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Effects of Mindfulness Meditation on Cognition and Quality of Life on Individuals with Mild Cognitive Impairment or early Alzheimer's Disease

by

Nancy Ikehara

A thesis

submitted in partial fulfillment

of the requirements for the degree of

Master of Science in the Department of Communication Sciences and Disorders

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Committee Approval

To the Graduate Faculty:

The members of the committee appointed to examine the thesis of Nancy Ikehara find it satisfactory and recommend that it be accepted.

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J. Anthony Seikel, PhD., CCC-SLP, Major Advisor

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Human Subjects Committee Approval Page

Dec 20, 2017

Nancy Ikehara
Comm Sci Disorders/Deaf Educ
MS 8116

RE: regarding study number IRB-FY2018-80 : Effects of mindfulness on cognition and quality of life on individuals with mild cognitive impairment or early Alzheimer's disease

Dear Ms. Ikehara:

Thank you for your responses from a previous full-board review of the study listed above. These responses are eligible for expedited review under OHRP and FDA guidelines. This is to confirm that I have approved your application.

Notify the HSC of any adverse events. Serious, unexpected adverse events must be reported in writing within 10 business days.

You may conduct your study as described in your application effective immediately. The study is subject to renewal on or before Dec 20, 2018, unless closed before that date.

Please note that any changes to the study as approved must be promptly reported and approved. Some changes may be approved by expedited review; others require full board review. Contact Tom Bailey (208-282-2179; email humsubj@isu.edu) if you have any questions or require further information.

Sincerely,

Ralph Baergen, PhD, MPH, CIP
Human Subjects Chair

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Effects of Mindfulness Meditation on Cognition and Quality of Life on Individuals with Mild Cognitive Impairment or early Alzheimer's Disease

Thesis Abstract--Idaho State University (2018)

Alzheimer's disease is currently the most common cause of dementia that has no known cure. Mild cognitive impairment is considered an intermediate stage of progression from normal cognition to dementia. Mindfulness meditation has been researched as a non-pharmacological treatment to improve cognition and quality of life. My research is a case study that explores the effects of mindfulness meditation on individuals with mild cognitive impairment or early Alzheimer's disease. There were two participants in this study. One participant completed an eight-week Mindfulness Based Stress Reduction program while the second participant did not participate in a mindfulness program. Both participants' cognition and quality of life were assessed pre-intervention and post-intervention. The results of this study suggest an increased quality of life and less cognitive decline in individuals with mild cognitive impairment who participate in mindfulness meditation, although the changes in cognition and quality of life were not statistically significant.

Key words: mindfulness meditation, cognition, quality of life, mild cognitive impairment, Alzheimer's disease

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Introduction and Review of Literature

Introduction

Alzheimer's disease (AD) is the most common cause of dementia and is often characterized by impairments of memory, cognition, and language (Centers for Disease Control [CDC], 2015). AD is estimated to account for approximately 60% to 80% of dementia cases (Alzheimer's Association, 2017). Because of increased life expectancies, it is predicted that by 2050, the number of Americans affected by AD will rise to 16 million with 115 million individuals affected worldwide (Ferris & Farlow, 2013). In addition, it is estimated that 43% of individuals with AD will require higher level care such as a nursing home by the year 2050 (Walter et al., 2011). The current cost of care for individuals with dementia worldwide is approximately $156 billion per year (Walter et al., 2011). Studies have suggested three groups of dementia classification: individuals who meet the standards for dementia, individuals who do not meet the standards for dementia, and individuals with cognitive impairments but do not meet the standards for dementia (Peterson et al., 2001). Mild cognitive impairment (MCI) is a term that refers to the latter group. The conversion rate of MCI that progresses to dementia ranges from 6% to 25% per year, which is a higher rate than individuals with normal cognition, indicating that MCI may be predicting AD (Peterson et al., 2001; Roberts & Knopman, 2013). Research has suggested that interventions for individuals with MCI have the possibility of being effective in delaying or inhibiting additional cognitive deterioration leading to dementia (Roberts & Knopman, 2013).

The present study seeks to explore the effects of mindfulness meditation on the cognition and quality of life on individuals with MCI or AD. The following review of

the literature first explores the criteria for diagnosis, risks, and treatment of individuals with Alzheimer's disease (AD). Subsequently, it examines the definition of mindfulness meditation and the creation of Mindfulness Based Stress Reduction (MBSR) for clinical uses. Finally, it discusses neuroanatomical research on mindfulness meditation and current research regarding mindfulness meditation and its effects on cognition and memory, individuals with AD and MCI, and its negative effects.

Diagnosis of Alzheimer's Disease (AD) and Mild Cognitive Impairment (MCI)

According to the *Diagnostic and Statistical Manual of Mental Disorders*, fourth edition (DSM-IV), AD can be characterized by memory impairment in addition to at least one of the following: aphasia, apraxia, agnosia, and/or disturbances of executive function (Fedor, 2005). A definitive diagnosis of AD can only be made post-mortem by the presence of amyloid plaques and neurofibrillary tangles in the brain (Chapman, Williams, Strine, Anda, & Moore, 2006; DeFina et al., 2013). Amyloid plaques and neurofibrillary tangles initially affect the medial temporal lobe structures involved with memory (primarily the hippocampus in the earliest stage, with neural degeneration advancing to the frontal, temporal, and parietal areas as the disease progresses) (DeFina et al., 2013).

Research is currently in progress regarding the ability to more definitively diagnose AD during life, in the hope of providing an assessment that is as reliable as post-mortem examination. Recent studies include use of positron emission tomography (PET) scans, analysis of cerebrospinal fluid (CSF), and structural magnetic resonance imaging (MRI) to detect beta amyloid, tau levels, and reduced metabolic activity (hypometabolism) in the temporoparietal region and the medial temporal lobes to identify mild and /or moderate forms of AD (DeFina et al., 2013). Use of these techniques for

diagnostic confirmation of AD is still experimental and is mostly used only in research, although confirming presence of amyloids using PET scans to complement diagnostic evaluations of AD is starting to be utilized in the field (DeFina et al., 2013).

In addition to the cognitive and physiological features, people with AD also experience behavioral characteristics including depression, behavioral delay, psychomotor slowness, and anxiety, which have been shown to decrease their quality of life (Lee, Lee, Park, & Kim, 2015).

Mild cognitive impairment (MCI) has been suggested as an intermediate stage of progression between normal cognition to AD and other dementias (Peterson, 2011). MCI is a decline in cognitive functioning that is not typical of normal aging and not due to dementia, and can be characterized by: memory complaints, objective memory impairments, normal general cognitive function, unimpaired activities of daily living, and MCI that does not meet dementia criteria (Peterson et al., 2001). MCI converts to dementia or AD at a rate of 6% to 25% per year; in comparison, incidence rate of AD for the general population is approximately 0.2% between 65-69 years of age and 3.9% between 85-89 years of age (Peterson et al., 2001). Because of the substantially increased risk factor for AD, MCI is a term that is often described in literature as prodromal AD or a preclinical stage of AD (Hirao et al., 2005). The National Institute on Aging (NIA) and the Alzheimer's Association (AA) have suggested another classification called MCI due to AD to specifically address MCI that leads to AD versus other dementias in research (Roberts & Knopman, 2013). In addition to the above criteria to diagnose MCI, the use of structural magnetic imaging or cerebrospinal fluid biomarkers may have the possibility to determine MCI due to AD (Roberts & Knopman, 2013).

Although this classification is currently being used in research and not clinically, there is a possibility for future prediction of AD using this classification due to current research that suggests individuals with MCI due to AD have an increased chance of AD (Roberts & Knopman, 2013).

AD vs Normal Aging

AD is not considered part of the normal aging process. Healthy older adults experience slowed processing speed and decreased working memory (Harada, Natelson-Love, & Triebel, 2013). Nondeclarative memory functions, such as singing a familiar song, remain unchanged throughout a normal individual's life (Harada et al., 2013). Semantic memory (e.g. knowing meaning of words) declines late in life while episodic memory (recalling specific events in a specific setting) slowly declines from age 30 (Harada et al., 2013). Visuospatial abilities and language, including vocabulary, remains unchanged throughout a normal individual's lifespan (Harada et al., 2013). Individuals with AD experience impairments in memory, visuospatial abilities, executive function, and language that affect the individual's daily life (Ferris & Farlow, 2013). The mild stages of AD, characterized by forgetfulness, short-term memory loss, repetitive questions, loss of interest in hobbies, impaired instrumental functions, and anomia, can lead to progression of cognitive deficits, aphasia, dysexecutive syndrome, impaired basic activities of daily living (BADL), and transitions in care in moderate AD (Ferris & Farlow, 2013). In severe stages of AD, the individual's language may be reduced to echolalia and verbal stereotypy, and the individual may be totally dependent on others for care including dressing, feeding and bathing (Ferris & Farlow, 2013). The Alzheimer's

Association listed ten differences and examples between normal cognitive aging and AD shown in Table 1 (Alzheimer's Association, 2017).

Table 1

Differences Between Normal Cognitive Aging and Alzheimer's Disease

Alzheimer's Disease	Normal Cognitive Aging
Memory loss that disrupts daily life	Sometimes forgetting names or appointments but remembering them later
Challenges in planning or solving problems	Making occasional errors when balancing a checkbook
Difficulty completing familiar tasks at home, at work, or at leisure	Occasionally needing help to use the settings on a microwave or to record a television show
Confusion with time or place	Getting confused about the day of the week but figuring it out later
Trouble understanding visual images and spatial relationships	Vision changes related to cataracts
New problems with words in speaking or writing	Sometimes having trouble finding the right word
Misplacing things and losing the ability to retrace steps	Misplacing things from time to time and retracing steps to find them
Decreased or poor judgment	Making a bad decision once in a while
Withdrawal from work or social activities	Sometimes feeling weary of work, family, and social obligations
Changes in mood and personality	Developing very specific ways of doing things and becoming irritable when a routine is disrupted

Note. Adapted from http://www.alz.org/alzheimers_disease_what_is_alzheimers.asp

Risk Factors for AD

There are several confirmed risk factors for AD, including old age and familial history of dementia (Ames, Burns, & O'Brien, 2010). Incidence increases exponentially with age and is considered an important factor for AD (Ames, Burns, & O'Brien, 2010). Familial history is also an important factor and a meta-analysis found that risk for AD is increased 3.5 times if that individual had a minimum of one first degree relative with dementia (Ames, Burns, & O'Brien, 2010).

Research has shown that education is a possible factor in contributing to AD (Ames, Burns, & O'Brien, 2010). Several studies have looked at the relationship between education and brain physiology in individuals with AD. Research has suggested that while medial temporal lobe atrophy (MTA) is associated with decreased cognition, the impact of MTA on cognition is reduced in individuals with higher education (Perneczky et al., 2009). An increased brain reserve evidenced by increased synapses in various parts of the brain has been suggested as an explanation for the decreased effect of atrophy in higher educated individuals with AD (Chiu et al., 2004; Stern et al., 1992). This suggested that more highly-educated individuals are better able to compensate for their cognitive decline (Stern et al., 1992).

Other studies have suggested a correlation between AD and verbal ability and cognition. One study reported that reading vocabulary was superior in predicting dementia than the individual's level of education (Schmand et al., 1997; Snowden et al., 1996). An epidemiological study indicated that verbal ability has the possibility of directly predicting pathology (Schmand et al., 1997; Snowden et al., 1996).

Studies have also shown that stress is also a possible risk factor for AD and can result in neurotoxic cell damage in the hippocampus (Khalsa, 2015). Chronic stress has shown to produce brain inflammation in the hippocampus which has been shown to be a hallmark of AD (Khalsa, 2015). AD results in neurofibrillary tangles and amyloid-β proteins contributing to extensive neuron death, affecting the hippocampus in the early stages (Mu & Gage, 2011). This neurogenesis decline has been correlated to cognitive impairments and AD (Mu & Gage, 2011). Research with mice showed an increase in β-amyloid plaques when the mice were under stress, which suggested a link between stress and advancement of AD (Innes et al., 2012). Another study by Wilson measured psychological distress and found that individuals who were scored as being highly prone to distress (90^{th} percentile or higher in distress proneness) were twice as likely to develop AD than individuals who scored in the 10^{th} percentile or below in distress proneness (Khalsa, 2015). It has also been suggested that stress is associated with several other risk factors of AD beyond cognitive decline that include insomnia, depressive symptoms, inflammation, calcium dysregulation, cardiovascular disease, hypertension, diabetes, insulin resistance, anxiety, physical inactivity, and smoking (Khalsa, 2015; Innes et al., 2012). Estimations of individuals with AD who experience various degrees of insomnia is as high as 64%, while up to 87% of individuals with AD exhibit depressive symptoms (Innes et al., 2012). DeGage et al. found a direct connection between anxiety, insomnia and AD when comparing 1,796 individuals with AD and 7,184 individuals without AD (Khalsa, 2015).

Treatment of AD

There is currently no known cure for AD and as a result, current treatment of individuals who have been diagnosed with AD is focused on managing the disease in terms of delaying the symptoms of the disease and maintaining their quality of life. The vast majority of current treatment and research in attempting to alleviate the symptoms associated with AD has centered on pharmacology (Hernandez et al., 2015). The current anti-dementia medications on the market have had various results regarding their efficacy (Campbell et al., 2013). While some studies have reported significant effects of anti-dementia medications in reducing the decline of cognition in patients with AD (Kishi, Matsunaga, Oya, Ikuta, & Iwata, 2015), other studies have reported the effects of medication on cognition to be insignificant (Campbell et al., 2013). Along with side effects such as nausea, diarrhea, and anxiety, certain antidementives have been linked to insomnia and an increased likelihood of hypnotic medication use (Mimica & Presecki, 2009; Stahl, Markowitz, Gutterman, & Papadopoulos, 2003). A study by Stahl et al. found a statistical relationship between donepezil (an antidementive used by individuals with AD to treat cognitive issues) and increased consumption of hypnotic (i.e. sleeping pills, sedatives) medication (2003). Campbell et al. reported that 1 of 3 patients who were prescribed antidementives ceased taking their medication due to side effects (2013).

