contrast to the type of training used in, e.g., Jha et al., 2007), and even though the authors had no control over the training, they chose one that, they reported, was structured so as to promote compliance with their theories. The choice of DSB as a measure of attention and working memory is well supported, and the ESs obtained are more than adequate to make strong claims for the effect.

A four-session yoga and meditation regimen was designed by Sanghani, Deavenport, Herring, Anderson, and Medina (2008) as a way to treat stress. Their study of the program's effectiveness also looked at stress-related psychological parameters, of which cognitive disorganization is of interest here. As previously described, Inhibitory Deficit Theory predicts that deficits in inhibition can disrupt problem solving and comprehension, and prevent coherency in
thought (Hasher et al., 1999, 2001; Lustig et al., 2007). In short, deficits in inhibition can result in cognitive disorganization. Sanghani et al. measured the variable by two items on a Canadian National Center for Health Statistics questionnaire. The four sessions constituting the intervention were 90 minutes long, two each week for two weeks. Each session included time for relaxation and meditation. Additionally, seven ways to breath (i.e., various breathing techniques of yoga) were taught during sessions 1 and 2; and 14 yoga positions were taught in session 3. Session 4 was a review of all techniques presented in the first three sessions. Participants in the intervention group were given DVDs containing the yoga and meditation exercises so they could practice at home. University faculty and staff, medical center staff and patients, and members of the community were the experimental group (n=40; age 22 - 62, average age 37). There were forty wait list controls from the university staff and student body (age 23 to 66, average 32). As measured by the two self-report items, cognitive disorganization became worse for the control group over the two-week study period and the intervention group improved (effect size = .99). At pre-test the control group's mean indicated insignificantly less cognitive disorganization than the treatment group (t = -0.51) but at post test, the comparison of means of the two groups showed a large effect for the intervention (effect size = 1.04). The authors acknowledged the possibility of a treatment bias in that participants may have responded to their expectations about receiving help.

This was a very ambitious study in terms of the breadth of treatment (seven breathing techniques, 14 yoga positions) in a short duration. It seems to be too much material for participants to learn to execute accurately, given the slight amount of practice time with an instructor. Techniques such as those listed require individualized feedback from an instructor based on observation of the student and not just student review of a DVD demonstration. The mixture of yoga and meditation also limits the relevancy of the study to the present study, although the expert panel assembled by Ospina et al. (2007) considered yoga to be a form of meditation. Another concern about the study is the method of measuring outcomes. Cognitive disorganization and other dependent variables were assessed by only two items each on a self-report questionnaire. Moreover, these researchers had shortened the original instrument from 18 to ten items because participants in a pilot test of the study procedures had felt it was too long.
Given these problems, the strong effect found for the treatment might indicate the power of the treatment, or perhaps only inaccuracy of measurement in a favorable direction.

Both Lutz, Slagter, Rawlings, Francis, and Greischar (2009) and Slagter, Lutz, Greischar, Francis, and Rawlings (2007) studied a group of 17 experienced meditators before and after they attended a three month retreat, and compared them to a control group of novices in order to study meditation's effects on attention. The experienced meditators ranged in age from 22 to 64 (median 41) and the novices were aged 20 to 62, same median. The retreat provided ten or more hours of practice a day. The novice group consisted of people who responded to a recruitment call that they were interested in learning how to meditate. They were given a 1-hour class and told to practice for twenty minutes a day for a week before they were tested. Pre-test for both groups occurred before the retreat began, post-test for both was after its end. One week before the post-test, the novices were again invited to the lab for another hour of group instruction and told to meditate for twenty minutes a day for the next week before returning for testing.

Slagter et al. (2007) measured attentional blink in their study. Attentional blink refers to the phenomenon of a brief slow down in mental processing due to having processed another very recent event; it is also called the psychological refractory period and is believed to result from limited attentional resources (Ashcraft, 2006). Slagter et al. operationalized the phenomenon by presenting two visual targets T1 and T2 in quick succession; if T2 cannot be seen, the visual deficit is attributed to attentional blink. The minimal time difference between T1 and T2 presentation at which T2 can be seen is a measure of interest, called attentional blink size. Slagter et al. suggest that a half-second is a smaller than normal size although most individuals are able to detect some T2 on at least a portion of trials when it is presented just 500 milliseconds (ms) after T1. They hypothesized that meditation lowers the amount of attention resource required to process T1, thus leaving more resource available for use in detecting T2. If true, the measurable result would be a smaller attentional blink size. This would be evidence of more efficient attention processes among meditators. In addition to recording performance on the attentional blink task, they recorded brain potentials from the scalp. The targets were presented at intervals either 336 ms or 672 ms apart. Participants did not engage in meditation during
performance of the attentional blink task. A three-way interaction of interval, group, and lab session (pre-test or post-test) was found. Only the experienced meditators showed a significantly smaller attentional blink at post-test both with and without including pre-test T2 accuracy as a covariate. However, both groups had significantly increased T2 accuracy at post-test. Short interval effect size (ES) was = .87 for novices and 2.26 for experienced meditators. The authors stated that possible explanations for some accuracy improvement is perceptual learning or improved prediction of the target stream, but that such general practice effects could not explain the effect in the short interval trails. The scalp-recorded brain potentials indicated that the smaller attentional blink was associated with reduced brain resource allocation to the first target, and those participants who showed the largest decrease in brain resource allocation to T1 generally showed the greatest reduction in attentional blink. The authors asserted that the study demonstrated that through the mental training afforded by meditation, it is possible that one can have increased control over how brain resources are used. They furthermore stated that the study corroborated the hypothesized life-long plasticity of brain and mental functions.

Lutz et al. (2009) used the dichotic listening task and EEG on the same two groups of participants studied by Slagter et al. (2007). Their objective was to investigate whether meditation could improve ability to sustain attention. The authors hypothesized that meditation enhances the stability of attention and thus sustained attention ability through three regulative functions: (a) monitoring the environment for stimuli; (b) disengagement from a distracting stimulus without further involvement; (c) redirecting focus promptly to the chosen object. These are the three skills listed above as required by samatha and other FA meditations. The authors further hypothesized that increasing levels of skill in meditation were accompanied by decreasing effort to sustain attention.

Dichotic listening tasks are tests of auditory attention. In this type of task, sounds (e.g., tones or human voices) are presented to participants through stereo headphones, so that one sound is presented only to the left ear while a different sound is being presented to the right ear. The participant is told to ignore the sound presented in one of the ears (noise) and to respond only to the sound in the other ear (the signal). Lutz et al. (2009) presented participants with a
series of tones ("tone pips"). There were two standard tones, which were presented as the majority of pips; and two deviant tones presented infrequently. Any of the four tones could be presented to either ear. The task was to detect an intermittent deviant tone in the designated signal ear channel and to respond with a button press. Throughout the trials, noise tones in the other ear were to be ignored. Participants were instructed to do this task as a meditational practice focused on the signal ear. Both the reaction time (RT) to respond to the tone and the variation in RTs were measures of interest. Variability in RT from one trial to another had previously been linked to impairment in ability to sustain attention. EEG measurements were collected to provide similar indicators of stability or variability in brain responses to the deviant tones.

There was a significant group X time (pre-test or post-test) interaction effect with both groups performing better at post-test. Effect sizes were ES = .53 for experienced meditators over time and .13 for novices. Both the behavioral RT data and EEG signal data indicated that meditation had enhanced attentional stability (measured as decreased variability) in responses. They also found that the more advanced meditators had reduced cortical engagement, that is, less effort in sustaining attention. Furthermore, meditation may have improved signal-to-noise ratios in neural networks involved in attention. That is, there was evidence that the signal stimuli (the task-relevant stimuli) were amplified and the noise stimuli (the task irrelevant stimuli) were dampened.

The Lutz and Slagter research team (2007, 2009) have offered enlightening evidence of the brain effects of meditation. Their research was theory driven based on current understanding of traditional meditation methods as experienced by meditators, and the hypotheses tested are relevant to IDT. The research did not use random assignment and some may view this as a limitation. However, random assignment is not feasible when studying people who have a skill developed over many years, whether that skill is meditation, music, or executive leadership. Here, the researchers attempted to equalize individual differences associated with self-selection to attend the meditation retreat, by recruiting controls who also had a stated interest in meditation and were willing to practice it. The novice meditators constituting the control group received very
little training in return for their participation. Yet their split two hours of training and at-home practice resulted in a large decreases in attentional blink. The procedures used in these two studies are categorically inappropriate for the present study; the results are not. The effect sizes for experienced mediators were very large in the first study and moderate in the second.

Polak (2008) noted that investigations into the effects of meditation have not yet determined the minimal "dose" to achieve effects. Her experimental condition was two 15-minute sessions of meditation with attention focused on breathing. There were two active control groups. Participants practiced the assigned task (focused breathing, relaxation, or neutral task) for 15 minutes at the first session meeting. This entailed following the directions from an audio recording. Then they came back within two days and did the same recorded training task. A total of 165 undergraduate students were randomly assigned to one of the three conditions. There were no significant differences among the three conditions in performance on the ANT, Stroop, and a verbal memory test. Clearly the dose used here was insufficient in some way, because the sample size was large enough to detect even a small effect and the instruments used have been successfully used elsewhere to detect differences, although Jha et al. (2007) had similar outcome with the ANT and Alexander et al. (1989) did not find statistically significant group differences with the Stroop. Possible causes for the lack of effect include the insufficient understanding of how to execute the meditation from the pre-recorded instruction, the minimized time of practice, and unmotivated participants whose interests were sufficiently served by being present in the lab without being engaged in the task. The value of this study is that it provides a lower bound in regard to procedures for the present study in terms of duration, involvement of an instructor, and engagement of participants.

Anderson, Lau, Segal, and Bishop (2007) tested the hypothesis that mindful meditation involves several modes of attention and inhibition of elaborative processing. Participants were randomly assigned either to an 8-week meditation, yoga, and relaxation training course (n=39, mean age 37) or to a wait list control group (n=33, mean age 42). The experimental condition was an MBSR course of weekly 2-hour classes that included meditation practices such as focused breathing, mindful stretching, body scan, and eating a meal more mindfully (i.e., paying
close attention to e.g., sensations of food in the mouth). There were also homework assignments to apply the skills in everyday life. The classes were oriented to improved coping with stress and anxiety. The authors stated that participants engaged in no other forms of meditation for the duration of the study.

At the pre-testing session, the participant was asked to sit on a mat in a dim room and relax for 10 minutes prior to the testing. At the post-testing session the control participants again relaxed for 10 minutes as before; and the meditation group participants were asked to do sitting meditation during this time. The meditation group was further asked that during the subsequent post-testing, they invoke mindfulness (non-judgmental awareness of one’s environment, thoughts, and sensations) as they had learned to do in the training. Post testing for both groups took place within 4 weeks of the completion of the course. Although the meditation group had larger changes than the control group in the direction of well-being on self-reports of depression, anxiety, and anger, there were no statistically significant results for any of the measures of attention. The authors stated that the efficacy of the meditation course was further validated by group and time comparison of scores on a measure of mindfulness, which showed an effect size of 1.59 for the meditation group and no change for the control group. Hence the lack of effect on attention was especially puzzling and the authors undertook analyses of potential confounding effects to find an explanation. Age, the amount of time people in the meditation group had practiced mindful activities, and baseline levels of emotional well-being were considered. None of these was found to be explanatory. The authors asserted that neither the delivery of the meditation training nor the task designs were responsible [sic] for the null effects of the training. Further analysis of the data collected via the mindfulness scale revealed it did not predict changes in two modes of attention (sustained attention and elaborative processing of emotion words personally relevant to the individual). Changes in mindfulness did predict performance on a third measure of attention, detection of target objects in a field (figure drawings) where the target was incongruent, for example a chicken in a living room. In the experimental group, but not the control group, better object detection was associated with greater increases in self-reported mindfulness i.e., an improved ability to evoke mindfulness. The authors pointed out that success
in this task required awareness unfiltered by expectations, which they indicated is different from basic attention control. The authors concluded that whereas the focus of the study design had been on the meditation's effects on basic attentional functioning, changes in quality of awareness such as that exhibited in the object detection task, might be better foci of future studies.

In summary, the eleven clinical studies above present solid evidence of meditation's effect on cognition. Alexander et al. (1989) clearly demonstrated that OAs aged 81 on average can learn to meditate using a mantra, that they will adhere to an experimental regimen of 12 weeks’ duration, and that they will be relatively compliant with a requirement for two twenty minute at-home practices a day. Moreover, the meditators found the training interesting and valuable, which likely resulted in the lower dropout rate of participants assigned to this condition compared to that of the other conditions. By including people with dementia and mild cognitive impairment in their study, they demonstrated that intact cognitive functioning is not an imperative qualification for future studies. Some of the success of the Alexander et al. training may have been attributable to the one-on-one time with the instructor in addition to the group class time. Tang et al. (2007) also claimed that accessibility to the instructor had been important. Jain et al. (2007) similarly provided group experience and access to instructor, notably via a 6-hour retreat in addition to weekly classes. In contrast, the lack of results or small effect sizes in other study designs may be attributable to delivering instructions without the high-touch condition of instructor's presence (Lutz et al. 2009; Pollack, 2008).

The medium effect sizes obtained by Wenk-Sormaz (2005) and Tang et al. (2007) indicate that, at least with university students, positive effects accrue after a very short time (one to five days), although Pollack's (2008) results indicated two days may be insufficient. Jha et al.'s (2007) findings of little difference post test on the ANT, which measures basic attentional functioning, seem to be confirmed by Anderson et al. (2007) that meditation enhances awareness without expectation rather than fundamental attention. Anderson et al.'s finding that the object detection task and only that task showed an intervention effect supports the idea that a task such as the RwDT (Connelly et al., 1991) might have sufficient contrast effect.
The effect sizes (ESs) obtained in the clinical studies reviewed are generally in the medium range or larger. The large ESs found in Alexander et al.’s study of OAs bodes well for similar studies of that population with meditation as the intervention. In addition to Alexander et al., two of the best-done studies are Jain et al. (2007) and Chambers et al. (2008), both of which obtained large ESs. Not all effects were large, and a main cause was likely the use of ad hoc instruments (i.e., word production, Wenk-Sormaz, 2005; attentional tasks by Anderson et al., 2007 and Chambers et al., 2008) or failure to anticipate practice effects (i.e., Raven's Matrices by Tang et al, 2007; ANT by Tang et al., 2007 and Polak, 2008).

Summary

Attention has been determined to be central to all of cognition (Ashcraft, 2006; Cohen et al., 2006). Hence, good cognitive functioning requires good attentional functioning, and problems with attention result in problems with cognition in general (Howieson and Lezak, 2002; Lezak et al., 2004). There are various ways to divide the function “attention” into subfunctions. The one most useful here is a major cleavage into excitatory and inhibitory functions; and then a minor cleavage of the inhibitory into access, deletion, and restraint (Hasher and Zacks, 1988). Excitatory functions are those that allow the individual to notice and attend to new stimuli; they arouse and stir to action. They increase the mental energy of which Ashcraft spoke. Inhibitory functions on the other hand, have a dampening effect. They decreases the energy, cut the energy flow to a stimulus. Inhibitory functions prevent, restrain, block. The first of the three inhibitory functions serves to block access to working memory (WM). Upon detecting some content of WM that is not needed or wanted, the deletion function serves to remove it. Restraint comes into play when a responses is forthcoming based on WM contents - it prevents responding in a manner that does not serve the individual's goals at that point in time; it inhibits impulsive responding.

The Inhibitory Deficit Theory (IDT; Hasher and Zacks, 1988) claims that the excitatory aspects of attention are maintained with age, but that the inhibitory aspects decline into deficit as
one gets older and older (Hasher et al., 1999). Hence, the common observation that cognition in older adults is often poorer than that of younger adults is due to inappropriate content in WM, "mental clutter" (Hasher et al., 1999). Given that IDT is supported by both behavioral (c.f. Lustig et al., 2007) and neuroimaging studies (Gazzaley & D'Esposito, 2007), the inhibitory attentional functions appear to be the cognitive rehabilitation target with the most leverage for attaining the goal of preventing age-related cognitive decline.