Furthermore, patients with AD are commonly prescribed additional drugs including anticonvulsants, hypnotics, selective serotonin reuptake inhibitors, and most commonly, antipsychotics, to treat various behavioral symptoms such as agitation, depression, and other psychotic features that are characteristic of the disease (Devanand, 1997). These additional drugs have side effects ranging from increased gastrointestinal

complaints, memory loss, risk of increased disorientation, extrapyramidal side effects, risk of orthostatic hypotension, and problems with tolerance and withdrawal, among others (Devanand, 1997; Harrison & Therrien, 2007; Porsteinsson, Smith, Keltz, & Antonsdottir, 2014).

In addition to side effects, drug interactions are a concern with the use of additional medications. Many of the concomitant medications prescribed for Alzheimer's disease change or compete for the same enzymes, resulting in reduction or negation of the efficacy of those medications (Campbell et al., 2013). For example, donepezil and galantamine are often prescribed to treat the demential aspects of Alzheimer's disease and are metabolized through the liver (Campbell et al., 2013). Paroxetine and bupropion are medications commonly given to patients for treatment of depression (Campbell et al., 2013). Both paroxetine and bupropion inhibit the CYP2D6 enzyme, which is important in the metabolism process of donepezil and galantamine (Campbell et al., 2013). Subsequently, there is a great deal of variability in the efficacy of these drugs in the treatment of Alzheimer's disease (Campbell et al., 2013).

With controversial findings of efficacy, possibility of side effects and drug interactions, as well as cost of all the various medications, many researchers have focused on alternative treatments for symptoms of AD (Campbell et al., 2013; Hernandez et al., 2015). Significantly, physical exercise and mindfulness meditation have been researched as nonpharmacological approaches in management and treatment of AD (Hernandez et al., 2015; Larouche, Chouinard, Hudon, & Goulet, 2015; Lautenschlager, Cox, & Cyarto, 2012). Studies suggest that both the practice of mindfulness and physical exercise have positive effects on stress, depression, and anxiety (Goldin et al., 2013; Strohle, 2009).

There are a multitude of studies that have compared exercise and mindfulness meditation on anxiety in population without dementia. One study compared mindfulness-based stress reduction (MBSR) to aerobic exercise and its effects on social anxiety (Goldin et al., 2013). The study suggested that mindfulness was more effective than aerobic exercise in reduction of negative emotion and increases in attention regulation (Goldin et al., 2013). Given that negative emotion is a component of decreased quality of life, it could be further extrapolated from the data that mindfulness may contribute more to increased quality of life than aerobic exercise. There are fewer studies comparing exercise and mindfulness meditation on cognition. Some studies have addressed the practices of mindfulness and exercise on cognition in normal aging healthy adults (Hawkes, 2013). One study reported that individuals who practiced both meditation and exercise, as well as Tai Chi practitioners, outperformed individuals who just participated in aerobic exercise in executive function measures and suggested that a mix of both aerobic exercise and meditation may delay cognitive decline seen in normal cognitive aging (Hawkes, 2013).

Although there is a fairly extensive amount of research in linking exercise and dementia, the research on mindfulness and its effects is fairly recent and often is limited to small sample sizes with very few cross-sectional and/or longitudinal studies available. A PsycInfo search on the term “mindfulness” results in 7,045 results; this is in contrast with the term “exercise” which produced 61,091 results.

Mindfulness Meditation

While research has suggested that mindfulness has been around for thousands of years, the study of mindfulness on perception and function is a relatively new field of

study compared to exercise, and research investigating the effects of *mindfulness meditation* have suggested a similar link between the practice of mindfulness and cognition (Puff, 2013; Stahl & Goldstein, 2010). *Mindfulness meditation* is based on the meditative practices taken from Buddhist disciplines, including Theravada, both Soto and Rinzai segments of Mahayana, Zen, Vendata, Krishnamurti, and Maharshi (Kabat-Zinn, 2011). The practice of *mindfulness meditation* can be defined by its emphasis on being aware in the present moment without judgment (Stahl & Goldstein, 2010). Being without judgment or non-judgmental, is not meant to refer to a specific frame of mind in which no judgment emerges from one's thoughts, but rather implies a focus on observing the sensations of mind and body, whether pleasant or unpleasant, without attempting to repress or change the experience, regardless of thoughts and opinions that may arise (Kabat-Zinn, 2011; Stahl & Goldstein, 2010). A two-part definition of mindfulness that included attention and awareness, and acceptance was proposed by Bishop et al. (2004, as cited by Brown & Ryan, 2004). Bishop et al. defined awareness as subjective insight into one's own intrinsic and extrinsic experiences, while attention was defined as being focused on specific facets of one's reality (Brown & Ryan, 2004). The authors suggest that attention and awareness are interrelated forms of consciousness (Brown & Ryan, 2004). The second component of mindfulness was identified as acceptance and was defined as being able to be aware of the present moment without attempting to alter one's feelings or thoughts and as a result, allow the individual to experience the moment fully without judgment (Brown & Ryan, 2004).

Mindfulness meditation is considered a type of insight meditation (Dunn, Hartigan, & Mikulas, 1999; Goldin et al., 2013; Stahl & Goldstein, 2010). Meditation

can be broadly categorized into concentration meditation and insight meditation (Dunn, Hartigan, & Mikulas, 1999). Concentration meditation is generally practiced by focusing on a single object or stimulus, such as a certain noise, visual stimuli, mantra, etc. (Dunn, Hartigan, & Mikulas, 1999; Nugent, 2013). Repetition of a phrase or mantra is often used in the practice of concentration meditation (Nugent, 2013). Insight meditation allows the practitioner to welcome and experience all the stimuli and focus on the breath is used to regulate attention to the present moment (Bhikku, 2012; Dunn, Hartigan, & Mikulas, 1999; Holzel et al., 2011). In the practice of concentration meditation, if the practitioner's thoughts stray from the object of focus, the practitioner should gently and firmly bring their thoughts back to the object of focus (Dunn, Hartigan, & Mikulas, 1999). In contrast, in the practice of insight meditation, the practitioner is not suppressing the awareness of various stimuli but is allowed to experience the stimuli as it is being experienced with openness, acceptance, and curiosity (Holzel et al., 2011). Traditional forms of concentration meditation include Transcendental Meditation (TM) and Rah Yogi, while Zazen and Vipassana are practices that are considered to be forms of insight meditation (Dunn, Hartigan, & Mikulas, 1999).

Various forms of *mindfulness meditation* have been practiced in the East for over two millennia, and have only recently been researched and combined into Western health care, most notably with the creation of the Mindfulness-Based Stress Reduction (MBSR) program (Goldin et al., 2013; Stahl & Goldstein, 2010).

Mindfulness Based Stress Reduction (MBSR)

MSBR is a meditation program adapted from the eastern meditation disciplines by a researcher at the University of Massachusetts (Stahl & Goldstein, 2010). Kabat-Zinn,

the founder of MBSR, reported a significant reduction in symptoms of anxiety, depression, stress, substance abuse, pain, and illness with mindfulness practice in patients who suffered from these conditions (Stahl & Goldstein, 2010). Other studies have suggested similar findings of the relationship between MBSR and reduction of depression, stress, and anxiety symptoms (Goldin et al., 2013). Mindfulness is a relatively newer therapeutic technique in the Western culture that, in addition to reducing symptoms of anxiety and depression, has the possibility of also delaying the onset of dementia.

The training of MBSR techniques comprises 2.5 hour sessions in an eight-week period along with one 6.5 hour session in week six (Khalsa, 2015). Techniques incorporated in MBSR include body scans, light stretching and/or yoga, and various forms of meditation such as sitting meditation, mindful breathing, and walking meditation (Khalsa, 2015; Stahl and Goldstein, 2010). Breath awareness is generally introduced first in MBSR training which leads to awareness of sensations such as touch, hearing, smell, and sight and awareness of emotions and thoughts (Khalsa, 2015; Stahl and Goldstein, 2010).

Mindfulness and Meditation Research

Research on cognition and memory.

Several studies have looked at mindfulness or meditation and its effects on overall cognition and memory. Prakash et al. (2012) compared short term memory, perceptual speed, attention, and executive functioning between long term meditators and non-meditators over the age of 55 years old. The results showed the long term meditators out-performed their non-meditator counterparts in all areas except the digit backward test

suggesting that the long term meditators had significantly increased cognitive capabilities compared to non-meditators (Prakash et al., 2012). Lenze et al. (2014) found similar findings when assessing verbal fluency, response inhibition, short-term working memory, list learning, and paragraph learning with older adults with anxiety and cognitive dysfunction utilizing a 12-week MBSR program. Results from Lenze's study found that there were significant differences between pre- and post data in the areas of list learning, paragraph learning, verbal fluency, and response inhibition (Lenze et al., 2014). The researchers suggested that the findings of improvement in the worry severity, memory, and executive function in this study were encouraging for the implementation of an MBSR program for older adults who have increased degrees of worrying or anxiety and varying degrees of cognitive dysfunction (Lenze et al., 2014).

Studies done on mindfulness and executive attention have utilized the Attention Network Test and the Stroop task (Holzel et al., 2011). Researchers found that individuals who participate in meditation outperformed non-meditators in the Attention Network Task, although results with the Stroop task have been mixed, with one study finding no effects of Stroop interference while another study found lower Stroop interference with meditators and meditation intervention (Holzel et al., 2011).

Neuroanatomical research.

Brain scans of individuals who practice mindfulness or meditation have suggested increased cortical thickness in the white and gray matter of the cortex (Kang et al., 2013; Goldin et al., 2013). Holzel et al. (2011) reported that gray matter was increased specifically in the hippocampus, posterior cingulate cortex, and the temporoparietal junction in individuals who participated in MBSR as opposed to non-meditators. A study

by Pagnoni and Cekic (2007) studied the gray matter of the brain and attentional performance by individuals who practice Zen meditation and non-meditators using voxel-based morphometry for MRI anatomical brain images and an attention task. The study found that gray matter and attentional performance reduced with age for the non-meditator group (Pagnoni & Cekic, 2007). However, the researchers found the correlation between aging and gray matter volume or attentional performance was not significant with the individuals who practiced Zen meditation, suggesting that meditation may serve to lessen cognitive decline in normally aging adults (Pagnoni & Cekic, 2007).

Brain scans have also found that mindfulness or meditation affects the regions associated with the Default Mode Network (DMN) (Kang et al., 2012; Goldin et al., 2013). The DMN includes the medial prefrontal cortices, posterior cingulate cortex, hippocampus, and lateral/inferior parietal cortex (Wells et al., 2013). Processes that involve self-referencing, summarizing of past situations and anticipation of future plans, as well as having alternative viewpoints are associated with the DMN (Prakash et al., 2012). Studies have suggested that experienced meditators have increased control over their DMN due to increased associations between the dorsal anterior cingulate cortex, dorso lateral prefrontal cortex, and posterior cingulate cortex compared to novice meditators (Holzel et al., 2011).

A study by Holzel et al. (2011) broke mindfulness meditation into specific components that correlated to precise areas of the brain. According to Holzel et al. (2011), mindfulness meditation is composed of 6 components: attention regulation, body awareness, emotional regulation- reappraisal, emotion regulation-exposure, extinction, and reconsolidation, and change in perspective on the self. Each of these components

was associated with distinct areas of the brain. The researchers concluded that attention regulation was associated with the anterior cingulate cortex, body awareness were associated with the insula and temporoparietal junction, emotion regulation-reappraisal was associated with the dorsal prefrontal cortex, emotion regulation-exposure, extinction, and reconsolidation was associated with the vendor-medial prefrontal cortex, hippocampus, and amygdala, and the change in perspective on the self was associated with the medial prefrontal cortex, posterior cingulate cortex, insula, and temporoparietal junction (Holzel et al., 2011).

Research on anxiety and other psychological factors.

Studies of mindfulness and meditation also showed decreasing symptoms of anxiety and depression, as well as a decrease in negative emotions, which are related to quality of life (Goldin et al., 2013; Stahl & Goldstein, 2010). A study in 2010 by Goldin and Gross found that there was a more rapid decline of amygdala activation when presented with a negative stimulus in individuals with social anxiety after participating in MBSR (as cited in Holzel et al., 2011). The reduced activation in the amygdala arises from increased emotional regulation in individuals (Holzel et al., 2011). Deficiencies in emotional regulation are associated with depression, social phobia, posttraumatic stress disorder, general anxiety, trait anxiety, and impulsive aggression (Holzel et al., 2011).

The perceived benefits of meditation are similar to those found in relaxation practices and an argument can be made that relaxation alone may be enough to experience these benefits. An electrophysiological study by Dunn, Hartigan, and Mikulas (1999) showed differences between mindfulness meditation and relaxation, suggesting that they are two different states of being. Using data from electroencephalographic

(EEG) activity, the researchers compared mindfulness meditation and relaxation and found there were not only unique frequency patterns of each state, but mindfulness meditation produced greater alpha wave amplitudes than relaxation especially in the central and posterior cortex, as well as greater mean beta wave amplitude in the cerebral cortex overall (Dunn, Hartigan, & Mikulas, 1999).

Research on mindfulness, AD, and MCI.

To date, the amount of research on mindfulness and AD is limited. A Psycinfo search using keywords "meditation or mindfulness" and "dementia or Alzheimer's or cognitive impairment or memory loss or cognitive decline or mild cognitive impairment" produced 151 results.

The pathophysiological sites of AD include the areas of the posterior cingulate cortex and medial prefrontal cortices (Prakash, De Leon, Klatt, Malarkey, & Patterson, 2012; Wells et al., 2013). The main components of DMN seems to coincide with parts of the brain affected by AD, which suggests that mindfulness may have an effect on cognition on individuals with AD or in disease prevention (Prakash et al., 2012; Wells, 2013). Other studies have suggested a correlation between memory impairments with an increased risk of AD and hypometabolism in the posterior cingulate cortex (Larouche, Hudon, & Goulet, 2015). In addition, episodic memory has been associated with the connection between the hippocampus and medial prefrontal cortex (Larouche, Hudon, & Goulet, 2015). The functional connectivity between the hippocampus and both the posterior cingulate cortex and medial prefrontal cortex has shown improvement after the implementation of MBSR (Larouche, Hudon, & Goulet, 2015). Studies have also implicated an atrophied corpus callosum in early AD compared to the control group with

an emphasis in the posterior region for those with mild cognitive impairment (MCI) and general cognitive impairment (Wang et al., 2006). Studies of meditation have suggested distinct structural variations in the anterior region of the corpus callosum of individuals who were long term practitioners of meditation (Fox et al., 2014).

A study by Innes et al. (2012) examined the effects of meditation on perceived stress, sleep, mood, memory functioning and blood pressure on individuals with cognitive impairment and their caregivers over the course of 8 weeks. Results found that over eight weeks, the individuals improved in all areas suggesting that a short term meditation program may be an effective form of intervention for reduction of blood pressure and stress, in addition to improving mood, sleep and cognitive function for individuals with mild AD and their caregivers (Innes et al., 2012). An increase in quality of life for individuals with mild to moderate dementia through a decrease in depression and anxiety using mindfulness intervention has been suggested (Churcher-Clarke, A. et al., 2017).

Negative effects of mindfulness or meditation.

Although the majority of research has focused on the positive effects and benefits of mindfulness and meditation, there are possible negative effects that have been mentioned in research that should be addressed. One study reported at least one adverse effect in individuals who practiced intensive meditation or long term meditation that included anxiety, depression, and psychosis (Farias & Wiklohm, 2016). Other reported negative effects by meditation practitioners include confrontation of difficult emotions, increased somatic, psychological and neurological problems, depersonalization, altered reality testing, and emergence of repressed memories (Farias & Wiklohm, 2016; Freeman, 2009). Research by Shapiro (1992) found that five of the 27 subjects in the

study experienced negative cognition before meditation including apprehension and fear (Shapiro, 1992). In another study by Shapiro (1992), 7.4% of individuals who participated in the study suffered from significant adverse effects from meditation (as cited by Freeman, 2009). Other side effects reported were increased tension, restlessness, fear from rapid release of tension, fear from rapid behavioral change, and taxing effects resulting from hypersensitivity to meditation (Freeman, 2009). Lazarus (1976) found that schizophrenics and individuals who had a tendency to be hysterical or depressed may be contraindicated for meditation (as cited by Freeman, 2009). Although studies have been few in this area and negative effects have not been common, addressing these issues is important in order to have a more complete view of mindfulness meditation and to ensure each case is treated individually and in the individual's best interest.

Hypothesis

Mindfulness has possible effects on individuals with mild cognitive impairment and Alzheimer's disease in the cognitive aspect, as well as overall quality of life to different degrees. The purpose of this research is to examine the extent to which mindfulness meditation practice would prove to be effective for individuals with MCI in both improving cognitive functioning and quality of life, which will be measured with the Consortium to Establish a Registry for Alzheimer's Disease- Neuropsychological Battery (CERAD-NAB), and Quality of Life-Alzheimer's Disease (QOL-AD) and/or World Health Organization Quality of Life Brief Version (WHOQOL-BREF) instrument within a case study. A clinician-generated informal questionnaire will measure the individual's personal experience to assess subjective positive and negative effects of mindfulness meditation.

The research hypotheses are as follows:

a. Mindfulness meditation will improve cognitive functioning in individuals with MCI or early AD.
b. Mindfulness meditation will improve overall quality of life in individuals with MCI or early AD.

Specific research questions are listed below:

a. Will mindfulness meditation practice have an effect on cognition based on objective measures?
b. To what extent does mindfulness meditation have an effect on cognition based on objective measures?
c. Will mindfulness meditation practice have an effect on quality of life based on subjective measures?
d. To what extent does mindfulness meditation have an effect on quality of life based on objective measures?
e. What were the subjective effects of mindfulness meditation based on the individual's perspective?
f. Did the individual suffer any negative effects from mindfulness meditation?
g. To what degree did the individual suffer any negative side effects of mindfulness meditation?

Methods

Ethical Statement

This study was approved by the Institutional Review Board (IRB) of Idaho State University. Participation in this study required informed consent of the eligible participants.

Participants

This research is a case study. Participants were enlisted through several sources including personal contacts, letters to local Speech-Language Pathologists, advertisements through local media, and flyers posted at the Hawaii Island Adult Care, and Hawaii County Office on Aging, Coordinated Services for the Elderly in the towns of Hilo, Puna, Pahoa, Ka'u, Na'alehu, Kona, Honoka'a, Waimea, and Kohala.

Eligible participants were recruited based on a diagnosis of MCI by a physician or an appropriate specialty or memory care clinic. MCI was chosen as a criterion due to its high incidence of conversion to AD with a higher level of cognition than individuals with AD. Individuals with MCI recruited for this study were required to be cognitively aware and able to self-regulate. Eligibility also included the ability of the participant to function independently and adequately participate in their activities of daily living. Individuals with MCI who were not cognitively aware, not able to self-regulate, or required a caretaker were excluded from consideration as a participant in this study.

Preferred eligibility requirements included a diagnosis of MCI or probable AD through cognitive-linguistic testing, brain scans, or criteria set by the DSM-V or the National Institute of Neurological Communicative Disorders and Stroke-Alzheimer Disease and Related Disorders Association (NINCDS-ADRDA). Under the NINCDS-

ARDRA guidelines, a probable AD diagnosis is based on clinical criteria without histological evidence (Galvin & Sadowsky, 2012; McKhann et al., 1984; McKhann et al., 2011). The NINCDS-ARDRA criteria for probable AD has been reported to have a sensitivity of 81% and specificity of 70% (McKhann et al., 2011).

Other participation requirements included: ability to communicate in English and consent of the participant to participate in this study. Exclusionary criteria included participants who have a concurrent diagnosis of mental illness such as schizophrenia.

Continued Participation Criteria

The participants were continually monitored throughout the 8-week intervention through weekly self-reports and weekly in-person interactions with the client. The program was to be suspended immediately if the participants reported any negative impacts of meditation including, but not limited to: anxiety, depression, psychosis, psychological or neurological problems, apprehension, and/or fear, as evidenced by the participant's scaled score equal to or lower than 28 in the Well Being Subjective Index, which indicates likely depression (see Appendix D). If the participants' scaled score was equivalent to 50 or lower, indicating low mood, not necessarily depression (see Appendix D), the participant was monitored daily. If their daily score continued to be equal to or lower than 50 three days in a row, the program was suspended, even if their daily scaled score was higher than the 28 point cut off. In addition to suspension of the program, the participant's emergency contact was to be immediately notified.

If the study was to be terminated for any reason, data up until that point would be analyzed and the researcher would ask if the participant would be willing to participate in the follow-up post intervention measures including the cognition assessment, quality of

life assessment, control measure, and follow-up interview. If the participant consented, the follow-up activities would be administered. If the participant objected, the follow-up activities would not be conducted.

Instruments

Initial assessment.

An initial case history form was filled out to acquire personal and medical background information (see Appendix A). This case history form was adapted from the Alzheimer's Association Documentation Guide (Alzheimer's Association, n.d.). Additional questionnaires were given to assess the participant's baseline level of exercise and meditation practices. Because current research suggests that physical exercise is correlated with improved cognition and quality of life, baseline physical activity levels were taken into consideration to minimize influence of variables (Langlois et al., 2013). The Physical Activity Scale for the Elderly (PASE) was used to assess current physical levels (see Appendix B). The PASE is a standardized questionnaire that can be administered in person, by mail, or over the telephone and is normed for individuals aged 65 years old and older (New England Research Institutes, 1991). The PASE scores correlate to grip strength, leg strength, static balance, resting heart rate, and perceived health status (Washburn et al., 1993). The instrument takes approximately 5-15 minutes to administer and exhibits acceptable validity and test-retest reliability in measuring physical activity levels in the older adult population (Harada et al., 2001; Washburn et al., 1993).

In addition, a general health screen was administered to exclude individuals with depression. The Beck's Depression Inventory (BDI) is a 21 question screener for

depression and takes approximately 5 to 10 minutes to complete (Sharp & Lipsky, 2002). The BDI has a construct validity of .80 (Beck, Steer, & Brown, n.d.). Research indicates the BDI can uncover depression undetected by the clinician and is diagnostically beneficial in questionable cases (Salkind, 1969). A higher score on the BDI indicates depression (Salkind, 1969). Interpretation of the BDI scores are as follows: 0-10 indicating no depression, 11-17 indicating mild depression, 18-23 indicating moderate depression, and 23 and above indicating severe depression (Salkind, 1969). The participant was required to score under 11 to be included in the study. The 11 point cut-off score is the optimal cut-off score used in general practice (Salkind, 1969).

An additional questionnaire was used to ask if the participant was currently engaging in any meditation practice including: formal meditation, informal meditation, tai chi, prayer, or other, and the amount of time per week the participant engages in these meditative practices (see Appendix C).

Quality of life assessments.

Quality of life was measured using an adapted version of the World Health Organization's five-item well being index (WHO-5) and the Quality of Life-Alzheimer's Disease (QOL-AD). A well-being subjective index adapted from the WHO-5 was used to log the participant's daily subjective measure of well-being. The WHO-5 is a self-administered screener for emotional well-being and depression that evaluates an individual every 14 days (McDowell, 2009; Snoek, 2006). The WHO-5 has an adequate validity, a weighted sensitivity of 86%, and specificity of 81% as a depression screening tool (Topp et al., 2015). The questions on the WHO-5 were adapted for daily completion for the purpose of this research (see Appendix D). The scoring criteria of the adapted

questionnaire is equivalent to the WHO-5. Each item is answered based on a 6 point Likert scale from 0 (At No Time) to 5 (All of the Time) with a total possible raw score of 25 (Snoek, 2006). The raw scores are multiplied by 4 to get a scaled score between 0-100 (Snoek, 2006). A higher score correlates to better well-being, with a score of less than 50 indicating a low mood, and a score of less than 28 indicating possible depression (Snoek, 2006). The adapted questionnaire was filled out daily by the participant, as well as within 30 minutes after every meditation session. The WHO-5 was chosen as the basis for the subjective adapted questionnaire based on its short length, ease of use, and its validity in measuring positive affect and depression, as well as its ability to be adapted for the purposes of this research (McDowell, 2009).

The Quality of Life-Alzheimer's Disease (QOL-AD) was used as an objective measure of quality of life at baseline. The QOL-AD is a broad instrument that includes both objective and subjective measures of quality of life (Ready & Ott, 2003). The QOL-AD was given before start of intervention and again after the intervention period. The internal consistency reliability of the QOL-AD ranged from .84 to .88, with statistically significant validity ($r = .40$, $p < .01$) in patient-caregiver agreement (Ready & Ott, 2003). It was reported that the internal consistency reliability and patient-caregiver agreement was not affected by moderate levels of cognitive impairment (Ready & Ott, 2003).

The World Health Organization Quality of Life Scale Brief Version (WHOQOL-BREF) was used as an alternate assessment of quality of life in the event the ceiling is attained on the 13 question QOL-AD. In order to more accurately show change over the intervention period, if the participant attained a score of 39-52 (good to excellent quality of life) on the QOL-AD, the WHOQOL-BREF was used as a more intensive measure.

The WHOQOL-BREF is a shortened version of the 100 question assessment from the World Health Organization Quality of Life-100 (WHOQOL-100) (Skevington, Lotfy, & O'Connell, 2004; World Health Organization [WHO], 1996). The WHOQOL-BREF consists of 26 questions that measure 4 domains of quality of life: physical health, psychological, social relations, and environment (Skevington et al., 2004). It has cross-cultural sensitivity across typically aging adults, individuals with mild-cognitive impairment, and dementia (Kasai et al., 2014; Lucas-Carrasco et al., 2011). If the WHOQOL-BREF was given pre-intervention due to attaining a ceiling on the QOL-AD, the WHOQOL-BREF was given after the intervention period as the quality of life measure.

Cognitive-linguistic assessment.

Cognitive-linguistic competence is measured through general cognitive function and memory function. Memory function serves as a proxy for hippocampal volume. A reduction in volume of the hippocampus over time has been linked to cognitive decline and as a potential marker for individuals with MCI and AD as seen in neuroimaging studies (Beck et al., 2012; Schuff et al., 2009). A decline in hippocampal volume between 20% - 52% has been noted in individuals with AD and has been associated with episodic memory (e.g. losing items, forgetting names), inhibition, and spatial function (Beck et al., 2012; Mega et al., 2002; Wicking, Nees, & Steiger, 2014). The Consortium to Establish a Registry for Alzheimer's Disease – Neuropsychological Assessment Battery (CERAD-NAB) was used as an objective measure of cognitive functioning and an indirect measure of hippocampal volume and functioning. The CERAD-NAB is a commonly used neuropsychological test battery for individuals with AD that measures

language, memory, praxis, and general intellectual status (Morris et al., 1989; Teipel et al., 2005). The CERAD-NAB consists of seven subtests: verbal fluency, modified Boston Naming Test, Mini-Mental State Examination (MMSE), word list memory, constructional praxis, word list recall, and word list recognition (Morris et al., 1989). Table 2 lists the variables of the CERAD-NAB, its corresponding cognitive domains, and the subtest description.