However, there has been very little research into ways to improve attentional functioning in OAs, and none targeting the inhibition functions. Of the attentional rehabilitation methods known to be effective in younger populations experiencing insult to the brain, the effect appears to be limited to improvement of the trained skills rather than a more generalized cognitive effect (Michel & Mateer, 2006). Given that these training methods do not specifically target inhibition skills, the limited effect is congruent with the predictions of IDT.

Widening the search for training programs with the potential to repair deficits in inhibition functions, meditation comes into view. There are many forms of meditation in many different contemplative traditions (Ospina et al., 2007). One of the most psychological (Wallace & Shapiro, 2005) and precisely defined (Lutz et al., 2007) traditions is that of Tibetan Buddhists. In this tradition, meditation is considered mental process training, and attention is its initial target (Wallace, 2006).

Meditation is a broad umbrella term, and even among Tibetan Buddhists it is generic with many specific forms of practice (Lutz et al., 2007). The style of practice that specifically seeks to train attention is samatha. In samatha, one attempts to keep attention fixed on an object for theoretically unlimited time (Wallace, 1999b). Hence, it uses and further develops three abilities: ability to sustain a focus on the object; a monitoring ability that can notice that attention has wandered; and ability to re-direct attention back to the object without delay (Lutz et al., 2007). Using the lens of IDT, the skills involved can also be expressed as (a) inhibiting distractors, (b) noticing when distractors have gained attention, and (c) deleting the distractor from WM and returning attention to the object. The analogy of this skill set to the inhibition functions defined by Hasher and Zacks is remarkable.
Although there is an immense body of research on meditation as a beneficial treatment for symptoms of physical illness (Ospina et al., 2007), there is a dearth of research on the effect of meditation has on OAs' cognitive abilities. However, there is evidence that members of this population can learn to perform some types of meditation and that these practices do have beneficial effect on cognition, including attention (Anderson et. al, 1989; Morone et al., 2008). The forms of meditation used in these studies share some aspects with samatha but are not samatha. There is also limited evidence that meditation has beneficial effect on younger populations' cognitive abilities (Chambers et al., 2008; Jain et al., 2007; Tang et al, 2007, and specifically attention (Chambers et al., Lutz et al., 2009; Slagter et al., 2007; Tang et al.; Wenk-Sormaz, 2005). No studies specifically on the effects on the inhibitory attentional functions appear in the literature.

Research Hypotheses

The purpose of this study was to evaluate a short training program in samatha Fixed Attention meditation as a cognitive enhancement protocol for OAs. The program was designed to create improvement in attentional functioning and specifically the inhibitory functions such that the improvements would be expressed both directly on measures of attention and inhibition, and indirectly as improved general cognitive functioning and self-assessed memory functioning. The study was designed to test the following hypotheses. Note that "practice" in the context of meditation means "to do" or "to work at" similar to its usage by professionals such as psychologists, attorneys, and physicians.

Research Hypothesis 1: The inhibitory sub-functions of attention in older adults can be improved by a short course of samatha practice.

Research Hypothesis 2: Cognitive functioning in older adults can be improved by a short course of samatha practice.

Research Hypothesis 3: Older adults' self-perceptions of cognitive functioning in the area of memory can be improved by a short course of samatha practice.

Research Hypothesis 4: Older adults' self-perceptions of being attentive to everyday and routine occurrences can be improved by a short course of samatha practice.
The purpose of the proposed study was to determine whether healthy, cognitively intact older adults who are meditation-naïve (i.e., have not yet learned to do mindful meditation) benefit in terms of cognitive functioning from the practice of a simple form of meditation. Here, the word "practice" refers to performance of the meditation techniques. Interest is in changes in OAs' attentional functioning, particularly inhibitory functioning, and consequently in cognitive functioning beyond attention. Additionally, there is interest in the extent to which OAs will engage in the practice and in their self-reported perception of any improvements in attentional misses and memory.

This chapter outlines the methodology used to test the research hypotheses posed at the end of the previous chapter. It describes how people were recruited to participate, inclusionary and exclusionary criteria, and assignment into experimental and control groups. The chapter also reviews the instruments that were used to collect quantitative data about demographics, self-perceptions of cognitive abilities, and objective data about cognitive functioning both before and after the training intervention. The treatment provided to the experimental group - the training intervention - is described in detail. Finally, the chapter states the statistical hypotheses and data analysis approach.

Research Design

The study was an experimental design with one independent variable, the treatment. The experimental treatment is the training in, and practice of, samatha meditation. Hence, participants were randomized into two groups, experimental and control. All participants were
assessed before and after the training period. This design allowed for control of pre-existing conditions and also allowed for estimates of treatment effects in spite of differences between the groups at the start of the study period. The use of repeated measures (albeit different forms of the measures) allowed each individual to be his or her own control, which typically increases the power and precision of statistical tests (Morris, 2008). Power analysis using $\alpha = .05$, $\beta = .2$, a conservative Cohen’s $d = .65$ based on the effect sizes of similar studies reviewed in Chapter II, and $\sigma$ estimates of 1.0 for the experimental group and .5 for the control group, also based on studies reviewed in Chapter II, indicated that a final target sample size of 35 participants would be sufficient (Lenth, 2006-9).

Participants

Community dwelling adults aged 62 years or older who had been retired for at least 2 years and who were experiencing no more than normal age-related (as determined by pre-test performance - see below) cognitive decline were recruited from several communities in Northeast Ohio. As retirees, participants would no longer have had a rigorous routine of working daily, which can keep the mind active and forestall cognitive decline (Adam, Bonsang, Germain, & Perelman, S., 1997; Lupton, Stahl, Archer, Foy, Poppe, Lovestone, et al., 2010). The majority of evidence reviewed above that supports the Inhibitory Deficit Theory was garnered from studies of adults aged 60 and above. Hence, the present study drew its sample from a similarly aged population.

Exclusionary criteria included (a) compromised physical health that would not allow the person to attend and fully participate in the training interactions (e.g., inability to ambulate to the meeting space, inability to sit for one hour); (b) insufficient cognitive capacity to comprehend instructions and complete the pre-test assessment; (c) severe mental illness (e.g., schizophrenia), although mild or managed depression and anxiety would not be cause for exclusion; (d) inability to attend at least five of the eight training sessions; (e) corrected eyesight insufficient to read test materials et cetera; (f) hearing insufficient for comprehending speech in a
group situation; (g) currently taking drugs such as donepezil (trade name Aricept®), memantine (trade name Namenda®), and rivastigmine (trade name Exelon®) that are reputed to have cognitive-enhancing effects; and (h) current, on-going meditation experience. Additionally, participants would have been excluded had they been unwilling a priori to provide requested demographic or assessment data; make a commitment to complete the study including pre- and post-tests; and agree to keep confidential the study procedures until the completion of data collection. Only criterion (e) was explicitly assessed at the pretest. Persons interested in participating in the study were asked to verify that they met all the inclusion criteria and none of the exclusion criteria. Several did not meet the age or retirement criteria, and several informed me that they did take one of the medications named above. No sensitive or personal health data were collected. The experimental treatment was hypothesized to be robust enough that a potential participant who was cognitively compromised, but motivated to join the study, able to comprehend the testing materials, and able to complete the pre-test assessment, is also able to potentially gain any benefit and not be subject to any additional risks.

Forty-eight older adults were enrolled in the study and pre-assessed. Twenty-five were randomized into the experimental group and 23 into the control group. Three women in the experimental group subsequently dropped out: during the first week of classes, one informed me that a family member was having surgery and she would need to care for him; and another informed me that she would have to miss half of the remaining classes to attend to storm damage. Follow-up phone calls to a third person after she had missed the third class were not returned and she did not attend further classes. In addition to the three drop-outs, a fourth person in the experimental group had severe back pain on the day of the post-assessment and did not want to re-schedule; his performance on the objective tests was not considered a valid representation of his abilities and his data were not included in the analysis. Of the 23 people randomized to the control group, one was dissatisfied with her assignment and chose to drop out of the study immediately. Another member of the control group was ill at the time of post-assessment. Hence, the number of participants who completed the study and whose data were analyzed was 42, 21 in each group. There were eight men (six in the experimental group). All
participants were white, European Americans with the exception of one woman who was Korean. Ages ranged from 62 to 92 ($M = 73.4$, $SD = 6.8$) for the entire sample. Ages of the experimental group ranged from 62 to 89 with average 72.4 (7.1). For the control group the range was 64 to 92 with average 74.4 (6.5)

Instrumentation

Self-reported status as qualified for the study, demographic data, self-perception of cognitive abilities, and objective data in regard to cognitive abilities were obtained. Participants were asked to record the days and durations of their at-home practice, and given opportunity to comment on the experience at the end of the study. This section identifies and describes the instruments used.

A document describing the study and providing contact information was composed in accordance with the requirements of the University of Akron for informed consent (Appendix B). A separate document (the Participation Agreement, Appendix C), reiterated basic qualifications and identified commitments necessary for participation. Basic demographic (name, age and gender) and contact data (residence, phone number, e-mail) were collected via the form in Appendix D.

Trail Making Test (TMT)

The Trail Making Test (TMT) was part of the Army Individual Test Battery developed circa World War II by US Army psychologists (e.g., Lezak et al., 2004). The test is in the public domain and is widely administered in neuropsychological assessments of attention and executive functioning (e.g., Chaytor, Schmitter-Edgecombe, & Burr, 2006). TMT is also used in construct validations of other measures of attention (e.g., Sherman, Strauss, Spellacy, & Hunter, 1995). This test is considered to reflect overall integrity of general brain functioning (Groth-Marnat, 2003). General cognitive ability has a significant correlation with TMT (Soukup, Ingram, Grady, & Schiess, 1998). The test is used to differentiate among various causes of cognitive dysfunction.
Most importantly for the present purpose, it has been used to effectively detect early stage dementia as well as track progressive decline in abilities over dementia's trajectory (Groth-Marnat). TMT has a strong cognitive flexibility component (Kortte, Horner, & Windham, 2002).

The test has two parts, A and B (see below). Part A primarily tests visuoperceptual abilities (Sánchez-Cubillo et al., 2009). Part B is considered a measure of the ability to inhibit a dominant, but incorrect, response (Barry & Petry, 2008) and to reflect working memory and task-switching ability (Sánchez-Cubillo et al.). Hence, this test was used in this study as a general measure of cognitive ability, especially as that ability arises from attention and executive function.

TMT is an individually administered paper-and-pencil test in which the time to complete the task is recorded, along with the number of errors, if any. The task is similar to connect-the-dots. Each of the two parts is presented on a single 8.5 X 11 sheet. Trails A has numbers 1 through 25 scattered on the sheet, each appearing in a small circle or bubble. The task is to draw a line to connect bubbles in order, and to do so with speed and accuracy. Trails B is similar except that there are letters as well as numbers appearing on the sheet in bubbles. For part B the task is to connect alternating number, then letter bubbles in order. Again there are 25 bubbles, containing numbers 1 through 13 and letters A through L. Trails A is always administered before Trails B and likely provides the examinee with some practice that has transfer to Part B. There is also a sample test for each part, consisting of eight bubbles; this is given before that part's administration and is untimed. See Appendix E for the protocols. During the standard administration of each part, the examiner points out any error as it is made and the examinee continues forward from the last correct connection, while elapsed time continues to accrue. Older examinees are sometimes given additional practice in TMT's motor skills component (speed and agility) by connecting 1 to 25 in bubbles which are regularly placed in columns. This protocol is also in Appendix E. As noted above, the two parts are considered to be measures of different cognitive mechanisms and for this study interest is in the broader cognitive functioning the which Part B taps. However, Part A was also administered for the important learning it provides for use on Part B.

Soukup et al. (1998) reported on factors that impact performance on the TMT. Higher
education is associated with better performance. Age is a critical factor in TMT performance, especially for examinees older than 50. Mild psychiatric disorders do not appear to impact performance. Ivnik, Malec, Smith, Tangalos, and Petersen (1996) and Tombaugh (2004) have published norms for OAs' completion times of each part. The Tombaugh norms for the 50th percentile by age show a range for Part A from 32 seconds for ages 60-64, to 54 seconds for ages 85-89. For Part B the range is 68 seconds for ages 60-64 to 138 seconds for ages 85-89.

**TMT Reliability and Practice Effects**

According to Lezak et al. (2004), test-retest reliability of the TMT is at least .60 in most studies, with many finding correlations in the .80s and some in the .90s. The design of the present study required participants to be tested initially before the training interaction and again after its conclusion. Thus, practice effects were possible. As Lemay, Bedard, Rouleau, and Tremblay (2004) noted, a test score can show a large practice effect, and nevertheless have a high test-re-test reliability if performance remains consistent across time. Consistent performance across time can be demonstrated by equivalent ranking of the examinees from one administration to another -- for example, the top 1% of examinees at first administration are identical to the set of examinees scoring in the top 1% at the subsequent administration. Improvement on TMT retest has been noted, but it is statistically significant only on part A, Lezak et al. (2004) stated, indicating that because group variation is higher for Part B, significance was not reached.

Practice effects have been observed, particularly when the second administration falls within three months of the first (Soukup et al., 1998). When the interval is 12 months, as it was for Basso, Bornstein, and Lang (1999), TMT scores did not change, although scores on three other measures of executive function improved significantly for 50 men whose mean age was 33. These authors commended use of TMT for serial examinations. Dikmen, Heaton, Grant, and Temkin (1999) studied the test-retest reliability and practice effects of several neuropsychological batteries and TMT was among the tests. Mean age of the 384 adults whose data were reviewed was 34. Test intervals ranged from two to twelve months (mean 9 months). Most of the tests had at least a moderate practice effect; TMT was in the minority with only a small practice effect.
Dikmen et al. also found that the magnitude of practice effect was an inverse function of age. Hence, practice effect will be less of a concern with the population being studied here.

One way to deal with practice effects is to have examinees attain the benefits of practice before the first administration of the test. Collie, Maruff, Darby, and McStephen (2003) repeatedly administered a battery of cognitive tests such as the TMT via computer over very short intervals of mere hours. They found that practice effects occurred mostly between the first and second administrations of the test battery, with very little more gained in the third and fourth administrations, all of which occurred on the same day. Falleti, Maruff, Collie, and Darby (2006) tested another way to eliminate practice effects, which is appropriate for the study proposed here. They had examinees (N = 45, age range 18 – 40) complete a battery of cognitive tests twice at ten minute test-retest intervals to eliminate the initial practice effect. They then administered the battery a third time at an interval of one month. No practice effects were observed.

In the present study practice effects were mitigated by giving participants an untimed practice exercise of connecting 25 bubbles, the same number as the TMT test versions, but placed at regular intervals. The protocol is in Appendix E. It was administered before the sample test for TMT A and was optionally administered at post-assessment; however, none of the participants chose to do this practice at that time.

**TMT Alternate Forms.**

Another way to mitigate practice effects is to use alternate forms, although using alternate forms does not assure the elimination of practice effects. Lemay et al. (2004) tested participants aged 52 to 80 three times on attentional and executive tests, some of which had alternate forms. The retest interval was 14 days. Although their battery did not include TMT, their finding is instructive: Tasks were generally subject to a practice effect, except for those with alternate forms. Moreover, tests with scores based on time had the best test-retest reliability without practice effect. Another study used trail making tests exclusively; however, the alternate forms are not described in published literature. Beglinger, Gaydos, Tangphao-Daniels, Duff, Kareken, Crawford, et al. (2005) used six alternate forms of each of the two TMT parts in five
weekly administrations. They found stability in the scores for the numbers-only, A-type forms, but
did not include the number-and-letter forms in the text of the results or discussion.

DesRosiers and Kavanagh (1987) devised parallel forms of parts A and B of the TMT,
which they called C and D. The alternate forms retained the same layout of 25 bubbles on the
page as the original forms, but inverted the labels. Hence, for part C, the bubbles containing 1, 2,
and 3 on A were re-labeled as 25, 24, 23, respectively, continuing for the entire sequence.
Likewise, part D was created from part B by changing the labels for 13, L, 12, and K on the latter
to 1, A, 2, B and so forth continued for the entire sequence. The authors claimed good face
validity for the substitutions since pencil movement time was constant across the sets so that any
differences in performance between alternate forms would be attributable to changes in decision
time. Using a retest interval ranging from 19 to 42 days, with an average of 29 days, they found a
strong intercorrelation across the sets, and test-retest stability. The correlation between parts A
and B was .656, between parts C and D, .891; and between the original form and the alternate,
.887. These same forms C and D were investigated by McCracken and Franzen (1992) and by
Franzen, Paul, and Iverson (1996). The latter study noted a trend for the second test set
administered, whether A and B, or C and D, to have faster scores than the first, but this effect
was not significant. Therefore these researchers concluded that times on the alternate forms
were comparable to the originals, and further that there was adequate reliability on the alternate
forms. Hence, they recommended clinical use. McCracken and Franzen (1992) further supported
the equivalency of the alternate forms to the originals via principal components analysis.