Table 2

CERAD-NAB Variables and Its Corresponding Cognitive Domains

CERAD-NAB Variables	Cognitive Domains	Subtest Description
Animal Fluency	Semantic Fluency, Executive Functions	Number of animals produced within 1 minute
Boston Naming Test (BNT)	Visual Naming	Number of spontaneously correctly named line drawings
Mini-Mental (MMSE)	Different Areas	Various questions
Word List – Learning	Verbal Episodic Learning (encoding)	Total number of correctly learned words across 3 learning trials
Word List - Intrusions	Verbal Episodic Learning (error control)	Total number of intrusions committed during word list encoding and delayed free recall
Figures – Copy	Visuo- Construction	Copy of 4 figures (circle, diamond, cube, overlapping rectangles)
Word List – Recall	Verbal Episodic Memory (recall)	Total number of correctly remembered words after delay

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CERAD-NAB Variables	Cognitive Domains	Subtest Description
Word List-Recognition	Verbal Episodic Memory (discriminability)	Rate of correctly recognized words from encoding
Word List – Savings	Verbal Episodic Memory	Proportion of correctly recalled words during delayed free recall relative to words learned in learning trial 3
Figures – Recall	Non-Verbal Episodic Memory (recall)	Number of correctly reproduced figures from figure copy following a delay
Figures – Savings	Non-Verbal Episodic Memory	Proportion correctly reproduced figures at figure delayed recall relative to figure copy

Note. Adapted from links.lww.com/AA/A943 and Gottel et al., 2016

The CERAD-NAB has several subtests assessing verbal episodic memory (word list learning, recognition, recall) and non-verbal episodic memory (figures recall) (Bonner-Jackson et al., 2015; Gottel et al., 2016; Morris et al., 1989). In typically aging adults, as well as patients with AD, reduced episodic memory has been linked to reduced hippocampal volume (Beck et al., 2012; Bonner-Jackson et al., 2015). A study by Beyer et al. suggested that recall and recognition verbal memory tasks are associated with hippocampus atrophy in individuals with Parkinson's disease (2014). Bonner-Jackson et al. suggested that both verbal and non verbal memory tasks were correlated positively with bilateral hippocampal volume; in addition, a relationship between non-verbal learning tasks and bilateral hippocampal volume was also observed (2015). The

CERAD-NAB subtests have also been associated with overall left hemisphere function and regional cerebral metabolism measured by fluorodeoxyglucose- positron emission tomography (FDG-PET) scan (Hsu et al., 2017; Teipel et al., 2005).

The CERAD-NAB incorporates an MMSE as as subtest, which addresses general cognitive function. The MMSE scores have been correlated to reduced hippocampal volume in individuals with MCI and AD and is widely used as an overall measure of dementia severity (Fjell et al., 2009; Teipel et al., 2006). The MMSE section quantifies the individual's cognitive ability with objective measures of orientation, registration, attention and calculation, recall, language, and ability to copy a figure (Galvin & Sadowsky, 2012). The MMSE has a reported sensitivity of 79% and specificity of 88% (Gavin & Sadowsky, 2012).

The average administration time for all seven subtests of the CERAD-NAB is a total of approximately 20 to 30 minutes (Morris et al., 1989). The CERAD-NAB has been noted for its ease of administration, as well as having good test-retest reliability, cross-center interrater reliability between 0.92 and 1.0 among the subtests, and longitudinal validity (Morris et al., 1989; Zehnder et al., 2007).

Control measure.

The Maximum Phonation Time (MPT) was used as a control measure. MPT is a measure to assess glottal efficiency and respiration (Robinson, 2017a; Robinson, 2017b; Stewart, Kling, & Allen, 2016). MPT determines the maximum time an individual can maintain the duration of the vowel or consonant sound in one breath (Robinson, 2017a; Stewart, Kling & Allen, 2016). The participant was asked to take a maximal inhalation and maintain the vowel /a/ for as long as possible at their normal intensity and pitch

without straining (Robinson, 2017a). The clinician initially modeled the procedure before the participant began the trials. The clinician timed the sustained /a/ with a stopwatch and recorded the time. The participant repeated this procedure for a total of 3 trials. The longest duration of /a/ of the 3 trials was the participant's MPT (Robinson, 2017a). This procedure was done pre-intervention as a baseline and prior to every weekly MBSR session. The MPT measurement was not expected to change throughout the course of the intervention.

Procedure

The researcher contacted the participants initially by telephone for initial introductions and to set up the first meeting prior to baseline assessments and intervention. The first meeting took place in a quiet place of the client's choosing to keep the client as comfortable as possible. This initial meeting included an informational letter that introduced the researcher and explained the purpose and procedure of the intervention. The participants were also asked to fill out the case history form, BDI, PASE form, current level of meditation form, and consent form during this initial meeting. The researcher then set up a second meeting for baseline assessments prior to start of intervention.

The second meeting included baseline assessments using the QOL-AD and CERAD-NAB before the start of intervention. A baseline measurement of MPT was also taken. The meeting took place in a quiet place of the client's choosing. The researcher and participant decided on a schedule and start date of the intervention program.

The participants received intervention for eight weeks. Prior to each weekly MBSR session, the researcher administered three trials of /a/ to determine MPT as part of

the control measure. The intervention consisted of participation in an eight week MBSR training program to introduce the various aspects of mindfulness meditation. Palouse Mindfulness, an online eight week MBSR course, was utilized for the intervention (Potter, n.d.). Palouse Mindfulness is derived from Jon Kabat-Zinn's MBSR program at the University of Massachusetts Medical School and includes online mindfulness meditation videos (Potter, n.d.). The videos range from approximately 15 minutes to 1 hour and include education, instruction on techniques and/or guided meditation practices (Potter, n.d.). Dave Potter, the creator and instructor of Palouse Mindfulness, is a certified MBSR instructor by the University of Massachusetts Medical School (Potter, n.d.). The researcher met the participants on the first day of intervention and participated with the clients in every weekly MBSR session. Each MBSR session was held once a week. The researcher taught the participants how to navigate the Palouse website and ensure the participants felt comfortable online. The techniques incorporated in the MBSR sessions included body scans, light stretching and/or yoga, and various forms of meditation such as sitting meditation, mindful breathing, and walking meditation. Each weekly MBSR session included education on mindfulness meditation and the MBSR program, instruction on various techniques, and/or guided meditation practices provided by the videos on the Palouse Mindfulness website. An outline of the weekly Palouse Mindfulness training sessions is listed in Table 3.

Table 3

Mindfulness Weekly Sessions

Week	Lesson	Practices
Week 1	Simple Awareness	Body Scan Meditation , Mindful Eating
Week 2	Attention and the Brain	Sitting Meditation
Week 3	Dealing with Thoughts	Yoga
Week 4	Stress: Responding vs Reacting	Yoga 2, STOP
Week 5	Dealing with Difficult Emotions	Soothe/Soften/ Allow, RAIN
Week 6	Mindfulness and Communication	Mountain and Lake Meditations
Week 7	Mindfulness and Compassion	Lovingkindness Meditation
Week 8	Conclusion	Developing a Practice of Your Own

In addition to the once a week MBSR session with the researcher, the participants were asked to participate in daily mindfulness practices on their own. If the participants required more structure or direction during their independent daily practice, they had the option of utilizing the guided meditation practices on the Palouse Mindfulness website. The researcher also gave the option of downloading the guided practices onto an mp3 format or CD if that was preferred by the participants. Subsequently, the researcher contacted the participants by telephone every day to provide support and troubleshooting. If additional support was needed, the researcher met with the clients in person as necessary to provide support and complete the intervention.

The participants were given a binder with the MBSR manual that included schedules, worksheets, readings, instructions, and practice sheets for the week that were

provided on the website (see Appendix F). The participants engaged in daily mindfulness meditation in addition to their weekly MBSR session with the researcher and were asked to keep a journal of the type of meditation practiced (body scan, deep breathing, mindful walking, yoga, etc.), the amount of time mindfulness meditation was practiced, daily premeditation results of the adapted WHO-5, and the results of the adapted WHO-5 after meditation (see Appendix C). The researcher assisted the participants in filling out the daily journal in the first session. The optimal time goal for daily mindfulness meditation practice is 30 to 60 minutes. Throughout the study, the researcher collected the data daily and logged into an Excel spreadsheet.

The participants were evaluated again at the end of the eight weeks. The researcher set up a time and place to meet with the participants for reassessment. The MPT was administered to see if there was any change in the control measure. The CERAD-NAB was given to re-assess cognitive function and determine whether there was any objective significant difference due to intervention. The QOL-AD or WHOQOL-BREF was given to re-assess quality of life. If the WHOQOL-BREF was given pre-intervention due to attaining a ceiling on the QOL-AD, the WHOQOL-BREF was used as the post-intervention measure for quality of life instead of the QOL-AD.

Results

A total of five individuals contacted the researcher for information regarding the current study. All five individuals were recruited through personal contacts. Two individuals were excluded because they did not have a diagnosis of MCI. One individual was diagnosed with AD but was excluded due to lack of independence that required a caretaker. The remaining two individuals were considered eligible for this study. Of the

two eligible participants, one participant (under the pseudonym of "June") was able to complete the eight week MBSR program. The other participant (under the pseudonym of "Barb") terminated the program prematurely; however, Barb participated in the follow-up post intervention measures including the cognition assessment, quality of life assessment, control measure, and follow-up interview.

Description of Participants

Participant 1.

Barb was an 80-year-old married female who was diagnosed with MCI approximately 2 years previous to beginning of this study. Barb lived together with her spouse and volunteered for approximately 5 hours a week at a local business doing activities such as greeting, cleaning, and basic filing. Barb's nephew lived on the island and visited Barb and her husband every few weeks. Barb's medication management and transportation were both handled by Barb's spouse. Barb did not use a calendar or planner, and scheduling of appointments and/or activities were handled by Barb's spouse. Barb reported mild memory loss that she had noticed for "a couple of years." Barb did not complete any part of the MBSR program due to various trips and scheduling conflicts. However, Barb consented to post-intervention follow-up intervention measures and participated in post-intervention cognitive assessment, quality of life assessment, control measure, and follow-up interview. Her post-intervention measures were done 8 weeks from her initial assessment. Barb scored a 5 on the BDI indicating "no depression." Barb's baseline PASE score was 87.2 indicating typical physical activity levels for her gender and age. Barb's initial MPT was timed with an iPhone and was 7.62 seconds.

Participant 2.

June was a 74-year-old married female who was diagnosed with MCI less than a year previous to beginning of this study. June was a retired tour guide who lived together with a spouse and both were still active in the community, including participation in church functions, various clubs, and family functions. June's daughter, son-in-law, and grandchildren lived next door to June and visited June almost daily. June self-managed medication with use of a pill-box filled weekly with supervision from June's daughter or son-in-law. Neither June nor June's spouse drives and transportation was provided by June's daughter or son-in-law during the weekends. During weekday activities (e.g. church, clubs, meetings with friends, etc.), June used the Senior Center shuttle provided by the County of Hawaii. June used both a calendar and a planner to keep up with various appointments and activities. June self-reported mild memory loss that was noticed about a year ago. June scored a 2 on the BDI indicating "no depression." June's PASE score was 90.7 indicating typical physical activity levels for her gender and age. June's initial MPT was timed with an iPhone and was 15.20 seconds.

Both Barb's and June's characteristics and initial scores are listed in Table 4.

Table 4

Participant Characteristics

Characteristics	Barb	June
Completed MBSR program	No	Yes
Gender	Female	Female

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Characteristics	Barb	June
Age	80	74
Education	12 years (High School)	12 years (High School)
MPT	7.62 seconds	15.20 seconds
BDI	5 (No depression)	2 (No Depression)
PASE	87.2 (Age: 76-100) (Norms: 62.3 +/- 50.7)	90.70 (Age: 70-75) (Norms: 89.1 +/- 55.5)

Note. MBSR = Mindfulness Based Stress Reduction, MPT = Maximum Phonation Time, BDI = Beck's Depression Inventory, PASE = Physical Activity Scale for the Elderly

Intervention Description: June

June completed the eight week MBSR course through Palouse Mindfulness. June participated in eight weekly practices with the researcher and 48 independent daily formal and informal practices. June initially did minimal participation of 5 - 10 minutes in her daily independent practice. After the fourth day of minimal independent daily participation, the researcher met with June in person the rest of the week to assist in her daily participation and troubleshooting. June did not have problems accessing the videos for daily practice. After discussion, June scheduled her mindfulness practices in the morning before breakfast. For the second week, it was agreed that the researcher would call June in the morning to assist in reminding June to practice, then called her later in the day to collect daily data. The researcher faded the cueing via morning reminder as the weeks progressed. By the eighth week, the participant was able to participate in her morning mindfulness practice independently without cuing of the morning reminder

phone call from the researcher. Sunday was the weekly practice session with the researcher, and Monday through Saturday was June's independent practice sessions. June's independent daily practices and minutes are listed in Table 5.

Table 5

June's Daily Independent Mindfulness Practice Sessions

Week	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1	BS 5 min	BS 10 min	BS 5 min	BS 5 min	BS 20 min	BS 32 min
2	BS 20 min	SM 20 min	BS 20 min	SM 20 min	BS 20 min	SM 20 min
3	SM 20 min	LY 37 min	SM 20 min	LY 37 min	SM 20 min	BS 20 min
4	SM, STOP 37 min	SY 36 min	SM, STOP 37 min	SY, STOP 41 min	SM 32 min	SY 36 min
5	SY 36 min	SM 32 min	LY 37 min	SM 32 min	LY 36 min	SM 32 min
6	SY, Lake, Mtn 57 min	SY, Lake 57 min	LY, Mtn 56 min	LY, Mtn 56 min	SY, Lake 57 min	LY, Mtn 56 min
7	BS 20 min	BS 20 min	LY, STOP 41 min	SY, STOP 42 min	LY 36 min	SY 37 min
8	SY 37 min	LY 36 min	LY 36 min	SY 37 min	SY 37 min	SY 37 min

Note. BS = Body Scan, SM = Sitting Meditation, LY = Lying Down Yoga, SY =Standing Yoga, STOP = stop, take a breath, observe, proceed, Lake =Lake Meditation, Mtn = Mountain Meditation

Cognition

Baseline.

Both Barb's and June's scores were collected pre-intervention with the CERAD-NAB to determine baseline cognition. The CERAD-NAB's subtests of Verbal Fluency (VF), modified Boston Naming Test (BNT), Mini-Mental State Examination (MMSE), Word List Memory (WLM), Word List Recall (WLR), Word List Recognition (WLRc), and Constructional Praxis (CP) provides individual scores that have been normed in various settings (Fillenbaum et al., 2011). The Constructional Praxis Recall (CR) was a subtest that was added several years after the original assessment to address concerns that the original CERAD-NAB emphasized verbal abilities; researchers suggested the addition of praxis memory would allow a more thorough description of the overall characteristics of cognition (Fillenbaum et al., 2011). Welsh-Bohmer et al. published CERAD-NAB scores for healthy English speakers in the United States with normal cognition that included the CR subtest normed for age and education (Fillenbaum et al., 2011; Welsh-Bohmer et al., 2009). Wolfsgruber et al. published CERAD-NAB's subtest and total scores that also included scores from the CR subtest with a population that included dementia-free individuals and individuals with prevalent AD dementia (2014).

Barb's CERAD-NAB subtest scores showed strengths in confrontational naming and constructional praxis. June's CERAD-NAB subtest scores at baseline showed strengths in confrontational naming, constructional praxis, and word list recognition. Barb's and June's subtest scores are listed in Table 6 along with Wolfgruber et al.'s (2014) and Welsh-Bohmer et al.'s (2009) norms. The Welsh-Bohmer et al.'s norms that were equivalent to the participants age and education level were used (2009).

Table 6

Baseline Subtest Scores

CERAD-NAB Subtests (maximum points)	Barb	June	Welsh-Bohmer et al. (2009)	Wolfsgruber et al. (2014)	
			66-85 years old Mean (SD)	Dementia-Free Mean (SD)	Prevalent AD Dementia Mean (SD)
VF (24)	11	14	18.7 (4.4)	20.6 (6.2)	11.2 (4.23)
Modified BNT (15)	13	11	14.3 (0.8)	13.6 (1.54)	11.1 (2.41)
WLM (30)	9	14	19.9 (3.6)	19.9 (4.63)	10.4 (4.11)
CP (11)	9	9	10.1 (0.9)	9.91 (1.48)	8.45 (1.95)
WLR (10)	0	3	6.8 (1.9)	6.03 (2.53)	1.12 (1.43)
WLRc (10)	6	7	9.7 (0.7)	9.10 (1.44)	5.20 (2.96)
CR (11)	3	5	8.7 (1.9)	6.58 (2.97)	2.03 (1.92)

Note. CERAD-NAB = Consortium to Establish a Registry for Alzheimer's Disease-Neuropsychological Assessment Battery, SD = Standard deviation, VF = Verbal Fluency, modified BNT = modified Boston Naming Test, WLM = Word List Memory, CP = Constructional Praxis, WLR = Word List Recall, WLRc = Word List Recognition, CR = Constructional Praxis Recall

The original CERAD-NAB did not provide a total score for detection or progression of cognitive impairment (Seo et al., 2010). In 2005, Chandler et al. proposed a CERAD-NAB total score (CTS) that was calculated by adding the raw score of six of the CERAD-NAB subtests: VF (max score 24), BNT (max score 15), WLM (max score 30), CP (max score 11), WLR (max score 10), and WLRc (max score 10) for a maximum score of 100 (Seo et al., 2010; Wolfsgruber et al., 2014). The CTS had good test-retest reliability and was able to accurately discriminate between normal controls,

individuals with MCI, and individuals with AD (Ehrensperer et al., 2010; Wolfsgruber et al, 2014). Chandler et al. also calculated a second total score (CTS-2) that consisted of the CTS (maximum score of 100) plus CR score (maximum score of 11) for a maximum score of 111 (Seo et al, 2010; Wolfsgruber et al., 2014). The CTS-2 score also showed good test-retest reliability and was able to discriminate between normal controls, individuals with MCI, and individuals with AD (Seo et al., 2010). The MMSE was not included in the CTS or CTS-2.

Barb had a raw CTS score of 48 and a raw CTS-2 score of 51 in the pre-intervention testing. Her MMSE score was 23, suggesting mild impairment with significant effect that may require some supervision or assistance in day to day functioning (Folstein, Folstein, & McHugh, 1975).

June demonstrated a raw CTS score of 58 and a raw CTS-2 score of 63 in the pre-intervention testing at baseline. Her baseline MMSE score was 26 suggesting no cognitive impairment but with deficits that were questionably significant and may affect more demanding activities of daily functioning (Folstein, Folstein, & McHugh, 1975).

Chandler et al. (2005) calculated a mean, SD, and T-score based on the raw score of the CTS that was corrected for age, sex, and education (see Appendix H and Appendix I). Using his formula, Barb had a corrected CTS score of 63, with a T-score of 17. June had a corrected CTS score of 71, with a T-score of 27. Based on these figures, a z-score was calculated for Barb's and June's baseline CTS. Both June and Barb's z scores were significantly lower than the mean ($z = -2.9$ was significant, $p = 0.00374$).

Table 7 shows Barb and June's pre-intervention MMSE, CTS, and CTS-2 scores at baseline, Chandler et al.'s (2005) normative data, and the cut-off score for NC vs MCI from Seo et al. (2010).

Table 7

Baseline MMSE, CTS, CTS-2, and Cut-Off Scores

		CTS		
	MMSE	Raw CTS	Corrected CTS	CTS-2 Raw Score
Barb (Baseline)	23	48	63	51
June (Baseline)	26	58	71	63
Chandler et al. (2005) mean (SD)	28.6 (1.3)	79.2 (9.6)	90.4 (7.8)	n/a
Seo et al. (2010) (Cut off score for NC vs MCI)	≤24.5	≤59.5	n/a	≤66.5

Note. MMSE = Mini-Mental State Examination, CTS = CERAD-NAB Total Score, CTS-2 = CERAD-NAB Total Score 2, SD = Standard Deviation, NC = Normal Controls, MCI = Mild Cognitive Impairment

Post-intervention cognition scores and statistical analysis.

Statistical analysis was done on baseline and post-intervention cognition scores of both Barb and June using the Blanchard and Schwartz equation (Blanchard & Schwartz, 1988). A score of 50% or more indicated a clinically significant change according to the Blanchard and Schwartz equation (Blanchard & Schwartz, 1988). The Blanchard and Schwartz equation is as follows:

$$\frac{PreScore - PostScore}{PreScore} \times 100 = Therapeutic\ Change$$

Change in cognition was assessed through pre-intervention and post-intervention testing with the CERAD-NAB. Barb's CERAD-NAB subtests scores showed decreases in Verbal Fluency (27.27% decrease), modified Boston Naming (23.08% decrease), Constructional Praxis (11.11% decrease), and Constructional Praxis Recall (33.33% decrease). She showed increases in Word List Memory (11.11% increase) and Word List Recognition (16.67% increase). Her Word List Recall and MMSE scores remained the same. Barb's CERAD-NAB Total Score (CTS) decreased by 10.42%, while her CERAD-NAB Total Score- 2 (CTS-2) scores decreased by 11.76%. None of the increases or decreases in scores were clinically significant based on the Blanchard and Schwartz equation (Blanchard & Schwartz, 1988).

As mentioned earlier, the z-score for both Barb and June revealed baseline CTS scores that were significantly below the mean. Both Barb's and June's post-intervention scores remained within the same SD, suggesting there was no significant change from pre-intervention to post-intervention.

Table 8 shows the results of the statistical analysis on Barb's CERAD-NAB's cognition scores at baseline and after 8 weeks.

Table 8

BARB – CERAD-NAB Baseline and After 8 Weeks Post Intervention Scores

Test/Subtest	Baseline	After 8 Weeks	% Change	Clinically Significant Change?
VF	11	8	27.27 % decrease	No
Modified BNT	13	10	23.08 % decrease	No

(continued)

(continued)

Test/Subtest	Baseline	After 8 Weeks	% Change	Clinically Significant Change?
WLM	9	10	11.11% increase	No
CP	9	8	11.11% decrease	No
WLR	0	0	0%	No
WLRc	6	7	16.67% increase	No
CR	3	2	33.33% decrease	No
MMSE	23	23	0%	No
CTS	48	43	10.42 % decrease	No
CTS-2	51	45	11.76% decrease	No

Note. CERAD-NAB = Consortium to Establish a Registry for Alzheimer's Disease-Neuropsychological Assessment Battery, VF = Verbal Fluency, modified BNT = modified Boston Naming Test, WLM = Word List Memory, CP = Constructional Praxis, WLR = Word List Recall, WLRc = Word List Recognition, CR = Constructional Praxis Recall, : MMSE = Mini-Mental State Examination, CTS = CERAD-NAB Total Score, CTS-2 = CERAD-NAB Total Score 2.

June's CERAD-NAB subtest scores in Verbal Fluency and the modified Boston Naming Test increased by 7.14% each. Her CERAD-NAB Total score (CTS) increased by 3.45%, while her CERAD-NAB Total Score-2 (CTS-2) increased by 3.17%. None of the increases were clinically significant. All other subtest scores remained the same. Table 9 shows the results of the statistical analysis on June's CERAD-NAB's cognition scores at baseline and after eight weeks.

Table 9

JUNE – CERAD-NAB Baseline and Post Intervention Scores

Test/Subtest	Baseline	Post Intervention	% Change	Clinically Significant Change?
VF	14	15	7.14% increase	No
Modified BNT	11	11	0%	No
WLM	14	15	7.14% increase	No
CP	9	9	0%	No
WLR	3	3	0%	No
WLRc	7	7	0%	No
CR	5	5	0%	No
MMSE	26	26	0%	No
CTS	58	60	3.45% increase	No
CTS-2	63	65	3.17% increase	No

Note. CERAD-NAB = Consortium to Establish a Registry for Alzheimer's Disease-Neuropsychological Assessment Battery, VF= Verbal Fluency, modified BNT = modified Boston Naming Test, WLM = Word List Memory, CP = Constructional Praxis, WLR = Word List Recall, WLRc = Word List Recognition, CR = Constructional Praxis Recall, MMSE = Mini-Mental State Examination, CTS = CERAD-NAB Total Score, CTS-2 = CERAD-NAB Total Score 2

A comparison between Barb's and June's MMSE, CTS, and CTS-2 scores revealed that June's baseline and post-intervention scores were higher than Barb's baseline in all three areas. Both Barb's and June's MMSE scores remained the same from baseline to post intervention; however, while Barb's CTS and CTS-2 decreased, June's CTS and CTS-2 increased post intervention. A comparison of Barb's and June's MMSE, CTS, and CTS-2 scores is shown in Figure 1.

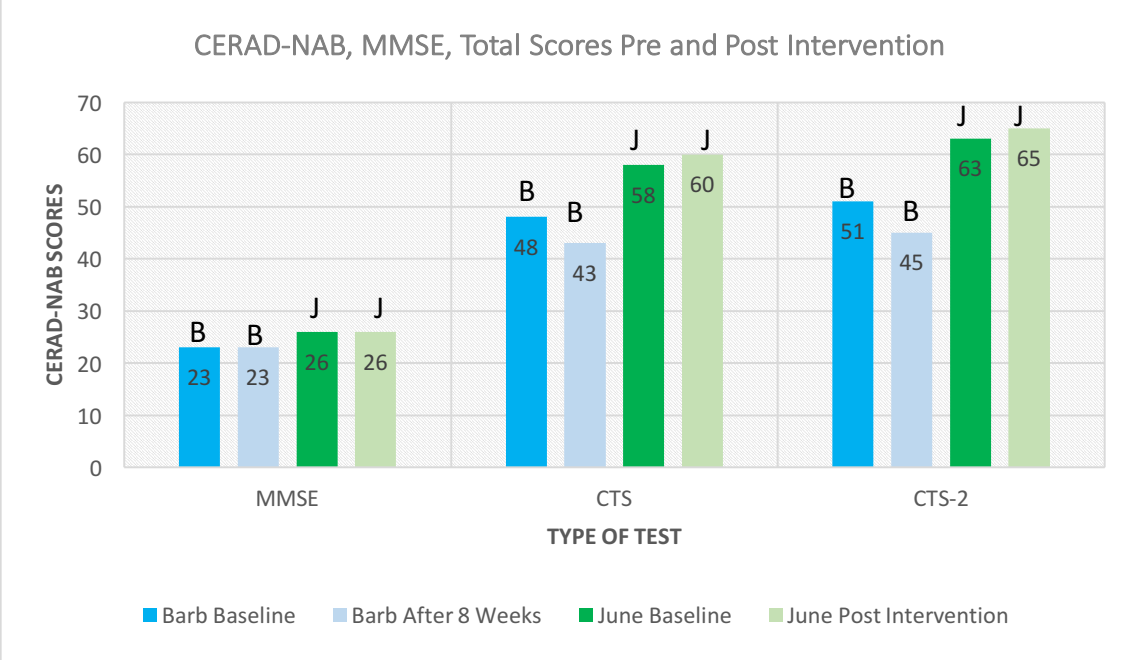

Figure 1. CERAD-NAB, MMSE, Total Scores Pre and Post Intervention. B = Barb. J = June. CERAD-NAB = Consortium to Establish a Registry for Alzheimer's Disease-Neuropsychological Assessment Battery, MMSE = Mini-Mental State Examination, CTS = CERAD-NAB Total Score, CTS-2 = CERAD-NAB Total Score 2

When contrasting the individual subtests of the CERAD-NAB, June's scores at baseline and post-intervention were higher than Barb's scores across all domains. Barb demonstrated a decrease in 4/7 subtests of the CERAD-NAB compared to baseline: Verbal Fluency, modified Boston Naming Test, Constructional Praxis, and Constructional Praxis Recall scores. However, the decreases were not clinically significant. Barb's scores increased on Word List Recognition. Both Barb and June increased their scores from baseline in Word List Memory. In addition, June's scores in Verbal Fluency also increased. Five of the seven CERAD-NAB subtests scores remained the same from June's baseline to post-intervention: modified BNT, Constructional Praxis, Word List Recall, Word List Recognition, and Constructional Praxis Recognition.