However, LoSasso, Raport, Axelrod and Reeder (1998) found that TMT-D appeared to
be more difficult in that people given that form for the test and TMT-B for the re-test, did better on
the retest than those who were given the two forms in reverse order (TMT-B before TMT-D). They
speculated that TMT-D was a greater challenge because it required spiraling inward from the
start point near a corner of the page, whereas TMT-B required spiraling outward from a start point
near the center of the page. They related this to prior research which had shown individuals scan
more slowly when items are in tightly packed arrays.
Modifications to TMT for Present Study

In light of the LoSasso et al. (1988) finding, and in spite of the DesRosiers and Kavanagh (1987), McCracken and Franzen (1992) and Franzen et al. (1996) results of sufficient equivalency of forms C and D, this research used alternate forms W and X, devised for this study. This set of alternates was devised by rotating the original forms A and B around the vertical axis to alter the orientation of the bubbles and the intended pathway connecting them, but not the spatial relationships. As a result of this manipulation, where the path goes up or down on form A or B, it goes up or down on W or X, respectively; where it goes right on A or B, it goes left on W or X, and where it goes left on form A or B, it goes right on W or X, respectively. Hence W and X have the virtues of forms C and D described above, without the complaint of opposite spiraling that LoSasso et. al. (1998) noted. See Appendix F for the alternate forms. In addition to using alternate forms to mitigate practice effects, the measurement of a control group enables isolation of treatment effects from practice effects.

For the present study, TMT completion times were recorded for A, B, W, and X. Cut-offs of 81 seconds for part A and 255 seconds for part B were set for the pre-test. The cut-offs represent performance at one standard deviation below the mean for age range 85 to 89 and up to 12 years of education, according to the norms provided by Tombaugh (2004). In neuropsychological testing of older adults, cognitive impairment is usually attributed to those whose performance is below more than one standard deviation below the mean. Had any participants been unable to complete the pretest TMT task by the time cut-off, they would have been excluded from further participation in the study; however, all who were given the pretest were able to meet the standard. Because the variable of interest was change from pre-test to post-test, it was not necessary to norm the level of performance.

Reading-with-Distraction Task (RwDT)

The Reading-with-Distraction Task (RwDT, Connelly et al., 1991), described in Chapter II, was developed to measure inhibition functioning and was used in this study to measure enhancement of that functioning as a result of the training interaction. This is an individually
administered test. Stories of approximately 125 words are read aloud by the examinee for speed and comprehension, and the reading time is measured. Each story has associated with it four questions each offering six multiple choices for answers (one is correct, all are plausible) to test comprehension. There are two test conditions. In the experimental condition, the stories are presented with the target text interrupted with distractor text in a different font; these are the target-plus-distractor, T+D, stories. In the control condition, stories are presented without distracter text and are known as target-text-only (TTO) stories. In the paper-and-pencil version, used here, each story is presented on a separate 8.5X11 sheet and has a title, which is also to be read aloud. In Connelly et al.’s administration, the story sheet is placed face down in front of the examinee; timing begins when the examinee turns the sheet over. The examinee is then given a second sheet with the four comprehension questions; answering the questions is not timed. The next story is then given face down and the timing routine repeats. The variables of interest are reading times for stories in each condition, and the number of correctly answered comprehension questions. These are averaged over the items in each condition so that there are two variables for each condition: T+D time, T+D comprehension, and TTO time and TTO comprehension. These can be further manipulated into variables of difference between the conditions on time and comprehension.  

RwDT's Variable Administration

As related in Chapter II, Connelly et al. (1991) experimented with different types of distractor material, using words related to the story content initially but then comparing the effect of unrelated words and strings of x's to the related material and control conditions. Carlson et al. (1995) altered the placement of the distracters within the text; and Darowski et al. (2008) modified the fonts. In addition to these studies, RwDT has been used by Duchek, Balota, and Thesing (1998); Dywan and Murphy (1996); Kemper, McDowd, Metcalf, and Liu (2008); Kim, Hasher, and Zacks (2007); Persad, Abeles, Zacks, and Denburg (2002); Salthouse, Atkinson, and Berish (2003); and others. There is no standard administration. Rather, the researchers have determined such parameters as the content of the stories, the number of stories in each
condition; type of material used for distractors; font style, size, and type (italic or standard); and administration medium (paper or computer).

Fourteen stories constituted the task as initially used by Connelly et al. (1991). The content of all fourteen concern young adults identified as students or as newly married or newly hired. One TTO story was used as a sample before the start of the task. Six TTO stories and six T+D stories were timed. The seventh T+D story was used after all the others in a catch-trial in which examinees were asked to recall any of the distractor words in it. Target text for all 14 stories was in Courier Italic 10 point font; distracters were in Courier standard 10 point. Examinees were told to read only the text in italics and to ignore any text in standard font. The questions were presented in Letter Gothic 12 point. In the second experiment, which had four conditions, only three stories were used in each condition.

Darowski et al. (2008) administered eight stories, four with strings of Xs as distracters (the light distracter condition) and four that used as distracters words that had meanings related to the story content (the high distracter condition). Target text was in italicized CG Times, a serif font; distracter words were in nonitalicized Abadi MT Condensed Light, a sans serif font (administered via computer, point size unreported). For the reading times, they reported coefficient alphas ranging from .93 to .96 across three age groups of OAs and both conditions. Internal consistency was estimated on the basis of the four difference scores (reading time difference between the two conditions); it ranged from .87 to .92 for the three age subgroups of OAs. From a reliability analysis using only the first half of the set of stories, they concluded that the task could be conducted with only four stories, two in each condition. Comprehension variables however, had unacceptably low reliability, at 41 and .42 for the two conditions, across all age groups of both YAs and OAs, and were not analyzed further. Connelly et al. (1991) similarly had stated that the comprehension accuracy data were "suggestive" but not quite "convincing" of age differences in the effects of the distracters (p. 538). Kim et al. (2007) did not use the comprehension questions.

Salthouse et al. (2003), with a sample of 261 adults between the ages of 18 and 84, converted both reading times and percentage correct of the comprehension questions into
z-scores, and then combined the two scores into one measure. They used four stories, two each for TTO and T+D, and 10 point Courier fonts in standard and italic. Kim et al. (2007) used four stories in the experimental condition and only one in the control condition, using 12 point Courier New in italic for target text. Here, distracters were semantically unrelated words presented in standard Courier New italic, 12 point. Duchek et al. (1998) created eight stories ad hoc, plus one for practice, modeling them after Connelly et al.'s (1991) descriptions. They presented target text in uppercase, bold font and distracters in lowercase italic font. As a pre-test that also offered some practice, they gave each participant a sheet of 30 unrelated words, half in bold uppercase and half in lowercase italics, and instructed them simply to read the uppercase words only. Dywan and Murphy (1996) similarly created their own stories, slightly longer at 136 words vs. Connelly et al.'s 125 words, and presented them in 13 point CG Times with distracters in italics. Distracters were four different words or phrases repeated ten times each at random for a total of forty distracters per T+D story (Connelly et al. and other studies used four words or phrases repeated 15 times for 60 distracters per T+D story). Distracter material was distinctly different but plausible to the story. They used six stories for each of two conditions. Visual examination of the Dywan and Murphy and the Duchek et al. sample test materials indicate that in the latter set there is much greater visual distinction between target and distracter text than in the former. To summarize, in spite of the many differences in the parameters applied when administering the RwDT, these studies found anticipated age differences and large differences in reading time between control and distracter conditions, indicating that the task is robust in these parameters.

Connelly et al. (1991) administered all six stories of each condition as one block. They noted practice effects among the OAs in the experimental condition (T+D stories) but not among YAs and not for the control condition (TTO stories). Their Newman Keuls test on the experimental stories revealed an improvement in reading time from first to third T+D story but no reliable differences after that. The graph of OAs' T+D reading times shows that the biggest decrease in reading times was from the first to the second T+D story; there was a lesser drop from second to third. Interestingly, the time on the fourth story jumped back up to the same level as the second; the reading time on the fifth and sixth stories were equal to each other and
somewhat longer than that of the third story but shorter than the second and fourth stories. The range of times was [120 sec, 139 sec] over the six stories, and the rank order from high to low of story position is [1, 4 & 2, 5 & 6, 3]. Hence it appears the Newman Keuls test was heavily influenced by the single big difference of longest to shortest reading time.

These same authors noted that the errors made while reading (e.g., hesitations, intrusions of foil words, omitting a word) were infrequent (about 1.5 per T+D story) and hence they considered slowing as the major impact of the distracters in the text. There was an age effect on the comprehension questions, with OAs answering fewer correctly than YAs in both conditions but the trend in the direction of greater disruption effect for OAs was nonsignificant. OAs and YAs were equally as likely to choose distracting material (the foil) as the wrong answer to the multiple choice questions.

Modification of RwDT for Present Study

A search of the literature failed to find any published studies where RwDT had been used as a pre-test and post-test of an experimental effect. Rather, it appears the test has been used only as a one-time assessment in which the focus was on the age effects -- or, in the case of Duchek et al. (1998), dementia effects -- in reading time and comprehension between TTO stories and T+D stories. Hence usage of the test in the present study differed in two ways from those reported in the literature. Here, the test was administered at two time points, before the training interaction and again afterward. Secondly, the variable of interest was comparison of the effects of distraction over time rather than comparison of TTO to T+D performance. In case the participant remembered the stories over the course of several weeks, the post-test used different stimulus materials from the pre-test administration.

This study used the stories of Connelly et al. (1991) which were provided to this researcher by Dr. Hasher's lab, modified to have older adults as the protagonists. They were presented in a larger and clearer font: 13 point Times Roman italic for target text and 12 point Arial for distracter text. Arial is a bigger font than Times Roman, so the single point difference in font size counteracts that difference. At each administration point, two TTO stories and two T+D stories were used. Similar to Duchek et al. (1998), examinees were given a sheet of 42 words
unrelated to any story content, about 60% in the target text font and 40% in distracter font; at the pre-test they were asked to read aloud only the italicized text. At the post-test, they were again given the sheet of 42 words as a reminder of the task and given the option to do the practice or not; no one took the option. Then, at both pre-tst and post test, a sample T+D story was given as practice before the four stimulus stories were administered. Reading time and number of stumbles were recorded, with the same signals for start (turning the page over) as used by Connelly et al. Comprehension questions were not administered. Stories and practice word list appear in Appendix G.

Attention-Related Cognitive Errors Scale (ARCES)

The Attention-Related Cognitive Errors Scale (ARCES; Cheyne, Carriere, & Smilek, 2006) consists of twelve items describing incidents of attentional failure. Respondents indicate the frequency with which they have experienced each of the twelve by responding on a 5-point Likert scale with anchors “never” and “very often.” The authors stated that the items reflect the cognitive mistakes which represent everyday lapses in attention cause. The advantage of using this scale instead of similar ones such as the Cognitive Failures Questionnaire (Broadbent, Cooper, FitzGerald, & Parkes, 1982) or the Mindful Attention Awareness Scale (Brown & Ryan, 2003) is that it has just one factor and is therefore closer to a pure measure of the distinct consequences of attention lapses without the effects of memory or other cognitive failure, and without recording the lapses per se or the tendency to experience lapses in attention.

The items for the ARCES came from the Cognitive Failures Questionnaire, from other research on attentional lapses, and from the authors’ (Cheyne et al.) personal diaries of lapses. Eight of the original items from these sources were dropped to form the current version. Cronbach’s α for ARCES was .88 in a sample of 449 undergraduates, and .89 in a web-community sample of 504. There was a good range of scores approximately normally distributed with minimal skewness and kurtosis. All the items had good item-total correlations. Principal components analysis of data from the latter sample found one factor with an eigenvalue of 5.50 accounting for 45.83% of common variance. It has good convergent and construct validity.
At pre-assessment, participants in the present study were asked to respond to the twelve ARCES items as they had experienced them during the previous two weeks; at post assessment they were asked to consider only the previous week. To score the ARCES, the five frequency responses were translated to numerical item responses (1 to 5, with "1" assigned to "never") and the 12 responses were summed to form a scale score. The instrument appears in Appendix H (items 1 through 12). Item 4 was modified with a text insertion to make it more meaningful to OAs. Specifically, "with unbuttoned buttons or" was inserted so that the item now reads, "I have found myself with unbuttoned buttons or wearing mismatched socks or other apparel."

Everyday Memory Failures Scale (MFS)

Cheyne et al. (2006) created the Everyday Memory Failures Scale (MFS) as part of their work to determine if ARCES preferentially measured errors caused by attention and not other cognitive failures such as memory errors. They pointed out that many of the everyday memory failures indirectly reflect prior attention lapses, for example by interfering with encoding. Since other measures of everyday memory functioning conflate the causes of the failures, the MFS items were chosen to minimize the contribution of attention. The authors concluded that their choices had been appropriate based on the results of a structural equation model. That model used data collected from 504 participants (ages ranging from "adolescence to senescence" [p. 584], mean age 32). The MFS failed to directly predict performance on an objective behavioral measure of sustained attention. The attention task used has been found to lead to habituation and distraction in examinees with insufficient ability to self sustain mindful processing. Whereas MFS was not related to that task performance, both ARCES and the Mindful Attention Awareness Scale were predictive.

Items for the MFS were selected from the Cognitive Failures Questionnaire, items from another widely used scale of everyday memory functioning, other research, and the authors' personal experiences. Cronbach's \( \alpha \) for the MFS items in the study described above was .86. A principal components analysis found a first factor with an eigenvalue of 4.74 accounting for 39.46% of common variance; a second factor had eigenvalue 1.27 and accounted for 10.54% of
common variance. Two items of the 12 formed the second factor, both referring to forgetting names. MFS is strongly correlated with ARCES ($r = .71$), which is consistent with the assumption (e.g., Broadbent et al., 1982) that everyday cognitive errors are multiply determined.

Similar to the instructions for the ARCES, participants in the present study were asked to respond to the twelve MFS items as they had experienced them during the previous two weeks at pre-assessment and to consider only the previous week at post-assessment. To score the MFS, the five frequency responses were translated to numerical item responses (1 to 5, with "1" assigned to "never") and the 12 responses summed to form a scale score. The instrument appears in Appendix H (items 13 through 24). The words "important ID codes like the PIN number for my bank card or my computer" were inserted into item 21 and a final "s" deleted to make it more meaningful to OAs. The item now reads, "I forget important ID codes like the PIN number for my bank card or my computer password."

Rosenbaum Pocket Vision Screener

The Rosenbaum Pocket Vision Screener, a commonly used instrument to check visual acuity, is a 6X4 inch eye chart developed by J. G. Rosenbaum to test the near vision of cataract patients confined to their hospital beds (Horton & Jones, 1997). It was introduced to the American Academy of Ophthalmology in 1963. It has been reproduced in major medical texts and is widely available from supply houses. It is reusable and reproducible by xerography. The type sizes range from 20/800 to 20/20. Per the directions on the card, the examinee holds it in good light 14 inches from the eyes, and the smallest distance equivalent and size print that can be easily and clearly read with both eyes and corrective lenses is noted. Not being able to read 20/70, 10 point would have disqualified the person from participating in the study; none failed to read the text. See Appendix I for a copy of the screener.
Practice Log

Participants in the experimental group were given a blank log each week and asked to record the days and durations of their practice sessions, and then bring the completed form back to the class. Sample forms are in Appendix J.

Experience Evaluation

At the post-test, experimental group participants completed an evaluation of the experience. Control group participants were asked at the posttest whether they had done any meditation since the pre-test; none had. These forms appear in Appendix K.

Procedures

The University of Akron Institutional Review Board for the Protection of Human Subjects approved the study; see Appendix L. This section describes the execution of the study.