June did not have any decrease in scores from baseline. A comparison of Barb's and June's CERAD-NAB subtest scores are shown in Figure 2.

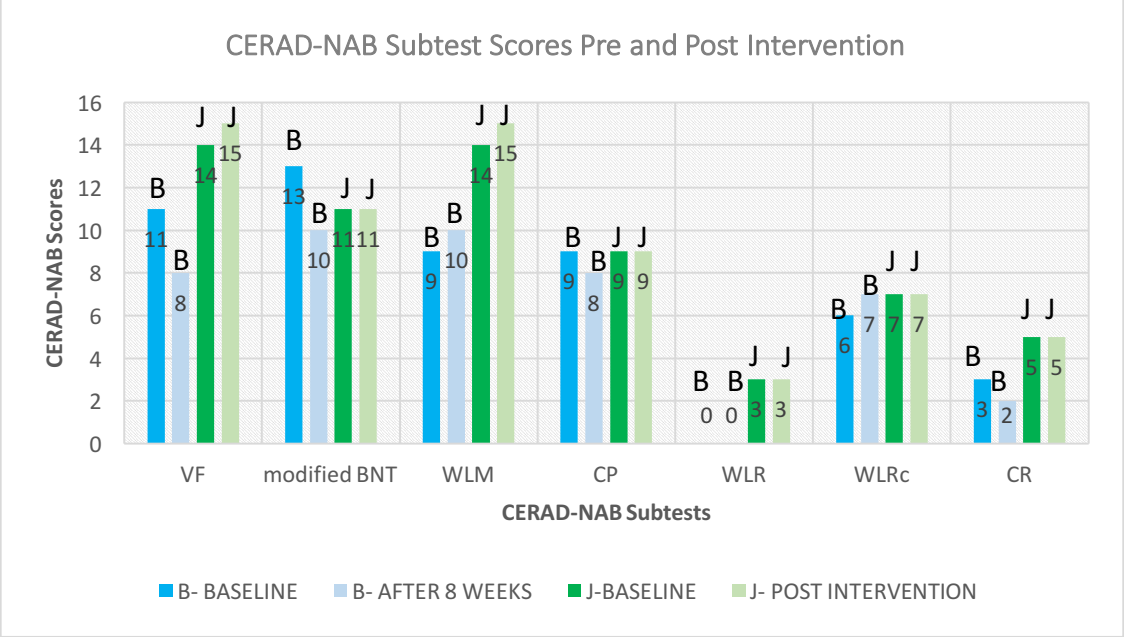

Figure 2. CERAD-NAB Subtest Scores Pre and Post Intervention. B = Barb. J = June. CERAD-NAB = Consortium to Establish a Registry for Alzheimer's Disease-Neuropsychological Assessment Battery, VF = Verbal Fluency, modified BNT = modified Boston Naming Test, WLM = Word List Memory, CP = Constructional Praxis, WLR = Word List Recall, WLRc = Word List Recognition, CR = Constructional Praxis Recall

Quality of Life

Baseline objective scores.

Quality of life at baseline and post intervention was measured with the Quality of Life-Alzheimer's Disease (QOL-AD). Logsdon et al. reported a mean of 38.03 (SD = 5.81) for individuals with probable AD with a mean age of 78.3 years (SD = 6.1), education level of 12.7 years (SD = 3.4), and mean MMSE score of 17.1 (SD = 5.6) (1999). Barb received a score of 32 on the baseline QOL-AD, and June scored a 34 on her baseline QOL-AD.

Post-intervention quality of life objective scores and statistical analysis.

Barb's QOL-AD scores remained the same at baseline and after eight weeks. The QOL-AD asked the respondent to score various areas of their life on a 4-point scale:

Poor, Fair, Good, Excellent. The Blanchard and Schwartz equation that was used on cognition scores were also used to assess significant change in quality of life based on the QOL-AD scores (Blanchard & Schwartz, 1988). Barb's percent change based on the Blanchard and Schwartz equation was 0%.

June's QOL-AD scores increased by 2 points, from 34 at baseline to 36 at post intervention testing. June's responses positively increased in the areas of Mood and Energy from Fair at baseline to Good at post intervention. All other areas remained the same from baseline to post intervention. Paller et al. observed a 1.8 point (SD = 0.5) increase in the QOL-AD after an eight week MBSR program with a population of individuals with MCI or dementia linked to possible AD neuropathology (2015). June's QOL-AD scores showed a 5.88% increase based on the Blanchard and Schwartz equation suggesting no clinically significant change in quality of life (Blanchard & Schwartz, 1988). Table 10 shows the QOL-AD baseline, after 8 weeks/post-intervention scores, and the statistical analysis for both participants.

Table 10

Participants' Baseline and After 8 Weeks QOL-AD Scores

Participant	Completed 8 Week MBSR Program	QOL-AD Baseline	QOL-AD After 8 weeks	% Change	Clinically Significant Change?
Barb	No	32	32	0%	No
June	Yes	34	36	5.88 % increase	No

Note. QOL-AD = Quality of Life-Alzheimer's Disease, MBSR = Mindfulness Based Stress Reduction

Daily well-being subjective index scores.

June completed all 8 weeks of the MBSR program and filled out her Daily Well-Being Subjective Index scores bi-daily: before her daily independent MBSR practice and after her MBSR practice. Her Daily Well-Being Subjective Index Scores never fell below the 50-point threshold that indicated Low Mood (not necessarily depression). Her pre-MBSR daily score was 56 on Day 1 of the the program and ended with a score of 60 on Day 56. Her post –MBSR score was 56 on Day 1 of the program and ended with a score of 64 on Day 56. Her lowest pre- and post-MBSR scores were a score of 52 on Day 43 and Day 44 of the MBSR program due to feeling under the weather. The participant was given the option of taking a break from the program but she opted to continue. The researcher suggested doing shorter and easier practices during this time (e.g. 10 minute body scan or breathing), until she felt better. Her highest pre-MBSR score was a 64 on Day 24, Day 27, Day 30, Day 38, and Day 52. Her highest post-MBSR score was a 68 on Day 9, Day 15, Day 19, Day 22, Day 24, Day 35, Day 36, Day 52 and Day 54. The greatest difference from pre-intervention to post-intervention was 8 points on Day 9, Day 15, Day 22, Day 35, Day 36, and Day 54. June's Daily Well-Being Scores throughout the 56 days are shown in Figure 3.

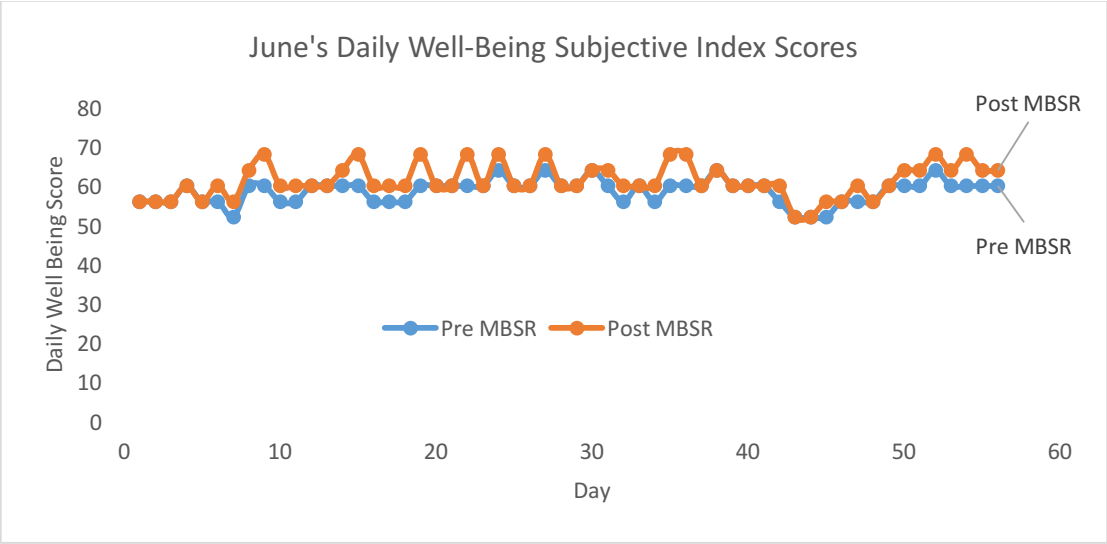

Figure 3. June's Daily Well-Being Subjective Index Scores. MBSR = Mindfulness Based Stress Reduction.

June's Well-Being Subjective Index scores were averaged weekly. Her pre-intervention scores were highest on Week 4 at 61.14 and lowest on Week 7 at 54.86. Her post-intervention scores were highest on Week 8 at 65.14 and lowest on Week 7 at 56. The greatest averaged weekly difference between pre- and post-intervention scores was 4.57 points on Week 8. Figure 4 shows June's averaged weekly Well-Being Subjective Index scores.

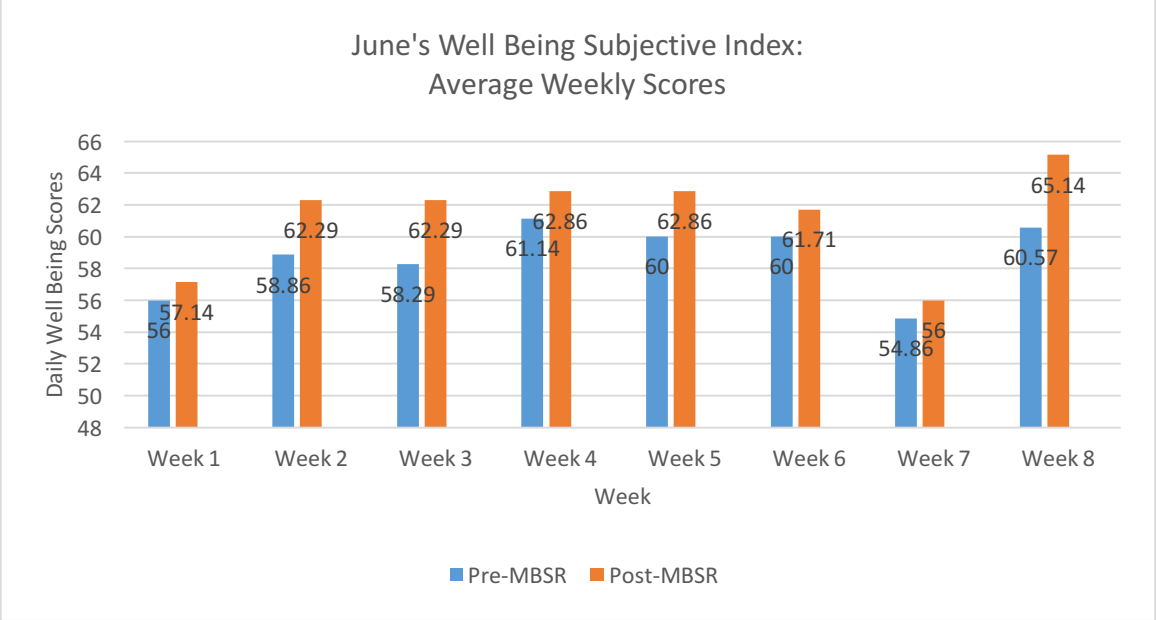

Figure 4. June's Well-Being Subjective Index: Average Weekly Scores. MBSR = Mindfulness Based Stress Reduction

Control

Maximum Phonation Time (MPT) was used as the control measure. MPT measures were taken using the stopwatch feature on the iPhone 7. The accuracy of the measurements was subject to human error based on the researcher's reaction time. Barb's MPT at baseline was 7.62 seconds and 9.57 seconds after eight weeks. June's MPT was 15.20 seconds at baseline and 15.25 seconds after eight weeks of MBSR intervention. A study by Ptacek et al. (1965) found that MPT in normal females over the age of 65 ranged from 7.0 seconds to 24.8 seconds. Both June and Barb's baseline and post intervention MPT values fell into the range of Ptacek et al.'s normative data (1965).

Barb's MPT measures at baseline and after eight weeks are shown in Figure 5 and June's MPT measures at baseline and post intervention are shown in Figure 6.

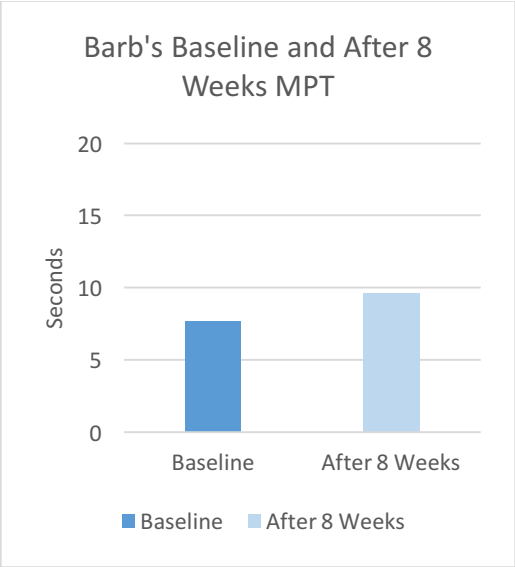

Figure 5. Barb's Baseline and After 8 Weeks MPT. MPT = Maximum Phonation Time.

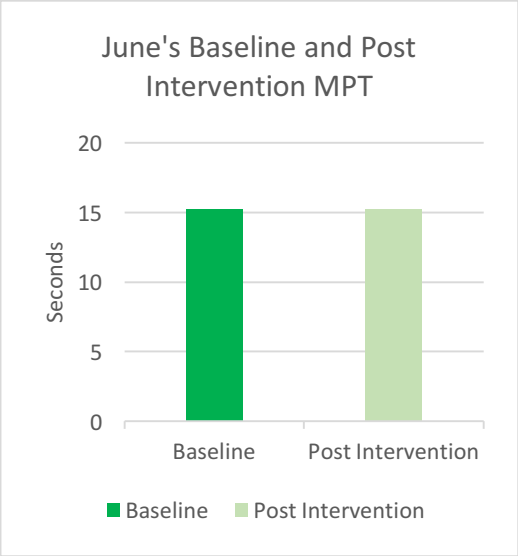

Figure 6. June's Baseline and Post Intervention MPT. MPT = Maximum Phonation Time.

June's MPT was measured before each weekly session of the MBSR program with the researcher. She had a total of 10 MPT scores: baseline, once a week for eight weeks, and post-intervention. Her lowest score was 13.25 seconds on Week 2 of the MBSR program. Her highest score was 15.25 on Week 8 of the MBSR program. Her averaged weekly scores are shown in Figure 7.

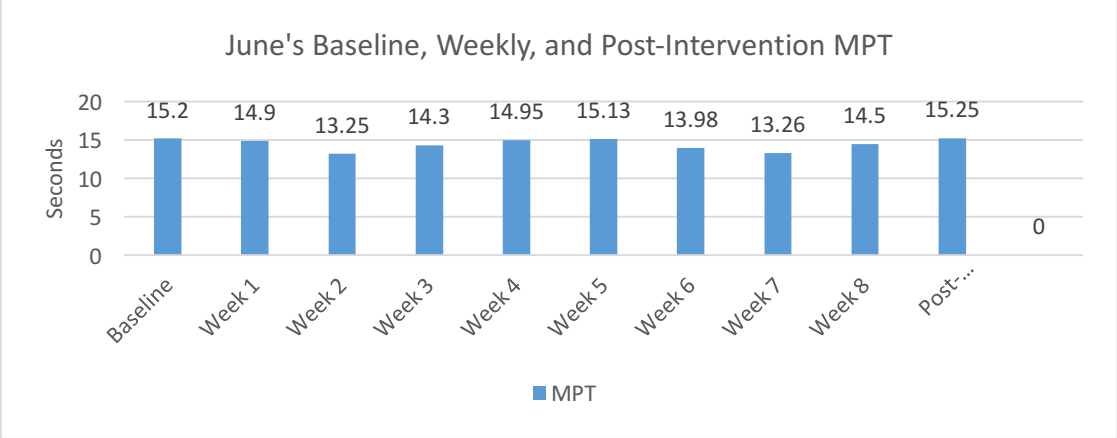

Figure 7. June's Baseline, Weekly, and Post-Intervention MPT. MPT = Maximum Phonation Time

Discussion

This present case study sought to explore the effects of mindfulness meditation on the cognition and quality of life on individuals with MCI or AD. Both Barb and June were diagnosed with MCI previous to the initiation of this study. While Barb's MMSE, CTS, and CTS-2 scores were consistent with an MCI diagnosis, June scored a 26 on the MME suggesting no cognitive impairment. The MMSE reported a standard cut-off score of 24 to determine possible cognitive impairment. Various research had reported a sensitivity of 0.63-0.66 and a specificity of 0.96-0.99 using the standard cut-off score of 24 (Kukell et al., 1994; O'Bryant et al., 2008). The 24-point cut-off score classified dementia with an accuracy of 89% (O'Bryant et al., 2008). A cut-off score of 27 demonstrated a sensitivity of 0.89 and specificity of 0.91 with 90% accuracy in classifying dementia, while a cut-off score of 28 showed a sensitivity of 0.78 and specificity of 0.78 (O'Bryant et al., 2008). Because of the more balanced sensitivity and specificity with a similar classification rate, some research suggested a higher cut-off score between 26 to 28 may be more appropriate for individuals with MCI or dementia (Kukell et al., 1994; O'Bryant et al., 2008). Zamarian, Weiss, and Delazer (2010) reported a median score of 27 (quartile 0.25 - 0.75 = 26 - 28) on the MMSE for individuals with MCI and a median score of 28 (quartile 0.25 - 0.75 = 28 - 29) for healthy adults. Another study reported a mean score of 28.9 (SD = 1.14) for healthy adults, 26.2 (SD = 1.60) for individuals with AD, and 26.5 (SD = 1.60) for individuals with other dementias (Schmid et al., 2014). The higher median and mean MMSE scores in the studies reinforced the suggestion of a higher cut-off score for individuals with MCI and dementia.

June's CTS and CTS-2 scores of 58 and 63 fell below the cut-off scores for prediction of AD (CTS= ≤68, CTS-2 = ≤75) and cut-off scores for Normal Controls versus MCI (CTS = ≤59.5, CTS-2 = ≤66.5) (Seo et al., 2010); Wolfsgruber et al., 2014). June's MMSE, CTS, and CTS-2 scores were consistent with scores reported by individuals with MCI (Schmid et al., 2014; Seo et al., 2010; Wolfgruber et al., 2014; Zamarian, Weiss, & Delazer, 2010).

The first two objectives of this study asked: (a) Will mindfulness meditation practice have an effect on cognition based on objective measures? (b) To what extent does mindfulness meditation have an effect on cognition based on objective measures?

June's scores indicated that mindfulness meditation had a positive effect on cognition, although the increases in scores were not clinically significant. Specifically, her scores on Verbal Fluency and Word List Memory both increased by 1 point reflecting a 7.14% increase after completion of the MBSR program. June's CERAD-NAB Total Score (CTS) increased by 2 points for a 3.45% increase while her CTS-2 score increased by 2 points for a 3.17% increase. In contrast, Barb's scores suggested a cognitive decline over the duration of eight weeks. This was consistent with findings that individuals who practice meditation showed less cognitive decline than individuals who did not participate in meditation (Pagnoni & Cekic, 2007; Wong et al., 2017). Similarly, Larouche et al. (2016) found less cognitive decline in individuals with MCI who participated in an 8-week mindfulness course (as cited in Wong et al., 2017).

The increase of June's scores may have been due to a practice effect from taking the same assessment twice. Characteristics of MCI include memory complaints and objective memory impairments (Peterson et al., 2001). Due to the memory impairments

characteristic of individuals with MCI and the 8-week time between administration of the assessments, it is unlikely that there was a practice effect, however, it cannot be fully dismissed.

Barb's decrease in cognition scores after eight weeks could be attributed to her husband's attendance in the assessment. The initial meeting to assess baseline cognition and quality of life was completed when Barb was alone at her home. Her second assessment was completed with Barb's husband in attendance. He was not verbally distracting and sat in another part of the room as Barb completed the assessment. Although her behavior seemed unchanged from the initial meeting, there was a possibility the presence of her husband increased her stress level or provided a distraction that was reflected in her attention level and overall performance on the assessment. There was also the possibility of other factors such as personal problems, lack of sleep, or other stress-related factors that could increase stress and decrease her scores in the cognitive assessment.

The third and fourth objectives of this study asked: (a) Will mindfulness meditation practice have an effect on quality of life? (b) To what extent does mindfulness meditation have an effect on quality of life?

June's scores suggested that mindfulness meditation had a positive effect on quality of life based on the QOL-AD, although her increases were not clinically significant. Her scores increased by 2 points for an increase of 5.88% after completion of the MBSR program. Barb's QOL-AD scores remained the same at baseline and after eight weeks. June's results were consistent with findings that quality of life measures increased after an 8 week MBSR program and the practice of mindfulness meditation

resulted in decreased symptoms of negative emotion and increased overall quality of life (Goldin et al., 2013; Paller et al., 2015; Stahl & Goldstein, 2010). As expected, June's quality of life scores increased after an MBSR program, however, the increases were not clinically significant.

Similar to the practice effect on the cognition tests, June's scores may have been affected by practice effect for the quality of life assessment. In addition, her scores may have been affected by the expectation of improvement based on initial education about mindfulness practices and its benefits.

The fifth, sixth, and seventh objectives asked: (a) What were the subjective effects of mindfulness meditation based on the individual's perspective? (b) Did the individual suffer any negative effects from mindfulness meditation? (c) To what degree did the individual suffer any negative side-effects of mindfulness meditation?

Subjective effects were measured through June's Daily Well-Being Subjective Index scores and the post-intervention interview. Her daily subjective scores after mindfulness practice always remained the same or increased from pre-meditation. When her daily subjective scores were averaged weekly (as seen in Figure 6), her post-meditation scores were higher than her pre-meditation scores over all eight weeks as expected. Even during Week 6-7 when June reported having a cold or allergy, her post-meditation scores were higher than pre- meditation scores. Because the Well-Being Subjective Index took into account general health ("I woke up feeling fresh and rested," "I feel active and vigorous"), a cold or allergy can have significant effects on the score depending on the severity of the cold or allergy. This was reflected in her pre-meditation

and post-meditation scores, both of which dropped considerably during the duration of June's cold or allergy at the end of Week 6 and the first half of Week 7.

June's post intervention interview was consistent with her Daily Well-Being Subjective Index scores. As expected, she reported that the MBSR program was beneficial to her in reduction of stress and being more calm and present. She reported that she would continue with the practices and would recommend the program to family and friends.

Neither the Well-Being Subjective Index nor the post-intervention interview revealed any negative effects of mindfulness practice. Her Daily Well-Being Subjective Index scores remained above the 50-point cut-off for low mood, and her post-intervention interview revealed that she did not report any negative effects of mindfulness meditation. Even when June had her cold or allergy, she reported that mindfulness practice made her feel better rather than worse.

Similar to the objective measures of quality of life, the subjective effects of mindfulness practice may have been affected by the expectation of improvement based on initial education about mindfulness practices and its benefits. Practice effects may have had the strongest affect with June's Daily Well-Being Subjective Index that she filled out bi-daily for 56 days. Over time, it's possible that she started filling out the bi-daily forms with less attention and care to each question resulting in a score that was not reflective of her actual state of being at the moment.

Study Limitations

One of the major limitations of this research was that this was a case study with one participant who completed the MBSR program. Because this study reflected the

experiences of a single individual who completed the MBSR program, it is not generalizable to the population. In addition, there was the possibility of researcher bias. The researcher administrated the assessments, collected the data, and interpreted the results. The researcher's subjective feelings about the benefits of mindfulness meditation may have influenced the results of the study.

Conclusion

Mindfulness has the potential to increase quality of life and cognition in individuals with MCI. Current treatment of MCI and AD is primarily focused on pharmacology (Hernandez et al., 2015). However, there are concerns regarding use of medications to treat symptoms of AD including questionable efficacy, increased side effects, drug interactions, and cost (Campbell et al., 2013; Hernandez et al., 2013). Because of these concerns, mindfulness meditation has been researched as an alternative treatment for symptoms of AD. In addition, Smith (2006) found that older individuals are responsive to mindfulness practices and that mindfulness programs may be more economical in terms of cost in comparison to other methods to reduce depression and anxiety (as cited in Paller et al., 2016).

Future research could focus on a larger sample size and a large control group with blind assessors and blind data collectors. Being able to compare mindfulness mediation with other practices would be beneficial as well. Lastly, it would be beneficial to assess long lasting effects of mindfulness meditation.

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Appendix A

CASE HISTORY FORM*

Name:_____Date:_____

Age:_____Date of Birth:_____Birthplace:_____

Street Address:_____

City:_____State:_____Zip:_____

Home Phone:_____Cell Phone:_____

Emergency Contact:

1. Name:_____Phone Number:_____
2. Name:_____Phone Number:_____
3. Name:_____Phone Number:_____

Marriage Status (circle one): Single Married Widowed Divorced

Name of Children	Age of Children
_____	_____
_____	_____

(use back of sheet if need more space)

Currently living alone (circle one) YES NO

If NO, then with whom (wife/son/daughter etc.)_____

Highest Education Level:_____

Person's
Employer:_____

Date person stopped working (if applicable):_____

* Adapted from Alzheimer's Association Documentation Guide and University of Tulsa Adults Case History Form

PERSONAL PROFILE

1. Memory
    a. What evidence can you give that you have ability to remember important information?
    b. In what way are you able to recall well-learned info?

2. Orientation to Time
    a. What is the time, date (day, month, date, year), and season? (without looking at calendar, phone, etc.)
    b. What are your habits regarding appointments and deadlines? (calendars, etc.)