Recruitment

Recruitment occurred at three community Senior Centers and took several forms, according to the preferences of the parties authorized to approve activities at the site. At one site, the board president allowed me to address the trustees at their monthly meeting and petition for permission to recruit from the membership and to use space at the center. The trustees were amenable, and the following week I gave a short talk to the membership at their monthly meeting. Additionally, a short article appeared in the center's newsletter. This was the newest center of the three and had the least space, the least programming, and a small but growing membership base. It is in an area that has been changing over from small rural town to suburb of a major city; professional staff had been added less than two years before; and it serves a mix of long-time residents and those who are moving into the area to occupy newly built, upscale retirement housing. Having a monthly membership meeting is atypical for the centers in more established areas with larger memberships. The recruiting activities here resulted in a high level of interest.
The sign-up was limited to 60 people, 25 of whom were enrolled for the current study (6 men). The enrollees reflected the community's mix of long-term and new residents.

Another site serves primarily working class seniors. It had a moderate amount of programming and square footage. Here, the executive director suggested I make an announcement about the project at the weekly luncheon and also put up a flyer on the bulletin board. Ten people (two men) were enrolled at this site; they included at least one former white collar worker and two teachers as well as several former factory workers.

The third site is located in an "up-scale" middle class area, and is known as one of the "premier" Senior Centers based on its physical facility and its programming. Without ever meeting or speaking with me, the executive director forwarded my initial email inquiry to the program coordinator, thereby delegating all decisions about my conducting the study at this site. The program coordinator scheduled me for a talk on brain health to be given twice as part of the center's health series. The talks were publicized in the monthly newsletter and each occasion attracted 60 to 70 people. During that talk I mentioned the study and invited people to speak with me about it afterward. Thirteen people were enrolled at this site, including one man. The enrollees here included former white collar managers, teachers, a secretary, and a stay-at-home mother.

The training I offered was free to participants, however, many programs offered at the Senior Centers such as physical exercise, crafts, field trips, and luncheons have a modest attendance fee; social work services and medical services such as blood pressure readings dispensed by nurses are funded by government grants. The funding of the centers is such that there are not restrictions on the seniors they can serve. That is, seniors are not restricted to belonging to the one in their own community, and "membership" entails little more than signing-up for the newsletter for a modest fee. Thus, people may belong to multiple centers, get several newsletters, and attend programs at any center. However, from my brief exposure, most individuals seem to habituate a single, primary center with occasional forays to other centers for a special program or activity not available at their favorite center. Hence, not all enrollees for this study actually lived in the community in which the center was located.
The three Senior Centers at which I recruited were chosen on the basis of their proximity to my own home as a matter of efficiency and practicality. None had diverse memberships, although younger segments of the population in these areas are slowly becoming more diverse.

At all sites, people interested in participating signed-up via the Senior Centers, providing their names and phone numbers. I contacted each by phone to answer additional questions and to schedule a time to meet them at the Senior Center for the pre-assessment.

Pre-test Assessment and Randomization

At the pre-assessment appointment, I reviewed the informed consent document and participation agreement with each person and obtained signatures and demographic data before proceeding to administer the measurement instruments. Review of the participation agreement included discussion about the person’s ability to attend the classes, and a commitment to attendance of the Phase 1 training if subsequently randomized into the experimental group was emphasized. At the time of the pre-assessment, the meeting times of Phase 1 sessions were known, but the meeting times for Phase 2 had not yet been scheduled at two of the centers. Most of the participants had their calendars with them and checked at this point to see if they were free for the Phase 1 meeting times. They were told that missing one or two sessions would be all right, and so one or two pre-scheduled appointments (medical appointments were predominant in their schedules) did not interfere with making the commitment asked for in the participation agreement. However, there were several cases of the person not being able to commit to attendance of the Phase 1 sessions. These cases were not formally tracked; anecdotally, a promise to pick up a grandchild after school, a planned vacation of 2-weeks duration, and surgery were some of the interfering prior commitments. In these cases, pre-assessment did not proceed.

The TMT including practice sheet, the Rosenbaum Pocket Vision Screener, and the RwDT including practice sheet were administered individually and privately. Participants completed the ARCES and MFS individually on-site. No protocols needed to be discarded for exceeding cut-off times on the TMT, and all were able to complete reading of the T+D stories. In
all cases at least 22 items of the ARCES garnered responses without evidence of random responding, and the same was true for the MFS with one exception. All pre-assessments were conducted within two weeks of the start of the training of the experimental group.

The 48 participants who were pre-assessed were randomly assigned to either the experimental group or the control group. Couples were randomized as one unit. One person, when informed she had been randomized to the control group, expressed dissatisfaction with her assignment and chose to no longer be a participant in the study. All others received the assignment with equanimity. At each of two sites, however, there was a person in the experimental group who determined after the first session that she would not be able to attend four sessions or more and dropped out. There were also several people in the control group who, although they were post-assessed, did not attend any of the Phase 2 training sessions and this was due variously to schedule conflicts, transportation issues, failing health, and unexplained.

Training Intervention

At each of the three sites, I conducted two phases of the training in samatha. Phase 1 was the training of the experimental group and Phase 2 of the wait-list control group. Data concerning the training of the control group were not collected for this project. The Samatha training was based primarily on Wallace (2006), which was written specifically as a guidance manual by an author who has himself conducted numerous retreats on samatha meditation and has distilled both his practice and teaching techniques into the handbook for the ten levels as indicated in Chapter 2. The author, a Buddhist monk prior to becoming an academic researcher, stated that his intention in writing the book was to "provide tools for anyone who is interested in training their capacity for attention to its fullest" (p. xii, italics added).

Only the first two stages, which are especially amenable to self-teaching, were taught during this project. The instruction for samatha itself offered by Wallace and others is simply stated for all the stages. The difficulty comes in the execution, the difficulty of developing a skill that modern life has atrophied. Development of the skill, as any skill, requires practice. The bulk
of the instruction Wallace offers to novices addresses obstacles to the practice and how to overcome them. Signs denoting accomplishment of each stage are also provided. The intervention for this study was planned for eight sessions over four weeks not because the instructions are so complex. Rather, the eight sessions were a means to provide encouragement to the participants; to give them information about researched effects of meditation that was expected to motivate them to practice regularly; to assure that they practice regularly; and especially to be with them while they developed the skill and to help them overcome the obstacles they encountered so that they could successfully develop the skill.

I contacted B. Alan Wallace via email about using his book (Wallace, 2006) as the text for teaching stage 2 samatha and leading participants in practice over an eight session intervention as mental process training to improve attention. I identified myself as a doctoral candidate in counseling psychology with a personal samatha practice using his guidelines. Specifically, I asked if a psychologist-in-training, by following his written guidance, was capable of conveying that guidance to others, at least to the second of the ten stages of samatha practice. Dr. Wallace replied, "I think this is an excellent idea and very feasible" (email exchange, September 20 and 21, 2010).

Qualifications of the Trainer

Neither the Ohio State Board of Psychology nor the American Psychological Association consider meditation to be a hazardous practice, according to the board's executive director, Ronald R. Ross (personal communication, September 20, 2010). There is no standard of practice for meditation for psychologists. The qualifications of the meditation trainers of the studies described in Chapter II had a broad range, from certification in a specific technique; to unspecified qualifications of trainers who merely provided an hour of instruction in the lab a week before pre-testing and then charged the trainees to practice on their own at home for the intervening week; to a 500-word instruction read from a book and recorded onto tape by an apparently untrained, non-practicing investigator for later listening in situ by participants. None of these techniques was identified as samatha.
I first learned Buddhist meditation over ten years ago, beginning with a 6-session class and then through weekly practice at a Zendo, which is a meditation hall in Zen Buddhism where sitting meditation is practiced. Samatha is somewhat different from the type of meditation taught at the Zendo I attended, but there are areas of overlap. I have been using the technique taught by Wallace (2006) for over a 18 months in a daily personal practice. Prior to conducting the training for this project, I taught the basic steps of the technique to older adult therapy clients in both individual and group modalities, similar to the initial sessions of the intervention of this study.

I have conducted group training sessions for over 30 years, initially in non-therapy settings and more recently in therapeutic arenas. I have also conducted training in relaxation, deep breathing, and visualization for chronic pain patients in both individual and group modalities as an intern. My doctoral training in counseling psychology and clinical experiences in pursuit of licensure as a psychologist, have prepared me well for leading and teaching such a group.

As preparation for my role as samatha instructor, I attended meditation sessions conducted by practitioners at three different levels of training, to observe their instructional methods. One session leader was a member of a local chapter of a national Tibetan Buddhist organization whose website describes a meditation practice similar to that detailed by Wallace, although the term samatha is not applied. Another was an ordained Tibetan nun whose vocation is to teach meditation and Buddhism in the greater Cleveland area. The third session was conducted by a group of monks visiting Cleveland from Tibet. There was a great deal of consistency among these sessions and with my own manner of instructing novices in the technique. I also consulted with both an Episcopalian minister who conducts an on-going meditation group; and a licensed psychologist who incorporates meditation techniques in his professional practices and also has a long time personal meditation practice. The psychologist agreed to be available for consultation on meditation-specific issues for this project, however his services were not required.

**Format**

The format was the same for both phases of the training. It consisted of two group meetings per week led by me over a period of four weeks, for a total of eight meetings. Each
meeting lasted 45 minutes to an hour. At these sessions, group participants were introduced to the first and second stages of mindful meditation as described by Wallace (2006). The protocol providing details for each session is in Appendix M. Each session included instruction in the method per Wallace (2006); multiple short practice sessions of the method beginning with one and two minutes the first meeting working up to 24 minutes by the seventh meeting; and debriefings on the participants’ experiences of both their at-home practice and the just-completed practice during the training session.

During the class, instructions were given prior to the start of a practice session to introduce a new aspect. In later sessions, these instructions were shortened reminders of how to do the technique. I did the practice with them so as to be a model of the posture and demeanor. Instructions were also given during the practice, and these were intermittent comments such as, “Notice the breath coming in through the nostrils;” “Let your body do the breathing naturally, and you be the observer of the breathing;” “Notice if you have been distracted, and if so, let go of the distracting thought and return your attention to the breath.” My choice of comments was based both on what the participants needed at their stage of learning (i.e., what was being emphasized in that class), and also my own experiencing in the moment. Thus, having a personal practice of samatha was vital to my conduct of the class.

In the debriefings, participants were validated in their triumphs and in their failures. Problem solving entailed suggestions from the other participants as well as from the trainer. One of the problems, mentioned by only a minority of the participants, was a tendency to drift off to sleep. According to Wallace (2006) this indicates a need for sleep, so the solution during practice at home is to then sleep and to do the practice later. During the in-class practices, I noticed regular breathing on a few occasions, presumably indicating the person was drifting off to sleep. In keeping with the class tenor of acceptance that I had cultivated for the sessions, and in order to not interfere with other participants’ practice, I did not arouse the person during the practice; the de-briefing in such cases always included an admission by the person that they had been sleeping, and problem solving. Making the experience more vivid is the antidote provided by Wallace for being drowsy.
Developing the ability to do samatha requires daily practice, in addition to twice-weekly class attendance. Homework was assigned at the end of the session, and compliance was often discussed at the beginning of the following session. Wallace (2006) refers to one or two daily practice sessions for stage 2 samatha. Participants were instructed and encouraged to practice at home daily for two sessions or more. At first the home sessions had a targeted duration of five minutes (four daily sessions), and the durations built up to twenty minutes twice daily by the seventh session. Participants were asked to keep a record of the time they spend at home meditating, and to bring the logs to the twice-weekly meetings.

Failure to Attend and Withdrawal from Study

Participants who missed a session without informing me ahead of time were contacted by phone to learn the reason for the non-attendance and expectations for future attendance. Of those who missed a session, only two did not give advance notice and only one of these could not be reached by phone for follow-up. Participants who could not attend five or more sessions were considered drop-outs. These were described above in the section on participants.

Post-test Assessment

The TMT, RwDT, ACRES, and MFS were re-administered to both the experimental and control groups as before in the pre-test assessment described above. The forms of the TMT and the content of the RwDT stories given to each individual were different from the forms used at the pre-test. Other post-intervention forms described above were administered. The post-test assessments were conducted within a week of the completion of the training, with the exception of one person in the control group whose post assessment occurred two weeks after the Phase 1 training completion.

Data Privacy and Security

The study design required that individually identified data be collected and kept so that the pre-assessment data could be matched to post-assessment data. No health data were collected. None of the data collected could reveal sensitive or damaging information, according
to IRB administrator Sharon McWhorter (personal communication, October 4, 2010). People interested in participating in the study willingly provided their phone numbers. All information collected was kept secure in my private home and will be destroyed after the follow-up contact has been made. Computerized case records were de-identified and therefore anonymous.

Statistical Hypotheses And Analysis

The four hypotheses about the efficacy of treatment (the training intervention) were tested by comparing the individual participants' gain scores to determine if there is a difference between the experimental and control groups. To compute a gain score, the participant's performance at post-assessment was subtracted from performance at pre-assessment. The gain score can be positive or negative.

The use of gain scores here was optimal given the increasing variability of cognitive and other areas of functioning with age (Dixon & Hutsch, 1999). Furthermore, it was the appropriate approach given the research questions. Data from similar research designs are sometimes analyzed as post-test scores with the pre-test scores used as covariates via ANCOVA. Using the pre-test scores as co-variates would have been inappropriate for this study because there is no evidence in the admittedly scant literature to date from similar studies that the treatment effect varies according to level of cognitive functioning. Yet co-varying with the pre-test scores would have the effect of equalizing the cognitive level of all participants. To use ANCOVA shifts the research question from "what is the effect of the treatment on the change from pretest to post test" to the question, "what is the effect of treatment on the post test that is not predictable from the pretest?" (Knapp & Schafer, 2009). The latter was not the research question of the present study.

Locascio and Cordray (1983) showed mathematically that the two methods (t-test and ANCOVA) are tests of identical effects if and only if the slope of the within-group regression of the posttest score on the pretest score is equal to one for both groups. Actually, if the pretest means are equal, then the two methods deliver equivalent conclusions as long as the within group
regression slopes are equal at any value. Such equivalency of the slopes is a requirement for appropriate application of ANCOVA. A slope of one obtains in the treatment group when there is a uniform effect of the treatment at all pretest score levels. However, as Brogan and Kutner (1980) noted, when an experimental group is to be compared to a control group, it is not likely that the slopes will be equal, preempting ANCOVA as an analysis procedure. Moreover, Maris (1998) showed that some of the oft-cited reasons for using the pre-test scores as covariates (regression toward the mean, measurement error, bias) are invalid. Even more poignant, he showed that if the assignment of cases to groups is not on the basis of the pretest, there is no basis for preferring the covariance approach to the analysis of the data.

Another procedure sometimes used to analyze the data from a pre-and post test design is a Repeated Measures ANOVA. However, in learning studies such as this one, the assumptions of coavariance equality and sphericity are not likely to be met, invalidating the method (Huck & McLean, 1975; Keselman, Algina, & Kowalchuk, 2001). Generally speaking, gain scores and other summary measures are considered to be good models for repeated measures designs (e.g., Delucchi & Bostrom, 1999; Matthews, Altman, Campbell, & Royston, 1990), and gain score analysis accords with the principle of parsimony (Huck & McLean). For all these reasons, the analyses will be conducted with gain scores as the dependent variables.

The hypotheses were:

1. The pre-to-post test improvement in performance on the Reading with Distraction Task (RwDT) is greater for the experimental group than for the control group. Performance on the RwDT was measured as the average time to read a Target + Distractor (T+D) story minus the time to read a Target Text Only (TTO) story. The TTO time set a baseline reading speed and hence was subtracted from the T+D time to gauge the delay caused by the distractor text. Two T+D stories were administered and their times averaged. A decrease in time, or a positive gain score, indicated improvement. This hypothesis was analyzed by using a Student’s \( t \) test statistic on the gain scores to group difference.

2. The pre-to-post test improvement in performance on the Trail Making Test Part B (the original form at pre-test and form X at post test) is greater for the experimental group than for the
control group. Performance on the TMT was measured by the time to completion. A decrease in that time, or a positive gain score, was an improvement. This hypothesis was analyzed by using a Student’s t-test statistic on the gain scores to determine group difference.

3. The pre-to-post test improvement in the Everyday Memory Failures Scale score is greater for the experimental group than for the control group. The score was calculated by summing the values assigned to the Likert response on each of the items. A decrease in the score, or a positive gain score was an improvement. This hypothesis was analyzed by using a chi-squared analysis on the gain scores, which are ordinal data, to compare the groups.

4. The pre-to-post test improvement in the Attention-Related Cognitive Errors Scale score is greater for the experimental group than for the control group. The score was calculated by summing the values assigned to the Likert response on each of the items. A decrease in the score, or a positive gain score was an improvement. This hypothesis was analyzed by using a chi-squared analysis on the gain scores, which are ordinal data, to compare the groups.

In addition to the primary research questions, descriptive analyses answered two preliminary questions: Can, and will, OAs learn the practice of samatha, a form of meditation that does not use a mantra? Will OAs practice samatha daily and accomplish the second stage of samatha as defined by Wallace (2006)? The first question was assessed through attendance and drop-out rates and via responses to the Experience Evaluation questionnaire in Appendix K. The second question was assessed via the diary reports (Appendix J) the participants were to turn in weekly. These data were collected only from participants in the experimental group.
CHAPTER IV
RESULTS

This chapter reports the results of the experiment. Forty-three participants completed both pre-assessment and post-assessment, 22 in the experimental group and 21 in the control group. However, the post-assessment protocols of one person in the experimental group could not be considered a valid representation of his ability because at the time of assessment he was experiencing severe back pain that interfered with his performance. Hence, the final sample size was 42, 21 in each group. Statistical procedures were executed via SPSS 19.

Participants’ Response To The Training Intervention

Forty-eight people were enrolled in the study and pre-assessed. Of the 25 people assigned to the experimental group, only one dropped out with neither advance notice nor response to follow-up. Two others were careful to warn me of that possibility when family obligations began to shift, and expressed regret when new duties led to an inability to attend. Of the 22 who completed the training, ten attended all eight classes, ten missed one class, and two missed two classes.

Compliance with the expectation for home practice was assessed via weekly practice logs (Appendix J) reporting the amount of time spent practicing each day. Most of the experimental group participants (13) turned in all four logs, and six others turned in three logs. The three other participants did not comply with the request to record their at-home practices, so the extent to which they practiced outside of class is undocumented.

Over half (7) of those who turned in all four logs, indicated engaging in 45 or more practice sessions; four more logged at least 32 sessions, and the remaining 2 logged 21 and 13
sessions (M = 44.6, SD = 16.6). Of those who returned three logs, the number logged ranged from 25 to 37 (M = 32, SD = 4.9). To summarize, seven participants demonstrated a high level of compliance with the practice requirement (4 logs, at least 45 sessions), nine demonstrated moderate compliance (4 logs but fewer than 45 sessions or only 3 logs), and three did not adequately demonstrate compliance (one or no logs). Furthermore, 16 participants reported on their log being able to maintain the practice for at least 20 minutes by the end of the classes.

As reported on the Experience Evaluation (Appendix K), everyone learned the technique at least "pretty well," and seven thought they had learned it "very well." The median response to the ease with which attention could be held on the breath without other thoughts or images intruding was "so-so" (neither difficult nor easy) and the median estimate of how long this focus could be maintained without distraction was 30 seconds. Everyone believed they could maintain focus for five seconds or more, and ten participants believed they could maintain it for at least 60 seconds. According to Wallace (2006), achievement of the second stage of samatha is marked by occasional continuity of the focus for about a minute. Participants had not been informed of the association of these times to stages of samatha achievement, so they are not likely the result of demand characteristics, although the multiple choice questions do lead the response more than an open question.

An important attentional skill expected to be taught in samatha is disengaging from an intruding thought and re-focusing on the object of attention (i.e., here, the breath). The median response to this question on the Experience Evaluation was that disengagement was "easy," chosen by 10 people with six and five choosing "so-so" and "very easy" respectively.

Improvement In Ability To Inhibit Distractions

The first hypothesis was that pre-to-post test improvement in performance on the Reading with Distraction Task (RwDT) would be greater for the experimental group than for the control group. Performance on the RwDT is measured as the average time to read a Target + Distractor (T+D) story minus the time to read a Target Text Only (TTO) story. The TTO time sets
a baseline reading speed and hence is subtracted from the T+D time to gauge the delay caused by the distractor text.

At both pre-test and post test, two TTO stories and two T+D stories were administered with the intention of averaging the reading times of each type to obtain a single metric at each administration for that type. However, at pre-test many of the examinees used extra time for the first TTO story, often in silence followed by a comment or question about the absence of any distracting text in that story. This was in spite of instructions that informed the examinees that some stories would be absent the distracters (i.e., TTO). At the post-test administration, this occurred much less frequently but did occur several times. To deal with this unexpected reaction to the first TTO story at each administration, the time to read the second TTO story was used to set the baseline, rather than the average of the two. This baseline was then subtracted from the average of the two T+D stories to measure the delay caused by the individual’s imperfect ability to inhibit the distractions in the text to calculate the gain score. This measure may be thought of as the cost of the distracting text.

A one-sample Kolmogorov-Smirnov test run separately for each group indicated that each group’s gain scores were normally distributed. Hence, the hypothesis that the training intervention would improve the ability to inhibit distractions was analyzed by Student’s t-test at \( \alpha = .05 \). Levene’s Test indicated that group variances were equal. Those in the experimental group significantly improved their ability to inhibit the distractor text compared to the control group. Thus, this hypothesis was supported. See results in Table 1.

**Improvement In Cognition**

The second hypothesis was that the pre-to-post test improvement in performance on the Trail Making Test (TMT) Part B (the original form at pre-test and form X at post test) would be greater for the experimental group than for the control group. Performance on the TMT is measured by the time to completion; a decrease in that time is improvement.
Table 1
Objective Measures of Improvement

<table>
<thead>
<tr>
<th>metric</th>
<th>experimental</th>
<th>control</th>
<th>sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improvement in Ability to Inhibit Distractions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n</td>
<td>21</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>8.57 sec.</td>
<td>-0.45 sec.</td>
<td></td>
</tr>
<tr>
<td>SD</td>
<td>12.18</td>
<td>10.15</td>
<td></td>
</tr>
<tr>
<td>t(40)</td>
<td></td>
<td>2.61</td>
<td></td>
</tr>
<tr>
<td>p</td>
<td></td>
<td>.007 (one-tailed)</td>
<td></td>
</tr>
<tr>
<td>d</td>
<td></td>
<td>.75</td>
<td></td>
</tr>
<tr>
<td>absolute effect size</td>
<td></td>
<td>9.02 seconds</td>
<td></td>
</tr>
<tr>
<td>95% confidence interval</td>
<td></td>
<td>[2.03, 16.02]</td>
<td></td>
</tr>
<tr>
<td>Improvement in Cognition</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n</td>
<td>20</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>range</td>
<td>-18 to 83 sec</td>
<td>-45 to 42 sec.</td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>14.00 sec.</td>
<td>4.45 sec.</td>
<td></td>
</tr>
<tr>
<td>SD</td>
<td>24.22</td>
<td>23.73</td>
<td></td>
</tr>
<tr>
<td>t(38)</td>
<td></td>
<td>1.26</td>
<td></td>
</tr>
<tr>
<td>p</td>
<td></td>
<td>.108 (one-tailed)</td>
<td></td>
</tr>
<tr>
<td>d</td>
<td></td>
<td>.40</td>
<td></td>
</tr>
<tr>
<td>absolute effect size</td>
<td></td>
<td>9.55 seconds</td>
<td></td>
</tr>
<tr>
<td>95% confidence interval</td>
<td></td>
<td>[-5.80, 24.90]</td>
<td></td>
</tr>
</tbody>
</table>

Each individual’s gain score was calculated by subtracting the time recorded for each participant on form X of the Trail Making Test at post-assessment from the time recorded on original form B at pre-assessment. Although performance on Part A was consistent over time for both groups, there were individual performances on TMT-B that changed widely in either direction from pre-test to post test in both groups. Over half (12/21) of the scores of the control group swung by 20 seconds or more in either direction (M = 22.7, SD = 18.7 for these 12), and three participants in the experimental group had negative gain scores of more than 15 seconds. In order to investigate the possibility that any of these extreme gain scores were the result of
recording error, the test times at both administrations were examined. This examination revealed that each group had one data point that met criteria for extreme value, and these cases were removed from further analysis to avoid their undue influence in the data set. Here, extreme values are outliers whose values are beyond either the first or third quartile by a distance greater than three times the distance between the 25th and 75th percentiles. See Table 1 for the wide ranges of gain scores that still obtained after removal of these two cases.

A one-sample Kolmogorov-Smirnov test run separately on the TMT B gain scores of each group indicated that each group's scores were normally distributed. The hypothesis that the training intervention would improve cognition was analyzed by Student's $t$-test at $\alpha = .05$. Levene's Test indicated that group variances were equal. A comparison of means revealed that on average the experimental group improved their cognitive functioning to a greater degree than the control group. However, even though the mean difference was 9.55 seconds in the direction of improvement for the experimental group, the difference was not statistically significant. Hence the experimental data were insufficient to reject the null hypothesis of no improvement. See results in Table 1.

Improvement In Self-Perception Of Memory Functioning

The third hypothesis was that pre-to-post test improvement in the Everyday Memory Failures Scale (MFS) score would be greater for the experimental group than for the control group. The item responses ranging from "never" to "very often" were translated into values of 1 to 5 and summed over the 12 items to get a scale score at each administration. A decrease in the item response or scale score is improvement.

At the pre-assessment administration of the MFS, one person in the control group neglected to complete the instrument; at post-assessment, one person in each group neglected to complete it. These three cases could not be included in the analysis. There were missing values in other protocols, but not sufficient for rejection: at pre-assessment, three people each neglected to respond to a single item; and at post-assessment, two people had one item missing.
and one person had three items missing. Missing values were filled in with the same value from the other administration so as to have a neutral effect on the gain score and still allow the case to be included in the sample. Final sample size was 20 for the experimental group and 19 for the control group.

The most common item response at pre-test was "rarely" (31%) followed by "sometimes" (28%) and then "never" (26%). Hence the everyday memory failures that make up the MFS did not occur with great frequency among the sample, which left little room for improvement in response to treatment - a floor effect. The post-assessment scale score was subtracted from the pre-assessment scale score to compute a gain score for each individual. The groups were compared using the Mann-Whitney U-test and the equivalent Wilcoxon rank sum test. Although the mean rank and sum of ranks of the experimental group were higher than those of the control group, the difference was not statistically significant. Hence, the experiment did not provide evidence in support of the hypothesis that training in and practice of samatha over a 4-week period would improve memory functioning as subjectively perceived. See Table 2 for results.

Improvement In Self-Perception Of Attentional Functioning

The fourth hypothesis was that pre-to-post test improvement in the Attention-Related Cognitive Errors Scale (ARCES) score would be greater for the experimental group than for the control group. The item responses ranging from "never" to "very often" were translated into values of 1 to 5 and summed over the 12 items to get a scale score at each administration. A decrease in the score is improvement.

At the pre-assessment administration of the ARCES there was a single missing value in a protocol of the control group, and at post-assessment, there was a single missing value in one protocol of each group. These missing values were filled in with the same value from the other administration so as to have a neutral effect on the gain score and still allow the case to be included in the sample.
Table 2
Self-Perception of Improvement

<table>
<thead>
<tr>
<th>metric</th>
<th>experimental</th>
<th>control</th>
<th>sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Memory Functioning</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n</td>
<td>20</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>range</td>
<td>-7 to 21</td>
<td>-6 to 12</td>
<td></td>
</tr>
<tr>
<td>Mdn</td>
<td>2</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>mean rank</td>
<td>22.03</td>
<td>17.87</td>
<td></td>
</tr>
<tr>
<td>sum of ranks</td>
<td>440.5</td>
<td>339.5</td>
<td></td>
</tr>
<tr>
<td>U</td>
<td></td>
<td>149.5</td>
<td></td>
</tr>
<tr>
<td>W</td>
<td></td>
<td>339.5</td>
<td></td>
</tr>
<tr>
<td>z</td>
<td></td>
<td>-1.143</td>
<td></td>
</tr>
<tr>
<td>p</td>
<td></td>
<td>.126 (one-tailed)</td>
<td></td>
</tr>
<tr>
<td>Attentional Functioning</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n</td>
<td>21</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>range</td>
<td>-5 to 18</td>
<td>-7 to 13</td>
<td></td>
</tr>
<tr>
<td>Mdn</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>mean rank</td>
<td>22.36</td>
<td>20.64</td>
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<tr>
<td>sum of ranks</td>
<td>469.5</td>
<td>433.5</td>
<td></td>
</tr>
<tr>
<td>U</td>
<td></td>
<td>202.5</td>
<td></td>
</tr>
<tr>
<td>W</td>
<td></td>
<td>433.5</td>
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<td>z</td>
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<td>-.454</td>
<td></td>
</tr>
<tr>
<td>p</td>
<td></td>
<td>.325 (one-tailed)</td>
<td></td>
</tr>
</tbody>
</table>

The most common item response at pre-test was "rarely" (35%) followed by "sometimes" (32%) and then "never" (25%). Hence, there was a floor effect limiting the amount of potential improvement that could be effected by treatment. The post-assessment scale was subtracted from the pre-assessment scale score to compute a gain score for each individual. The groups were compared using the Mann-Whitney U-test and the equivalent Wilcoxon rank sum test. Although the mean rank and sum of ranks of the experimental group were higher than that of the control group, the difference was not significant. Hence, the experiment did not provide evidence
in support of the hypothesis that training in and practice of samatha over a 4-week period would improve everyday attention as subjectively perceived. See Table 2 for results.

Results Summary

The data indicate that older adults can and will learn samatha when the technique is taught in an 8-session, 4-week protocol, as indicated by attendance, compliance with the schedule of home practice, and self-evaluations of learning. The data also support the hypothesis that samatha training and practice effect improvement in ability to inhibit distractions, as measured on the Reading with Distraction Task. Results for this hypothesis were statistically significant at $\alpha = .05$ and had standardized effect size $d = 0.75$.

The hypothesis that samatha training and practice would effect improvement in cognition as measured by gain scores on Trail Making Test Part B was not supported via statistical significance, but did garner a standardized effect size $d = 0.4$. The hypotheses that samatha training and practice would effect improvement in participants' self-perceptions of both memory functioning and attentional functioning were not supported via the data collected on the MFS and ARCES. The next chapter discusses these results and explores ways in which future research might provide a more appropriate test of the intervention. It also addresses this study's implications for practice.
CHAPTER V
DISCUSSION

The population of the developed world is aging. Cognitive impairment is prevalent among the old (e.g., 41% among women 85 years and older; Yaffe et al., 2011). So far, no medications have been found to be efficacious for even the most common of the dementias, Alzheimers, and none are on the near horizon (Blennow, 2011). These three facts point to a need for low-cost, non-pharmaceutical methods that older adults (OAs) can employ to maintain their cognitive abilities as they continue to age. Hasher and Zacks's (1988) Inhibitory Deficit Theory (IDT) points to attention, and more specifically to inhibitory processes, as a major leverage point for interventions in this regard. IDT and the body of evidence supporting it indicate that many age-related cognitive deficits arise from a decreasing ability to regulate attentional distraction (for a review of some of the evidence, see Healy, Campbell, & Hasher, 2008).

The current study proposed that samatha, a well-defined form of meditation that seeks to increase attentional functioning, has the potential to improve distraction control and cognitive functioning in OAs, that OAs could learn and would practice the technique, and that OAs themselves would subjectively observe improvements in memory and attention in their everyday situations. Forty-eight community-dwelling adults between the ages of 62 to 92 were enrolled in a randomized controlled study of the efficacy of a 4-week, 8-session training program in samatha (stages 1 and 2, according to Wallace, 2006) for improving inhibitory control and cognition. They were assessed on two objective and two subjective instruments before the training program began, and again afterward. Those who were in the training (experimental) group kept track of the amount of time they spent at home practicing the technique, and they self-evaluated their ability to execute the technique by the end of the training.
The remainder of this chapter reviews the findings of the study and the implications of those findings. It also addresses the study's limitations and identifies future research that could extend the results here.