3. Orientation to Place
    a. How do you respond to orienting in various places, finding directions, etc.?
    b. How do you make adjustments to changes in environments?

4. Judgment
    a. Give an example of your former ability to make choices and decisions.
    b. How do you react to complex situations?
    c. In what ways do you use appropriate judgment?
    d. Do you have appropriate control of impulses (sexual, personal such as toileting, buying and saving?)

5. Language
    a. Explain how you are able to communicate effectively.
    b. What is your manner of talking (vocab, profanity)?
    c. Can you give evidence of your use of appropriate use of words and names?
    d. Are you usually able to be understood?
    e. What are your language habits regarding repetition of words or phrases?

_____

_____

_____

6. Capabilities and activities of daily living
    a. What are your patterns of daily routine, including sleep, eating and dietary habits?
    b. Describe your former natural dress and grooming.
    c. What characterized personal manners (courtesy, politeness, table manners)?
    d. What are your reading habits, writing skills including creativeness and mechanics (spelling, math, and handwriting)?
    e. Describe your problem solving skills. Do you have appropriate understanding of tasks?
    f. What are your interests, business, experience activities and education achievements?

_____

_____

_____

7. Sociability
    a) How would you describe your personality?
    b) What are your relationships with other people? Did you have many activities/social events?
    c) How would you characterize your independence?

_____

_____

_____

8. Expression of feelings

a) How do you tend to handle or express your feelings?
b) Indicate whether you are prone to emotional outbursts (anger, crying).
c) Describe if you have had dramatic mood changes or disturbances.

_____

_____

_____

9. Thinking
a) Show how you have the ability to concentrate, plan and think things through.
b) Describe how you are able to fulfill required roles.

_____

_____

_____

10. Job performance
a) What was your vocation, occupation and/or former occupations?
b) What was job performance? How did you react to stresses of deadlines?
c) Describe your efficiency on the job.
D) How do you react to complex problems on the job?

_____

_____

_____

1 1. Other influences
a) Comment on any factors that may affect your behavior, such as sensory loss – hearing or sight
b) What is your customary use of drugs and medications including alcohol?
c) Have you had any other illnesses? Describe, telling when they started.
d) Do you have anything else to add?

_____

_____

_____

Medical History

o Stroke
o Other Communicative Disorder
o Dementia
o Memory Impairment
o Clinical Depression
o Hearing Loss
o Aphasia
o Right or Left sided weakness
o Head Injury
o Seizure Disorder
o Smoker
o Other

Please explain all items checked and list date of occurrence:

_____

_____

_____

Excess Disabilities (other physical and sensory impairments: eyesight, hearing, diabetes, high blood pressure, etc.)

_____

_____

_____

list former illnesses and injuries including major surgeries etc.

_____

_____

list any allergies or sensitivities:

_____

_____

list physicians:

Name of Physician:_____Date of last visit:_____

Name of Physician:_____Date of last visit:_____

Medications you currently take: (include non-prescription drugs):

Medicine Name	Dosage/color	When and how taken
_____	_____	
_____	_____	
_____	_____	

Appendix B

CURRENT LEVEL OF EXERCISE

Physical Activity Scale for the Elderly (PASE) HEPESE Questions

Leisure Activity
Please complete this questionnaire by selecting the correct response and answering the questions.

1) Over the past 7 days, how often did you participate in sitting activities such as reading, watching TV or doing handcrafts? (Circle one below)

Never Seldom Sometimes Often

a) On average, how many hours per day did you engage in these sitting activities?_____

2) Over the past 7 days, how often did you take a walk outside your home or yard for any reason? For example, for fun or exercise walking to work, walking the dog, etc.? (Circle one below)

Never Seldom Sometimes Often

a) On average, how many hours per day did you spend walking?_____

3) Over the past 7 days, how often did you engage in light sport or recreational activities such as bowling, golf with a cart, shuffleboard, fishing from a boat or pier or other similar activities? (Circle one below)

Never Seldom Sometimes Often

a) On average, how many hours per day did you engage in these light sport or recreational activities?_____

4) Over the past 7 days, how often did you engage in moderate sport and recreational activities such as doubles tennis, dancing, hunting, ice skating, golf without a cart, softball or other similar activities? (Circle one below)

Never Seldom Sometimes Often

a) On average, how many hours per day did you engage in these moderate sport and recreational activities?_____

5) Over the past 7 days, how often did you engage in strenuous sport and recreational activities such as jogging, swimming, cycling, singles tennis, aerobic dance, skiing (downhill or cross-country) or other similar activities? (Circle one below)

Never Seldom Sometimes Often

a) On average, how many hours per day did you engage in these strenuous sport and recreational activities?_____

6) Over the past 7 days, how often did you do any exercises specifically to increase muscle strength and endurance, such as lifting weights or pushups, etc.? (Circle one below)

Never Seldom Sometimes Often

a) On average, how many hours per day did you engage in exercises to increase muscle strength and endurance?_____

Household Activity

7) During the past 7 days have you done any light housework, such as dusting or washing dishes?

8) During the past 7 days, have you done any heavy housework or chores, such as vacuuming, scrubbing floors, washing windows, or carrying wood?

9) During the past 7 days, did you engage in any of the following activities? Please circle YES or NO for each item).

a) Home repairs like painting, wallpapering, electrical work, etc. YES NO

b) Lawn work/yard care, i.e. leaf removal, wood chopping, etc. YES NO

c) Outdoor gardening YES NO

d) Caring for another person, i.e. children, dependent spouse, or another adult. YES NO

Work Activity

10) During the past 7 days, did you work for pay or as a volunteer?

11) How many hours per week did you work for pay and/or as a volunteer?

APPENDIX C

Weekly Home Practice Log: Formal Practice
(*adapted from Paula Seikel's activity log for MBSR and tinnitus study)

Date log was started:_____

Date log was ended:_____

What matters most about this log is that you are honest in completing it. The more care and accuracy you provide while completing this form will further help your own coping with MCI as well as provide ongoing feedback for helping others in the future. Thank you for filling it out!

Please record your daily Well Being Subjective Index raw score pre-meditation and after meditation in the table below.
Approximately how much time did you spend on "formal" home practice this week? Please write the number of minutes you practiced each day under the type of home practice you completed. We welcome your comments at the bottom of the form.

Practice	Sun	Mon	Tues	Wed	Thurs	Fri	Sat
Well-Being Subjective Index Raw Score Pre-Meditation							
WBSI After Meditation Raw Score							
Body scan							
Sitting meditation							
Lying down yoga							
Standing yoga							
5-min. breathing space							
Walking meditation							
Other							

Comments:_____

_____

_____

You will turn a new log in during the class following the week you recorded

Appendix D

Well – Being Subjective Index*

DATE:_____TIME:_____

		All of the time	**Most of the time**	**More than half the time**	**Less than half the time**	**Some of the time**	**At NO time**
1	I feel cheerful and in good spirits	5	4	3	2	1	0
2	I feel calm and relaxed	5	4	3	2	1	0
3	I feel active and vigorous	5	4	3	2	1	0
4	I woke up feeling fresh and rested	5	4	3	2	1	0
5	My daily life is filled with things that interest me	5	4	3	2	1	0

Total Raw Score: _____

Scaled Score: (raw score x 4) _____

Severity level of WHO-5

Scaled Score	**Severity**
➢ 28	Likely depression
➢ 50	Low mood (not necessarily depression)

*adapted from WHO-5

APPENDIX E

Examples of Possible Changes in Functional Loss of Abilities

1. Memory impairment
    a) Inability to remember important information (an event. meeting, trip, child or
    b) Inability to remember/recall well-learned information and/or inability to learn new
    c) Perseveration - repetitive movements or persistence in statements or questions (tapping, folding, hand-wringing or saying a phrase over and over).
2. Disorientation to time
    a) Dressing inappropriately for the season or weather (heavy coat in very hot summer).
    b) Missing important appointments or deadlines.
3. Disorientation to place
    a) Getting lost in familiar surroundings (losing the way home from the workplace which has been the same for many years, possible unexplained absences where person has difficulty finding directions from one place to another).
    b) Inability to orient in unfamiliar place (finding the bathroom).
4. Impairment of judgment
    a) A change in decision making ability (poor household decisions or business/
    b) Difficulty in concentration.
    c) Inappropriate judgment (calling police for unwarranted suspicions).
    d) Inappropriate control of impulses (exhibitionism, sexually inappropriate remarks or actions. change in toileting habits such as urinating on street, marked change in buying or saving habits).
5. language impairment
    a) Change in ability to communicate effectively.
    b) Marked change in vocabulary (soft-spoken words to harsh profanity).
    c) Change in language skills (a lot of searching for words, particularly nouns).
    d) Conversations which are incomprehensible, irrelevant or where person loses
    e) Person has difficulty understanding what is said, may become argumentative
    f) Person tends to repeat the same words or phrases.

6. Decline in capabilities and routine activities of daily living
    a) Change in eating or dietary habits (dramatic change - more or less - in
    b) Changes in sleep patterns.
    c) Significant change in the way person dresses or grooms (not bathing).
    d) Regressive change in table manners (using fingers or eating directly

from plate)
e) Marked change in reading habits (not reading newspaper).
f) Marked change in writing abilities (the mechanics of writing evidenced in checkbook
g) Changes in ability to do simple perceptual tasks (unlock door or familiar tasks such as paying bills, evidenced in non-payment or duplicate payment of bills which were usually paid on time).
h) Loss of measured intellectual ability (evidenced from former records; school, military, employment testing, films, artwork or written material).
i) Marked change or difference in interests and activities.

7) Change in personality and/or marked difficulty maintaining social function
a) Noticeable personality change (confident to indecisive. extroverted to withdrawn accommodating to demanding or vice versa).
b) Difficulty in maintaining friends and former social relationships.
c) Increased dependency (independent to clingy).

8) Changes in expressions of feelings
a) Withdrawal or disassociation from activities and/or situations.
b) Inappropriate or unwarranted anger, frequent crying in one who never or rarely cried.
c) Dramatic mood swings from happy to sad. stubborn or docile or vice versa.

9) Thinking disturbances
a) Unwarranted suspiciousness (thinking food is poisoned or that people are stealing things).
b) Seeing/hearing/touching things and/or people that are not there, imaginary friends or enemies (in mirror or tv).
c) Imaginary powers such as invincibleness.

10. Job performance
a) Marked change in vocational interest.
b) Missed deadlines or appointments.
c) Reduced efficiency on the job.
d) Catastrophic reactions to problem situations.

11. Other influences
a) Marked change in acceptance of physical limitations.
b) Drug or alcohol abuse.
c) Marked changed because of other

APPENDIX F

PALOUSE MINDFULNESS GENERAL SCHEDULE

Palouse Mindfulness MBSR Course

Introduction	Getting Started MBSR –An Introduction MBSR Research Summary
Week 1	Simple Awareness Introduction to the Body Scan
Week 2	Attention & The Brain Introduction to Sitting Meditation
Week 3	Dealing with Thoughts Introduction to Yoga
Week 4	Stress: Responding vs. Reacting STOP: The One-Minute Breathing Space
Week 5	Dealing with Difficult Emotions/Sensations Soften, Soothe, Allow
Week 5	Special Instructions for Physical Pain The Five-Step PAIN Process
Week 6	Mindfulness and Communication Lake & Mountain Meditations
Week 7	Mindfulness and Compassion Lovingkindness Meditation
Week 8	Conclusion Developing a practice of your own

Appendix G

Post-Intervention Questionnaire

1) Do you feel that you benefitted from this MBSR program?

    a. Explain.

2) How do you rate your stress levels since completing the program (increased/decreased/same)?

3) Did you have any negative effects after practicing mindfulness? (anxiety, depression, etc.)

    a. If yes, describe.

    b. How would you rate the severity of your negative effects? (1-10, 10 being most severe)

    c. How often did you experience these negative effects?

4) Do you think you will continue with mindfulness practices?

    a. If not, why?

5) Would you recommend the MBSR program?

6) Other comments:

Appendix H

Corrected CTS Scores from Chandler et al. (2005)

Online Supplemental Data

Table (E) T-1 Demographic Correction Factors for Method One CERAD Total Scores

	Age 50 -55		Age 56 –60		Age 61 –65		Age 66 –70		Age 71 – 75		Age 76 – 80		Age 81 –85		Age 86 - 90	
Education	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
≤8	13	10	14	12	16	13	18	15	19	16	21	18	23	20	24	21
9-11	11	8	13	10	14	11	16	13	18	15	19	16	21	18	22	19
12	9	6	11	8	13	10	14	11	16	13	17	15	19	16	21	18
13-15	7	4	9	6	11	8	12	9	14	11	16	13	17	14	19	16
16	6	3	7	4	9	6	11	8	12	9	14	11	15	13	17	14
≥ 17	5	2	6	4	8	5	10	7	11	8	13	10	15	12	16	13

Correction factors should be added to the CERAD Total Score.

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Appendix I

T-Scores from Chandler et al. (2005)

Table (E) T-2 *Normative Data (T-Scores) for Corrected Method One CERAD Total Score*

Corrected Total Score (Raw + Correction Factor)	T-Score	Corrected Total Score (Raw + Correction Factor)	T-Score
≥102	≥65	79	37
101	63	78	35
100	62	77	34
99	61	76	33
98	60	75	32
97	59	74	30
96	57	73	29
95	56	72	28
94	55	71	27
93	54	70	25
92	52	69	24
91	51	68	23
90	50	67	22
89	49	66	20
88	48	65	19
87	46	64	18
86	45	63	17
85	44	62	16
84	43	61	14
83	41	60	13
82	40	59	12
81	39	58	11
80	38	57	≤10

T-scores have a mean of 50 and SD of 10.