Findings

Findings from the study fall into the three categories of learning and compliance, attentional functioning, and other cognitive functioning. Each of these are discussed below, followed by a summary.

Learning and Compliance

All participants in the experimental group (n = 21) who completed training in samatha reported that they had learned the technique. Over 75% (16/21) believed they could maintain attention without any distraction for at least 30 seconds, and reported that it was "easy" to disengage from distracting thoughts and return attention to the chosen object (the breath). Nearly half (10/21) reported that they could focus without distraction for a full minute or longer; this achievement is the benchmark for the second stage of samatha as defined by Wallace (2006). As stated above, daily practice is an important feature of samatha and near-daily practice is essential. A third of those receiving instruction (7/21) practiced daily or more often. Hence, the results of this experiment give evidence that OAs can and will invest themselves in learning the practice of samatha over the course of four weeks.

As self-reports of achievement, the data above may partially be demand characteristics or socially desirable responding. To counteract this possibility as much as possible, I was accepting of participants' reports during class discussion that they had not practiced as often, or had not practiced as long as assigned for homework. Part of the attitude one must adopt for samatha is to be accepting and not judgmental of oneself when the practice is difficult or too great a challenge: this was one of the training concepts conveyed during the intervention. Each of the groups had one member who repeatedly reported being unable to find time or to stay with the
practice for the recommended times, and my reaction to these participants signaled my appreciation of their honesty as well as confidence that whatever level of effort they made was worthwhile.

For this study, there was no reason for the participants to be concerned about my disapproval, and for such a situation, Berkowitz (1971) asserted, there is scant evidence that study participants would be motivated to confirm the researcher’s hypothesis. Although no recent studies seem to have been done explicitly on the incidence of socially desirable responding among OAs, one can deduce that it is low among this population from the following: Well-being and self acceptance are very high among OAs (Ranzijn& Luszcz, 1999), and self-acceptance is inversely correlated with fear of negative evaluation (Durm & Glaze, 2001). Consistent with this deduction, Wells, De Vaus, Kendig, and Quine (2009) found an absence of a social desirability response set in their study of retirees’ well-being. Hence, the self-reports on at-home practice and achievement likely are absent demand characteristics.

The high level of compliance among the experimental group participants likely is attributable to several aspects of the training situation. The tenor of the classes was very positive. For example, participants were instructed not to be harsh toward themselves when they found themselves distracted while practicing the technique; individual differences and preferences were acknowledged as alternate paths to the same ends struggles were cast as occasions for trouble-shooting rather than personal failures; external distractions were frames as opportunities for increased practice in returning the focus to the breath. The participants also appeared to be highly interested in the research on meditation that formed some of the learning topics I presented. Many participants shared observations of benefits stemming from (or at least, occurring concomitantly with) making a regular practice of the technique, some as early as the second week. They were highly motivated to learn the technique as a means to their own well-being, buoyed by the research reports and especially by the personal reports of their classmates. When individuals asked questions to clarify what they were to do and about possible alternatives and reasons for outcomes, all members of the class appeared to be interested in the answers. I had a good deal of personal experience to share with them about the struggles to learn the
technique and practice daily. At one site especially they seemed to view me as someone who could answer questions they had about the brain, cognitive aging, and dementia. They engaged in warm, friendly conversations before and after the class sessions among themselves. It appeared that they had made a solemn commitment to attendance as a result of signing the participation agreement during the enrollment process. All these aspects of the training appeared to be factors that resulted in the high level of compliance.

Attentional Functioning

The primary target of the intervention was improvement in the ability to inhibit attentional distractions. This ability was objectively measured by the Reading with Distractions Task (RwDT; Connelly et al., 1991) before and after the 4-week training. Whereas the experimental group showed improvement on this task after the training, the control group's performance had virtually not changed from pre-test to post test. The standardized effect size of the experimental group's improvement compared to the control group was .75. Hence, it appears that the inhibitory sub-functions of attention in older adults may be improved by a short course of samatha practice.

Samatha is often identified as training the attention. One of the primary mental processes that one must employ to do samatha is to detect that one has been distracted from the object of attention (i.e., the breath, in the first two stages) and return the attention back to the chosen object. Hence, it is strengthening the weakness predicted in Hasher and Zacks' (1998) IDT. Improvement on the RwDT found here demonstrates that samatha does specifically train the inhibitory functions, that it does trains the person to quickly detect distraction and to return the focus of attention back to the chosen object. Improved mean performance on RwDT suggests that the ability developed in the mental process training generalizes to a visual task. The absence of change for the control group implies that the experimental group's improvement is not mere practice effect.

Interestingly, those who had the training in samatha did not perceive improvement in everyday attention. This was assessed subjectively on the 12-item Attention-Related Cognitive Errors Scale (ARCES; Cheyne et al., 2006) which asked about frequency of situations such as
misplacing keys and getting mixed up about what one is doing while thinking about something else. Several participants commented in the classes that they were noticing some improvements of the sort captured by the ARCES, providing anecdotal evidence that samatha can have an effect in those realms. However, the responses at pre-assessment indicated that the listed situations were rather infrequent in the lives of this sample. “Never” and “rarely” comprised 59% of the responses, leaving no or only small room for improvement (i.e., a decreased frequency) with training. Individual participant’s responses on the ARCES changed in both directions from pre- to post-test. There was no change in the experimental group’s median scale score.

In addition to the low frequency in participants’ lives of the ARCES situations, it is likely that there is little ecological difference between “never” and “rarely” and between “sometimes” and “often” to many people, so that response selections were somewhat arbitrary. This might account for the inconsistencies among the responses. A more refined item scale on the instrument that would permit capture of more nuanced changes, might also have shown a consistent direction of change from pre-test to post-test among the experimental group. Among the experimental group, perhaps the period of time was too short for changes to manifest in the majority who did not acknowledge changes anecdotally during class discussions.

Other Cognitive Functioning

The overall goal of the intervention was to determine whether samatha could provide a means to maintaining or improving cognitive functioning of older adults, as IDT predicts. A widely used neuropsychological test, the Trail Making Test part B, was chosen as a simple, straight-forward way to measure this complex human attribute. Although there was a medium effect size, the variance in the gain scores and sample size interfered with achieving statistical significance. The study did not adequately support the hypothesis that cognitive functioning in older adults can be improved by a short course of samatha practice.

As noted above, there was on average a 23-second change from pre-test to post test for the control group, for whom there could have been no treatment effect. Nor could these swings be attributed to practice effects, since they were bi-directional. Had there been practice effects,
they would likely have surfaced on form A as well; but there was no improvement on form A. Test-retest unreliability seems therefore to be a viable explanation, in contrast to reports of adequate reliability by Basso, Bornstein, and Lang (1999), Dikmen, Heaton, Grant, and Temkin (1999), and Lezak et al. (2004). However, these intra-person swings are comparable to the inter-person swings reported by Tombaugh (2004) as standard deviations ranging from approximately 19 to 77 over the age groups encompassing this study’s sample. Intra-person swings of similar magnitude may have occurred among the experimental group as well and indeed, may occur for any older adult undergoing neuropsychological testing for dementia.

Perhaps it was unrealistic to use just one test to assess the very complex human attribute of cognitive functioning. When TMT is typically used in neuropsychological assessments, it is just one of a number of tests in a battery, and the clinician looks for consistencies among the results when rendering an opinion on the person’s capabilities. Such batteries can take three to 4 hours, however (Lezak, et al., 2004) which was not feasible for this study.

Although the samatha training and practice appeared to improve inhibition of distractors (the first hypothesis) over a mere four weeks, perhaps it takes longer to improve cognitive functioning beyond attention. Other studies, reviewed above, that found cognitive improvement, had much longer interventions. For example, Alexander et al. (1989) trained participants for 12 weeks; Morone et al. (2008), Jha et al. (2007), and Anderson et al. (2007) used an 8-week training protocol; and Lutz et al. (2009) and Slagter et al. (2007) examined participants before and after a 3-month retreat.

It is also possible that samatha does not improve any cognitive functions except attention. However, IDT postulates that the improved inhibitory functioning in evidence on the RwDT is a mediator for overall cognition, and this theory is well supported by data on a variety of measures. Hence the most likely explanations of the TMT findings have to do with the insufficiency of the instrument and the duration of the intervention to detect and affect general cognitive functioning. Additionally, a larger sample size may overcome the issue of variability in the gain scores.
Evidence of cognitive improvement was also solicited via subjective assessment. At both pre- and post-assessment participants completed the Everyday Memory Failures Scale (MFS; Cheyne et al., 2006). Similar to the ARCES (see above), the memory situations listed on this instrument were rather infrequent in the lives of this sample: “never” and “rarely” comprised 57% of the responses. Although the median change on the MFS scale scores was in the direction of improvement for the experimental group, with no change for the control group, the wide range of gain scores within both groups and the small group change were not adequate to support the hypothesis that older adults’ self-perceptions of memory functioning was affected by a short course of samatha practice. A larger sample size may mitigate the effects of the variation.

A longer duration for the training may have provided more time for changes in the experimental group’s everyday lives to be noticed. An instrument that captured situations that older adults experience with greater frequency at baseline than the MFS did, and a more refined item scale on the instrument that would permit capture of more nuanced changes, might also have increased the effect size.

Summary of Findings

Based on the current results, samatha appears to be an effective means of improvement in attentional functioning with potential to improve cognitive functioning beyond attention. Older adults can learn the technique and are willing to practice it at home nearly daily. The 4-week intervention had sufficient duration and strength to produce objectively measurable improvements in inhibitory functioning of attention (effect size = 0.75). The four weeks of training and practice were sufficient to produce a medium effect size on objective measurement of general cognitive functioning. However, this effect was not consistent across the experimental group, evidenced in a variance so large that the result was not statistically significant. Because the variance of the control group data was similarly large and the range of the control group’s data overlapped even the high ends of the experimental group’s gains, the adequacy of the instrument used to measure the cognitive effect is suspect. It could be that samatha’s effects on cognition manifest earlier in the inhibitory functions, but take longer to be demonstrable in other functions.
Quite a few trainees volunteered during class that they were noticing improvements in thinking, and several more made similar comments during the one-on-one post assessment. In contrast to this anecdotal reporting, little change was captured on formal measures of self-perception. This may be attributable to a floor effect leaving little room for improvement in the everyday situations itemized in the instruments. There was a trend in the direction of improvement of everyday memory functioning. In spite of objective evidence of improvement in attention, self-perceptions of improvement in attention were absent.

Strengths And Limitations

The study had several notable strengths. First, it employed a randomized controlled design, which allowed casual interpretations of the results in relation to the 4-week training in samatha. Second, it studied the older adult population, whose representation in the attention and meditation literature is minimal. Third, pre-and post-tests allowed each participant to be his or her own control for pre-existing conditions and also allowed for estimates of treatment effects despite differences between the groups at the start of the study period. Given that age-related capacities diverge widely in the older adult population, this is an important feature of the study. Fourth, participants were recruited from and training took place at community senior centers. Such centers are tremendous venues for reaching older adults to provide services. The brochure rack which can be found in virtually every center, as well as the center’s packed calendar of events, give testimony to these centers being the focal point of outreach to community dwelling older adults. Hence the setting was ecologically appropriate and the participants realistically engaged, which supports widely offering this intervention. The fifth strength was that the training protocol appeared to be sufficient to keep the participants motivated to attend all eight sessions in most cases, so that the drop-out rate was minimal and the drop-outs that occurred were not due to the structure or content of the training sessions. It is also notable that RwDT was used in a test-retest paradigm here. Use of this instrument in a longitudinal study had not been reported before.
The absence of a change in the control group is perhaps is preliminary evidence of its test-retest reliability, although that was not explored in this small sample.

The study has its limitations and weaknesses as well as strengths. A primary weakness is the lack of diversity in the sample. Therefore the results cannot be generalized to the entire population of older adults. The participants were middle class European Americans with a single exception of a Korean woman, all of whom lived in suburban settings of a major city in the mid-Western United States. Hence, the effectiveness of samatha may not carry over to other economic, geographic, or ethnic groups. For example, it could be that members of some religious traditions would not be able to embrace the samatha practice that has its roots in Buddhism.

This sample of people were members or otherwise associated with the community senior centers. They had a level of agency that was sufficient to initiate their enrollment in the study by responding to the recruitment activities, in contrast to participants of some studies where an authority figure such as a social worker or nurse practitioner make a direct appeal for enrollment. They were comfortable enough in a group training session to join in the practice and discuss the triumphs and problems they experienced in trying to learn the technique. The protocol might not be as effective for those with less agency or with social anxiety, and so generalization is limited in that respect.

Samatha is difficult to do when one is new to the practice - it is hard to keep one's attention focused on the breath. Yet the study sample was willing to undertake this arduous practice with the expectation of the potential benefits. Given the number of people who likely saw the senior centers' notices about the study, only a small number expressed interest. As a way to roughly estimate the portion of older adults who would partake of offered classes, consider: The two talks I gave at one senior center were very well attended (about 60 - 70 each time), held the audiences' attention for an extraordinarily long time (over an hour with most of that time devoted to questions) according to both the program coordinator and some of the attendees who frequent the center, and was very well received judging from the applause. Clearly they were concerned
about maintaining their cognitive functioning as they aged. However, only 16 people attending those talks were interested in learning samatha for my research project, with ten finally enrolled and the other six disqualified.

There is a widespread preference for medications over more effortful treatment, and the use of medications is very high in the United States: 81% among adults in 1999 (Kaufman, Kelly; Rosenberg, Anderson, & Mitchell, 2002). Prescription drug use increased over the past ten years from 44% to 48% among Americans of all ages (Gu, Dillon, & Burt, 2010). Would-be patients actively seek or even demand drugs from their physicians (Gilbody, Wilson, & Watt, 2005; Moynihan, Heath, & Henry, 2011). At the same time, several mortal diseases are reaching endemic levels even though changes in behavior (e.g., cessation of smoking) and lifestyle (e.g., becoming more physically active) could bring them under control and save lives (Mathers, Stevens, & Mascarenhas, 2009). An increasing proportion of mental health outpatients are receiving psychotropic medication without psychotherapy, which plays only a minor role in outpatient mental health care (Olfson & Marcus, 2010). This demographic evidence of Americans' predilection for easy medications over difficult behavioral change, indicates that the sample, all of whom were willing to engage in an effortful preventive measure, may not represent the larger population of older adults.

Another limitation of the study, which is part and parcel of any study that similarly attempts to teach a mental process technique, is that there can be only subjective evaluation of how well the participant learns, which has an indeterminable accuracy. Here, all the members of the experimental group believed they could maintain focus for at least five seconds, and nearly half reported they could maintain it for at least 60 seconds. Evaluating one's own ability to focus steadily on the breath may be similar to self-evaluation of one's ability to multitask, that is, highly inaccurate.

Two final weaknesses stem from the study design. One was the lack of an active control group. Had there been a third group who met with the same frequency and duration and with the same trainer as the experimental group, but did not learn samatha, the study would have been able to rule out a placebo or Hawthorne effect. The other weakness was that at post-assessment
the researcher was aware of the participant’s group. Had the assessments been done by someone blind to group assignment, opportunity for bias, even unconscious bias, would have been minimized.

Implications For Future Research

This study begins to fill a vacuum in the meditation and attention literature on older adults. The moderate success here that attentional inhibitory functioning improved with statistical significance and effect size .75, did not answer conclusively questions about the intervention's effect on cognitive functioning and perceptions of everyday memory and attention functioning. Further research with larger samples, more diverse samples, and more sensitive instruments are called for. There are many questions that this initial foray did not attempt to answer. One of these is, is there an age effect? Although the age range of the sample here was very broad, 62 to 92, the sample size was too small to examine the data for age effects. Is there a an effect for the duration of practice? Here, participants' homework was to engage in 20-minute sessions. Perhaps 30-minute at-home practice durations would have a stronger effect, or perhaps 10 minutes daily is sufficient to improve attention and other cognitive functions.

On a related note, does the consistency, regularity, and duration of practice predict the strength of effect, on objective measures and on self-perceptions? Future studies with larger samples could answer this question by correlating data from practice logs with gain scores. The sample size of the present study was too small to have reliable correlations. Here, the two participants with the greatest gains on RwDT were also the ones with the greatest gains on TMT-B; one had a high level of compliance with at-home practice; although the other did not return his practice logs, his in-class comments indicated regular daily or twice-daily practice sessions at home and strong perceptions of beneficial changes in attention.

Broadening the sample to include those with mild dementia but still able to understand the instructions for samatha, would provide valuable guidelines for practice. For the intervention protocol, what is the effect of a longer duration but shorter frequency (i.e., the same eight training
sessions, but stretched over eight weeks)? How long can improvements continue to accrue? Will the participants continue to engage in the samatha practice after they are no longer meeting with an instructor to lead and motivate them? Follow-up studies several months and several years out would be useful here. Another design improvement would be separation of the roles of researcher, trainer, and assessor into separate persons so that there could be no suspicion of bias.

Future studies might include an active control group to mitigate the weakness identified above. This would rule out the Hawthorne effect, which might have arisen here from the general tenor of the class and the promotion of self-acceptance. However, the alternate treatment must be carefully chosen: There are several paths to retain or improve cognition as one ages, and so an active control group engaging in mental math, for example, might only show an equivalence rather than tease out a unique effect of meditation.

Implications For Practice

In my clinical experience, my everyday encounters with older adults, and my activities both recruiting for and conducting this experiment, I have encountered many older adults who were concerned about their aging brains, some to the point of anxiety. This study did not answer all the research questions and much more research is needed. However, results do suggest some practice implications. The study suggests that older adults can and are willing to learn a mindfulness meditation technique, samatha, that can improve their ability to inhibit distractions, and this, in turn, should improve overall cognitive functions according to Hasher and Zacks's (1988) Inhibitory Deficit Theory. There is an important cost benefit to older adults who learn samatha, and to the larger society that takes on some of the funding burden for their health and well-being. Once the technique is learned, it can be practiced for the rest of the life span with no on-going or periodic costs, as there would be for the medications or for computer equipment and software upgrades which might be found to have similar benefits.
This study looked only at the effect of samatha on cognitive functioning. However, there are also emotional benefits to be gained, especially for anxiety, depression, interpersonal relationships, and response to pain (see for example Ospina et al.’s 2007 comprehensive report; Brown & Anthony, 2010; Lutz, Brefczynski-Lewis, Johnstone, & Davidson, 2008). These collateral benefits strengthen the impetus for practice.

A caveat for those who would incorporate samatha into their practice: Having a personal practice of samatha, even for as short a time as 12 months, is necessary both to understand the struggles that the client will likely experience, and to project the authenticity that makes the teaching credible.

The study also provides information about a training protocol that is efficacious for teaching a specific form of meditation. This protocol offered instruction in samatha and opportunities for guided practice. It had a schedule of ramping up from very short practice sessions of just two minutes to sessions of 24 minutes duration. It introduced the habit of doing a brief physical exercise before sitting down to practice, and demonstrated several exercises, some of which can be done sitting for those who have limitations in balance or standing. It introduced the parallel practice of Loving Kindness meditation and the reasons for using it along with samatha that have been expounded by Wallace (2006) and others. An important aspect of the protocol was the review of relevant research results on the effects of meditation, to give the participants a basis for expectations that they could benefit from this arduous task that was set before them daily.

The study also showed that a group modality can be effective for keeping participants engaged and broadening the experience through the natural interactions that occur. It also provided information about venues in which the intervention can be offered successfully: community senior centers.

May it be so.
REFERENCES


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APPENDIX A

RwDT SAMPLES

The Three Reading Samples from Carlson, Hasher, Connelly and Zacks (1995)

a. Distractors are in regular locations, alternating lines (p. 428)

* * *

The Volunteer

Bertha McKee was working as a volunteer at the information

sxxs gallery college in a carton gallery college Van Dyck

booth at the museum. She brushed off the snow which had fallen

sxxs gallery in a carton gallery college Van Dyck gallery Van Dyck

on her as she came from her high school. She took her seat in

sxxs gallery in a carton Van Dyck college in a carton gallery

the round booth and waited for the evening’s art viewers to

sxxs Van Dyck in a carton gallery college Van Dyck college

arrive. She liked her job because it allowed her to see all of

sxxs in a carton college Van Dyck in a carton gallery Van Dyck

college the different types of art that moved through the displays.

sxxs college gallery college gallery in a carton

Bertha picked up a box full of new pamphlets that told of

sxxs Van Dyck gallery college in a carton college gallery

upcoming displays. When she looked through one of them she

sxxs gallery in a carton college Van Dyck college gallery

became very excited. One of her favorite painters, Van Gogh, was

sxxs Van Dyck in a carton college Van Dyck in a carton gallery

being highlighted in an exhibition soon. She couldn’t wait.

sxxs in a carton Van Dyck college in a carton gallery

Figure 1. Example display (related distractor condition) for Experiment 1.
b. Distractors are in regular locations, same column for each line (p. 432).

c. Distractors are in regular locations, alternating columns in alternating lines (p. 433). Left- and right-justified text makes the spaces between words variable; space between two target text words could be greater than the intended distance between columns.
APPENDIX B

INFORMED CONSENT

Mental Process Training to Enhance Thinking Skills

You are invited to participate in a research project being conducted by Jeanette Biermann, doctoral student in the Counseling Psychology program at The University of Akron.

Purpose: The study will help determine whether a short course (4 weeks) in mental process training that is similar to meditation can enhance the thinking skills of adults aged 62+ who have been retired for at least 2 years and are in relative good health and aging normally. Approximately 40 to 50 people are being sought to participate.

Procedures: Participants will be assigned either to the Phase 1 training group or the Phase 2 training group. The training consists of 45 minute sessions, twice a week, for 4 weeks (8 sessions total). Daily practice of the techniques at home will be expected. All participants will be asked to attend an assessment session at the start of the study and again at the end of the Phase 1 training. Both assessments consist of a reading test, a short paper-and-pencil test, and answering a 24-item multiple choice questionnaire. Additionally, at the end of Phase 1, participants will be asked to complete 5 multiple choice questions about the experience.

Exclusion: People who currently practice meditation are not appropriate for this study. People who are taking medications to enhance memory such as Aricept and Namenda are not appropriate for this study.

Risks and Discomforts: There is no foreseeable risk or discomfort to participants.

Benefits: It is anticipated that participants' cognitive skills will be enhanced by full participation in the training and practice sessions. Previous studies have shown that this type of activity has physical health and psychological benefits. Adults who engage in this type of activity report that they feel calmer and have a better sense of well being. Neuroimaging studies have shown that the brains of long time meditators have more neurons in some areas of their brains than those who do not have that experience of meditating. However, you may receive no benefit from participating in this study.

Right to refuse or withdraw: Participation is voluntary. There is no penalty for choosing to not join this study or to withdraw at any time.

Confidential Data Collection: Any identifying information collected will be kept in a secure location and only the researchers will have access to the data. Participants will not be individually identified in any publication or presentation of the research results.

COLLABORATIVE PROGRAM IN COUNSELING PSYCHOLOGY

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Department of Psychology
Akron, OH 44325-4301
330-972-7280 + 330-972-5174 Fax

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Only aggregate data will be used. Your signed consent form will be kept separate from your data, and except for the researchers, no one will be able to link your responses to you.

Confidentiality of records: Data will be kept confidential via coding identification data. At the conclusion of the study, individualized data will be destroyed and only de-identified and aggregate data will be kept.

Who to contact with questions: If you have any questions about this study, you may contact Jeanette Biermann by leaving a message at 330 972-7779 or James Rogers at 330 972-8635. This project has been reviewed and approved by The University of Akron Institutional Review Board (IRB). If you have any questions about your rights as a research participant, you may call the IRB at 330 972-7666.

Acceptance & signature: I have read the information provided above and all of my questions have been answered. I voluntarily agree to participate in this study. I will receive a copy of this consent form for my information.

______________________________  __________________________
Participant Signature       Date
APPENDIX C

PARTICIPATION AGREEMENT

My signature below indicates that to the best of my knowledge I do not presently have any physical or mental health limitations that would limit my ability to fully participate in the Meditation Feasibility Study.

I am at least 67 years old. I do not currently practice meditating. I am willing to provide contact information and basic information about my age and educational level.

I agree to attend the pre-assessment session on ________ and complete all paperwork.

If I am selected to be in the study I agree to attend the post assessment session on ________ complete all paperwork.

I do not have any plans that would conflict with attending the twice-weekly training sessions, 8 sessions in all, on Tuesday and Thursday mornings from 9:00 am to 9:45.

I am committed to attending these sessions if I am included in Phase 1 training.

If I am selected to participate in the Phase 1 training, I agree to
• practice at home in-between training sessions for the minimum time assigned for homework (20 minutes).
• keep a good record of the time I spend meditating at home in-between training sessions.

If I am included in Phase 1 training, I agree to not divulge to others the content of the training classes until Phase 1 of the study is complete.

___________________________               ____________________________
SIGNATURE                                                 PRINTED NAME
DATE_______________________
APPENDIX D

DEMOGRAPHIC AND CONTACT DATA

name ______________________________

residence __________________________

phone number _______________________

e-mail ______________________________

which is your preferred means of notification: email or phone

do you have an answering machine? yes no

Is it all right to leave messages about the study on this machine? yes no

age ____________

gender _____________

education _____________
APPENDIX E

TRAIL MAKING TEST (TMT)

Part A
APPENDIX F

TRAIL MAKING TEST (TMT) ALTERNATE FORMS

Part W
Part X
APPENDIX G

READING WITH DISTRACTION TASK (RwDT)

A New Home

Amanda had just moved into a new apartment. She had been living in a house with her husband for over thirty years. She was still unpacking and arranging her things the cabinets and community drawers. Since she was alone now, the idea of living in an apartment complex with mostly other retired people appealed to her. She was looking forward to having other people her own age near-by to talk to. Why, just today when she picked up her mail, she struck up a conversation with Peggy, who lived on the fifth floor. Peggy had moved in last year and told her how friendly everyone was about all the activities. All the unpacking suddenly made her very hungry. She wondered if she should go to the grocery to get some food and cook something, or just go out to eat.
A Day at Work

At 7:30 in the morning the alarm clock began to ring frantically. Today was Larry's last day of work at the Ohio Corporation. He was looking forward to retiring after fifty years of good productive work. Larry got out of bed, his head filled with high expectations of what retirement would be like. This day marked the end of a major chapter in his life. He was filled with a mix of emotions about leaving many younger friends behind. But overall, he was so happy he was whistling an Irish jig. He began to think of how he would improve his golf game and really improve his swing. He got a little carried away, pulled too hard on his shoe lace, and broke it. Oh, well, he wouldn't be wearing these shoes much after today.

At the Eye Doctor's

Betsy Robson a cigarette entered odor the optometrist's medicine office and told the odor young secretary odor that she had a cigarette arrived medicine for her two o'clock the receptionist appointment. Betsy a cigarette had noticed the receptionist the newspaper medicine was getting odor fuzzier a cigarette lately, and the receptionist suspected that she needed medicine new glasses. odor She hoped medicine she did not have a a cigarette cataract. A sweet aroma the receptionist began to filter odor into a cigarette the waiting room. Betsy the receptionist looked medicine around, wondering what it the receptionist could be,
when medicine the doctor walked medicine up to her with a pipe the receptionist clenched between odor his smiling teeth. "Come on a cigarette back and the receptionist we'll take a a the receptionist look at your medicine eyes" he odor said. a cigarette He led Betsy medicine to the a cigarette examining the receptionist room and gave medicine her eyes a odor thorough a cigarette examination. She odor was relieved when the receptionist he told her medicine that there a cigarette was odor no sign of medicine cataract the receptionist or glaucoma. He odor wrote out a cigarette the prescription for the receptionist a new a cigarette pair of glasses odor and sent medicine her on her way.

**The New Baby**

*Fred McGee steamed and his ears friend Ivan the halls walked down an acquaintance the pale ears green an acquaintance corridors of steamed the hospital. Fred an acquaintance was excited. They the halls were steamed going to see ears his an acquaintance first grandchild, and the halls he wanted to an acquaintance show her steamed off to his friend. the halls As they ears arrived steamed at the nursery ears window, the halls Fred pointed to a small ears bundle the halls right near ears the front. an acquaintance Fred an acquaintance pressed his ears face up steamed against the glass and the halls began to fog the halls it up. "Isn't she steamed beautiful?" Fred said ears to his pal. "She's got an acquaintance her mother's ears eyes." Ivan replied, steamed "Those are your an*
acquaintance eyes, too, steamed Fred. She looks like the halls you!” an acquaintance. After another ears minute of the halls watching, they steamed saw the nurse pick an acquaintance up the infant and bring her the halls outside to them. ears The nurse steamed said she was about an acquaintance to take the the halls baby ears down to the halls the mother. The two men an acquaintance walked down ears the corridor the halls following her to Fred’s steamed daughter’s room.

*Learning to Use a Computer*

Catherine Rice took a seat at one of the computers in the third row, next to a window. She had decided to take the class at the public library since it was offered in the early afternoon while all the kids would still be in school. She was a little nervous about learning how to use a computer. Roger, a neighbor of hers, sat down next to her. It was good to see that she wasn’t the only one who did not know how to work a computer. About five minutes later the instructor walked in. He began to talk to the class in a slow, easy to understand manner. Catherine felt herself relax. This was going to be ok, and soon she would be sending e-mail to her friend in Colorado.
At the Mall

The mall was quite empty when William and Irene walked into it. The doors had just been opened and they came in to do some power walking since it was so cold outside. As they began to do their warm-up stretches, other walkers began to arrive and cheery conversations filled the air. "How's your knee today, William?" called out his pal Sam. William was wondering himself how his knee was. It seemed to be loosening up now, compared to the original stiffness when he had first awakened. Irene came over and informed him she and Louise intended to do a bit of shopping when they had completed their walking. William sighed. Didn't they have enough of everything already? But he knew she mostly liked to look and to visit with her friend more than spend money.

The Bus Ride

Sharon's unreasonable old Ford train pass needed so many the park repairs that the park it was no longer train pass safe. She auto needed the park to get around unreasonable town so auto she applied to the park get a Senior Citizen's unreasonable bus pass. It would train pass give her a 75% discount train pass on the bus fare. She didn't auto relish train pass the idea train pass of riding the the park unreasonable bus, but the unreasonable discount made the park it almost free to auto ride. And she auto could get almost the park everywhere unreasonable she needed to the park go by train pass bus. Mostly, unreasonable
it was the shopping, the park doctors auto visits, and the auto zoo. She had a auto membership to the train pass zoo, and auto liked to go at unreasonable least once train pass a month, the park Winter, train pass Summer, Spring, and the park Fall. With unreasonable the bus train pass pass, she the park would train pass not have to auto pay the $12 unreasonable parking the park at the zoo. the park The more she auto thought unreasonable about it, the more train pass Sharon the park realized that the auto idea of taking the auto bus was unreasonable a good one.

The Trip

This was the first trip to Europe for Joan and Charlie. Their children had all pooled their funds to give their parents the trip for their 50th wedding anniversary. Joan was especially excited about seeing Paris, and Charlie most wanted to go to a Swiss cheese shop. They found their seats on the plane, put their carry-on bags in the overhead compartment, and buckled up. Charlie stood up again to get the travelers checks out of that bag and put them in Joan's purse where they would be safer. To his surprise and dismay, they were not in the bag he had stowed over head! In a panic, he was about to tell Joan their trip was ruined, when he remembered he had already moved them to safety - they were in his coat pocket.
Time to Lose Weight

Howard Smith was eating habits looking sugar at his belly body in the middle age bathroom belly mirror. Now that he was middle age in his sugar fifties, his old belly routines didn't eating habits seem to be middle age working. sugar He realized he eating habits needed belly to take action middle age if he sugar belly was going to continue middle age being attractive to the eating habits ladies. He belly would have to sugar change his eating habits diet. Which sugar one, out of all middle age the diets out there, middle age he wondered. He belly began to eating habits think of the sugar guys belly he knew who had eating habits developed sugar diabetes at his age. middle age He did belly not want eating habits to end middle age up like that. belly He thought sugar about getting eating habits a personal middle age trainer to rev up belly his daily exercise middle age routine. It eating habits would belly be expensive, sugar in addition to the gym middle age membership he already eating habits paid. But sugar it would be sugar worth it. The eating habits old middle age exercises he had belly been doing for belly years just were sugar not enough eating habits any longer.
READING PRACTICE

Directions: Read the words in italics. Ignore the words in regular font.

application
waiting
financial
afternoon
wrong
oak
lunch
frustration
minutes
finally
party
evening
credit
kangaroo
picture
automatic
paper
judge
narrow
quiet
until

cushion
alternative
mathematics
dangerous
socialize
rabbit
generous
church
habit
interesting
lead
margarine
breakfast
nasty
complete
Mexico
tailgate
library
pencil
crush
lawnmower
APPENDIX H

SUBJECTIVE QUESTIONNAIRES

Attention-Related Cognitive Errors Scale (items 1 - 12)

Everyday Memory Failures Scale (items 13 - 24)
Name: ________________________________

Directions:
For each situation in the first column, circle the frequency word to the right that best describes how often you have experienced the item over the last 2 weeks.

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I have absent-mindedly placed things in unintended locations (e.g., putting milk in the pantry or sugar in the fridge).</td>
<td>never</td>
<td>rarely</td>
<td>sometimes</td>
<td>often</td>
<td>very often</td>
</tr>
<tr>
<td>2. When reading I find that I have read several paragraphs without being able to recall what I read.</td>
<td>never</td>
<td>rarely</td>
<td>sometimes</td>
<td>often</td>
<td>very often</td>
</tr>
<tr>
<td>3. I have misplaced frequently used objects, such as keys, pens, glasses.</td>
<td>never</td>
<td>rarely</td>
<td>sometimes</td>
<td>often</td>
<td>very often</td>
</tr>
<tr>
<td>4. I have found myself with unbuttoned buttons or wearing mismatched socks or other apparel.</td>
<td>never</td>
<td>rarely</td>
<td>sometimes</td>
<td>often</td>
<td>very often</td>
</tr>
<tr>
<td>5. I have gone into a room to get something, got distracted, and left without what I went there for.</td>
<td>never</td>
<td>rarely</td>
<td>sometimes</td>
<td>often</td>
<td>very often</td>
</tr>
<tr>
<td>6. I fail to see what I am looking for even though I am looking right at it.</td>
<td>never</td>
<td>rarely</td>
<td>sometimes</td>
<td>often</td>
<td>very often</td>
</tr>
<tr>
<td>7. I begin one task and get distracted into doing something else.</td>
<td>never</td>
<td>rarely</td>
<td>sometimes</td>
<td>often</td>
<td>very often</td>
</tr>
<tr>
<td>8. I have absent-mindedly mixed up targets of my action (e.g., pouring or putting something into the wrong container).</td>
<td>never</td>
<td>rarely</td>
<td>sometimes</td>
<td>often</td>
<td>very often</td>
</tr>
<tr>
<td>9. I make mistakes because I am doing one thing and thinking about another.</td>
<td>never</td>
<td>rarely</td>
<td>sometimes</td>
<td>often</td>
<td>very often</td>
</tr>
<tr>
<td>10. I have gone to the fridge to get one thing (e.g., milk) and taken something else (e.g., juice).</td>
<td>never</td>
<td>rarely</td>
<td>sometimes</td>
<td>often</td>
<td>very often</td>
</tr>
<tr>
<td>11. I have to go back to check whether I have done something or not (e.g., turning out lights, locking doors).</td>
<td>never</td>
<td>rarely</td>
<td>sometimes</td>
<td>often</td>
<td>very often</td>
</tr>
</tbody>
</table>

please continue on other side
<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>12. I go into a room to do one thing (e.g., brush my teeth) and end up doing something else (e.g., brush my hair).</td>
<td>never</td>
<td>rarely</td>
<td>sometimes</td>
<td>often</td>
<td>very often</td>
</tr>
<tr>
<td>13. I leave important letters/emails unanswered for days.</td>
<td>never</td>
<td>rarely</td>
<td>sometimes</td>
<td>often</td>
<td>very often</td>
</tr>
<tr>
<td>14. I forget appointments.</td>
<td>never</td>
<td>rarely</td>
<td>sometimes</td>
<td>often</td>
<td>very often</td>
</tr>
<tr>
<td>15. I forget people’s names immediately after they have introduced themselves.</td>
<td>never</td>
<td>rarely</td>
<td>sometimes</td>
<td>often</td>
<td>very often</td>
</tr>
<tr>
<td>16. I forget people’s names, even though I rehearsed them.</td>
<td>never</td>
<td>rarely</td>
<td>sometimes</td>
<td>often</td>
<td>very often</td>
</tr>
<tr>
<td>17. I find I cannot quite remember something though it is on the tip of my tongue.</td>
<td>never</td>
<td>rarely</td>
<td>sometimes</td>
<td>often</td>
<td>very often</td>
</tr>
<tr>
<td>18. I forget what I went to the supermarket to buy.</td>
<td>never</td>
<td>rarely</td>
<td>sometimes</td>
<td>often</td>
<td>very often</td>
</tr>
<tr>
<td>19. I forget important dates like birthdays and anniversaries.</td>
<td>never</td>
<td>rarely</td>
<td>sometimes</td>
<td>often</td>
<td>very often</td>
</tr>
<tr>
<td>20. I double-book myself when scheduling appointments.</td>
<td>never</td>
<td>rarely</td>
<td>sometimes</td>
<td>often</td>
<td>very often</td>
</tr>
<tr>
<td>21. I forget important ID codes like the PIN number for my bank card or my computer password.</td>
<td>never</td>
<td>rarely</td>
<td>sometimes</td>
<td>often</td>
<td>very often</td>
</tr>
<tr>
<td>22. I remember facts but not where I learned them.</td>
<td>never</td>
<td>rarely</td>
<td>sometimes</td>
<td>often</td>
<td>very often</td>
</tr>
<tr>
<td>23. Even though I put things in a special place I still forget where they are.</td>
<td>never</td>
<td>rarely</td>
<td>sometimes</td>
<td>often</td>
<td>very often</td>
</tr>
<tr>
<td>24. When I go to introduce my friends I forget their names.</td>
<td>never</td>
<td>rarely</td>
<td>sometimes</td>
<td>often</td>
<td>very often</td>
</tr>
</tbody>
</table>
APPENDIX I

ROSENBAUM POCKET VISION SCREENER

Card is held in good light 14 inches from eye. Record vision for each eye separately with and without glasses. Presbyopic patients should read thru bifocal segment. Check myopes with glasses only.

PUPIL GAUGE (mm.)

DESIGN COURTESY J.G. ROSENBAUM, M.D., CLEVELAND, OHIO
APPENDIX J

PRACTICE LOG

Name

Week beginning Tuesday ____________________

Please enter the length of time you practiced in your morning session and in your afternoon or evening session. There is space to make comments.

<table>
<thead>
<tr>
<th>Day</th>
<th>morning first session</th>
<th>comment</th>
<th>evening 2nd session</th>
<th>comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tuesday</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wednesday</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thursday</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Friday</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saturday</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sunday</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Monday</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
First Week Practice Log

Name

Week beginning Tuesday _________________

This first week, try to practice for short periods of time of 5 minutes or so, at least 5 times a day. Please enter the length of time you practiced in each "mini" session.

<table>
<thead>
<tr>
<th>Day</th>
<th>mini session</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Tuesday</td>
<td></td>
</tr>
<tr>
<td>Wednesday</td>
<td></td>
</tr>
<tr>
<td>Thursday</td>
<td></td>
</tr>
<tr>
<td>Friday</td>
<td></td>
</tr>
<tr>
<td>Saturday</td>
<td></td>
</tr>
<tr>
<td>Sunday</td>
<td></td>
</tr>
<tr>
<td>Monday</td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX K

EXPERIENCE EVALUATION

for the control group:

Name _______________________

1. Since you joined this research study, have you engaged in any meditation, not including prayer and meditations in your church?

2. If you answered yes to the Question 1 above, please briefly describe the type of meditating that you did, and how often you did it.
for the experimental group

EXPERIENCE EVALUATION

Name _______________________

Please underline the answer that best describes your experience.

1. How well did you learn how to do the mental process technique as taught in the classes?
   did not  almost learned  learned pretty well  learned very well

2. When you are doing the practice, how easy is it for you to focus your attention on your breath without any other thoughts or images intruding?
   very easy  easy  so-so  difficult  very difficult

3. When you are doing the practice, how many seconds are you able to focus your attention on your breath before another thought or image intrudes?
   2 sec  5 sec  30 sec  60 sec  more than 60 sec

4. When you are practicing and you notice yourself thinking of something other than your breathing, how easy is it to immediately disengage from the intruding thought and re-focus on the breath?
   very difficult  difficult  so-so  easy  very easy

5. Would you be willing to be contacted by the researcher Jeanette Biermann in several months as a follow-up to complete a short questionnaire about this study?
   yes     no

6. Please use the space below and the back to comment on any aspect of the experience of the classes or your own private home practice.
APPENDIX L

PROJECT APPROVAL BY THE UNIVERSITY OF AKRON
NOTICE OF APPROVAL

October 13, 2010

Jeanette Biermann
36297 Southington Court
Avon, Ohio 44011

From: Sharon McWhorter, IRB Administrator

Re: IRB Number #20101008 “Improving Cognition in Normally Aging Older Adults: A Randomized Controlled Trial of Mindfulness (Samatha) as a Treatment for Attentional Inhibitory Deficits”

Thank you for submitting your Exemption Request for the referenced study. Your request was approved on October 13, 2010. The protocol represents minimal risk to subjects and matches the following federal category for exemption:

☐ Exemption 1 - Research conducted in established or commonly accepted educational settings, involving normal educational practices.

☒ Exemption 2 - Research involving the use of educational tests, survey procedures, interview procedures, or observation of public behavior.

☐ Exemption 3 - Research involving the use of educational tests, survey procedures, interview procedures, or observation of public behavior not exempt under category 2, but subjects are elected or appointed public officials or candidates for public office.

☐ Exemption 4 - Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens.

☐ Exemption 5 - Research and demonstration projects conducted by or subject to the approval of department or agency heads, and which are designed to study, evaluate, or otherwise examine public programs or benefits.

☐ Exemption 6 - Taste and food quality evaluation and consumer acceptance studies.

Annual continuation applications are not required for exempt projects. If you make changes to the study's design or procedures that increase the risk to subjects or include activities that do not fall within the approved exemption category, please contact me to discuss whether or not a new application must be submitted. Any such changes or modifications must be reviewed and approved by the IRB prior to implementation.

Please retain this letter for your files. This office will hold your exemption application for a period of three years from the approval date. If you wish to continue this protocol beyond this period, you will need to submit another Exemption Request. If the research is being conducted for a master’s thesis or doctoral dissertation, the student must file a copy of this letter with the thesis or dissertation.

☒ Approved consent form/s enclosed

Cc: James R. Rogers - Advisor
Cc: Stephanie Woods - IRB Chair

Office of Research Services and Sponsored Programs
Akron, OH 44325-2102
330-972-7666 • 330-972-6281 Fax
The University of Akron is an Equal Education and Employment Institution

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The training consists of eight group meetings over four weeks. Each class is planned to last 45 minutes to an hour. Each class has several elements. Except for the first class, it begins with a debriefing on homework, that is the practice sessions conducted since the last class, to discover what went well and problems encountered. The debriefing includes validation by the instructor and problem solving. Next is a preparation for the upcoming sitting practice. This element is varied so as to offer students alternatives for their home practice. The preparations conducted at the first three classes are stretching exercises and the students are cautioned to do only what is comfortable and safe for them. There are two or three meditation practice sessions in each class, the duration of which increase from two minutes in the first class to 24 minutes by the seventh class. Each practice is followed immediately by a debriefing as described above. Between the practice sessions are one or two brief learning sessions that advance the students’ understanding of meditation. The final element is a preparation for home practice in which the homework is described and the practical aspects of executing the homework are discussed.

The first three classes emphasize the techniques of the concentrated attention (samatha) practice. The next two classes introduce some of the psychological aspects of meditating and serve to deepen understanding and to encourage students to lengthen the time of each sitting session. The leaning topics of the final three classes communicate the brain-beneficial aspects of meditation so as to further motivate adherence to the homework schedule.

Details of the meditation practice sessions for the eight week course of training are shown in Table M1; Table M2 contains the Preparation and Learning Topics. The explanations by Wallace (2006) of the first two stages of samatha are the basis for the training.
Table M1.

Practice Schedule

<table>
<thead>
<tr>
<th>Class</th>
<th>Practice 1</th>
<th>Practice 2</th>
<th>Practice 3</th>
<th>Home Practice</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2 min mental clutter</td>
<td>2 min</td>
<td>5 min</td>
<td>5 min sessions</td>
</tr>
<tr>
<td>2</td>
<td>2 min</td>
<td>3 min</td>
<td>10 min w counting</td>
<td>5 min X 2 + 10 min</td>
</tr>
<tr>
<td>3</td>
<td>5 min</td>
<td>10 min</td>
<td>5 min</td>
<td>10 min X 3 eat a raison</td>
</tr>
<tr>
<td>4</td>
<td>5 min</td>
<td>20 min</td>
<td>20 min</td>
<td>20 min</td>
</tr>
<tr>
<td>5</td>
<td>5 min</td>
<td>5 min LK</td>
<td>10 min LK</td>
<td>20 min samatha &amp; 10 min LK</td>
</tr>
<tr>
<td>6</td>
<td>5 min LK</td>
<td>20 min</td>
<td>20 min X 2 samatha &amp; LK</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>5 min LK</td>
<td>24 min</td>
<td>24 min samatha X2 Or samatha &amp; LK eat a raison</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>2 min LK</td>
<td>24 min</td>
<td>5 min LK</td>
<td>24 min X 2</td>
</tr>
</tbody>
</table>

*Note.* Meditation form is samatha unless otherwise indicated. LK = Loving Kindness.
<table>
<thead>
<tr>
<th>Class</th>
<th>Preparation</th>
<th>Learning topic 1</th>
<th>Learning topic 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>general stretching, +</td>
<td>H2 samatha BAW16</td>
<td>brain Hz</td>
</tr>
<tr>
<td></td>
<td>3 long, deep breaths</td>
<td></td>
<td>I ≠ my thoughts</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Be at ease, be still, be vigilant</td>
</tr>
<tr>
<td>2</td>
<td>stretch arms,</td>
<td>3 attentional functions</td>
<td>counting as monitoring</td>
</tr>
<tr>
<td></td>
<td>body scan</td>
<td></td>
<td>Stage 2 BAW31-32</td>
</tr>
<tr>
<td>3</td>
<td>standing stretch</td>
<td>dullness &amp; overexcitement</td>
<td>Vividness BAW35ff</td>
</tr>
<tr>
<td></td>
<td>twist torso, lift legs</td>
<td>are threats, relaxing &amp;</td>
<td>2 meanings of mindfulness</td>
</tr>
<tr>
<td></td>
<td></td>
<td>vividness are cures</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>May I be peaceful ...</td>
<td>learning takes practice</td>
<td>Default brain &amp; negative emos</td>
</tr>
<tr>
<td></td>
<td></td>
<td>review cures to threats</td>
<td>samatha + LK retrain brain</td>
</tr>
<tr>
<td>5</td>
<td>May you be peaceful....</td>
<td>H2 LK e.g., BAW41</td>
<td>craving, emotions attachment to events</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>BAW23ff</td>
</tr>
<tr>
<td>6</td>
<td>visualization: dropping</td>
<td>lifelong neuroplasticity</td>
<td>Neuroscientists working with</td>
</tr>
<tr>
<td></td>
<td>your baggage</td>
<td></td>
<td>Tibetan monks</td>
</tr>
<tr>
<td>7</td>
<td>visualization: ideal self</td>
<td>consciousness &amp; bare attention</td>
<td>&quot;spacing out&quot; is harmful</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BAW47</td>
<td>BAW44-46 balancing tensions of 2 threats</td>
</tr>
<tr>
<td>8</td>
<td>free form</td>
<td>peace, peaceful dying</td>
<td>longevity</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Alexander et al., 1989</td>
</tr>
</tbody>
</table>

*Note.* H2 = how to do. BAWn: n indicates page in Wallace (2006) where the topic is elucidated. LK = Loving Kindness. emos = emotions