ASSESSMENT OF COGNITIVE TRAINING IN PEOPLE WITH MILD TO MODERATE DEMENTIA

by

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ABSTRACT

HILLARY JEAN ROUSE. Assessment of cognitive training in people with mild to moderate dementia. (Under the direction of DR. MARK FAUST)

The main goal is to see how computer game play experiences can affect cognitive, social, behavioral, and psychological functioning in a population of older adults with mild-to-moderate dementia. Participants engaged in various cognitive games from the Posit Science Corporation's (San Francisco, CA) computer game-based cognitive training software. The theory driving these computer games is neuroplasticity, as it is seen in healthy older adults that computer games can help to reverse negative plasticity that is typically associated with older age and dementia. This experiment also examined how social interaction can affect cognitive training effects in those with mild to moderate dementia. The participants were divided into two different groups where one had high social interaction with the researcher and the other had low social interaction with the researcher. Cognitive function was measured with the Montreal Cognitive Assessment and Repeatable Battery of Assessment of Neuropsychological Status, the occurrence of behavioral and psychological symptoms with the Neuropsychiatric Inventory, and finally quality of life with the Quality of Life-Alzheimer's Disease scale (Cummings, 1997; Duff et al., 2008; Nasreddine et al., 2005; Thorgrimsen et al., 2003). Computer game training sessions were also measured qualitatively using the guidelines found in the Observational Measurement of Engagement tool (Cohen-Mansfield, Dakheel-Ali, & Marx, 2009).

Alzheimer's disease is a devastating illness affecting millions of Americans today, because there is no cure yet for this disease it is important to look at alternate ways of treating the symptoms associated with it. Alzheimer's disease is a progressive diffuse

neural degradation resulting in declines in cognition, especially memory, and this results in cognitive and social withdrawal. Those with Alzheimer's are increasingly being housed full-time or in a day care basis where symptoms of cognitive and social withdrawal can be exacerbated by lack of staff resources to provide stimulating environments. This research is important because not much is known about how computer game-based cognitive training will affect those with dementia, especially in regards to social, cognitive, and behavioral/psychological domains. It also isn't known if the games could be easily implemented, with a minimum of one-to-one staff interaction, or whether these individuals can effectively engage in the computer games in an autonomous manner.

In this study it is hypothesized that those with cognitive training and high social interaction will see stability in cognitive status and an improvement in behavioral and psychological symptoms, while those with low social interaction will only see stability in cognitive status. To assess these hypotheses, we tested a sample (n=8) of individuals with mild to moderate dementia, as indicated by their Montreal Cognitive Assessment score. These scores were confirmed as six of the participants already had a formal diagnosis of some type of dementia by a doctor. These participants engaged in twelve sessions of computer-based game training on a battery of computer games found to lead to cognitive improvement in healthy older adult samples through Posit Science.

Keywords: Alzheimer's disease, cognitive training, social interaction, behavioral and psychological symptoms

INTRODUCTION: COMPUTER GAME TRAINING EFFECTS

Alzheimer's disease affects millions of people every year, either by being a person who is newly diagnosed or a family member who is trying to cope with the progression of the disease, it touches everyone in its own unique ways. The disease's primary symptoms are characterized by a general decline in cognitive function (e.g., visuospatial, language, processing speed) in addition to the defining characteristic of declining memory function (e.g., loss of spatial route memory, word finding, and remembering names). New drug treatments designed to slow the progression of memory loss (e.g., Aricept, that affects neurons in the memory system that rely on the neurotransmitter acetylcholine) have come to be increasingly prescribed for those diagnosed with AD. These drugs are only marginally effective (Douglas, James, & Ballard, 2004) and non-pharmaceutical cognitive therapies may hold promise to augment the effectiveness of these drugs. A pharmacological treatment typically involves the use of antipsychotics. Antipsychotics are very well-known for their serious side effects, like increased risk of death, and tend to be only marginally effective in people with dementia. It is therefore very important that researchers continue to study and find strong, supporting evidence for non-pharmacological therapies that, if used, could be of greater benefit for these people with dementia who are presenting behavioral and psychological symptoms. Another challenging symptom associated in people with dementia is social withdrawal. As soon as one is diagnosed with dementia, we often see that interactions with others are not as high of quality as before. Finding new ways for these people to maintain involvement in meaningful activities and boosting their confidence by showing them the abilities they still have intact help them to preserve their dignity, maintain their

identity, and keep their sense of autonomy. Social interaction has continuously shown to help preserve older adults memory, as well have many other health benefits (Ertel, Glymour, & Berkman, 2008). Social interaction will be assessed in this study to see if it is a strong influence for people with dementia like it is claimed to be, especially during these training sessions. Researchers, like Backman (1992), found that those with dementia need more support than healthy older adults to enhance memory through cognitive training. Computer game-based cognitive training holds promise of a self-motivated interactive experience for people with dementia with minimal demands on staff.

This study assessed how social interaction can affect the outcomes of computer-based cognitive training game play, as well as if it can help cognitive, behavioral, psychological, and quality of life domains for people with mild to moderate dementia in an assisted living day-care setting. These domains are thought to improve through game play and by using a pre- and post-assessment, we will look to see any changes that occurred in these domains. In addition to this data, qualitative notes will be taken during each session to record how the game play sessions went and how the participants liked each game. The computer-based games are accessed through Posit Science (San Francisco, CA) and are adaptive so they are designed to reverse negative plastic changes in the brain due to changes in perception and interactions with the environment.

TABLE OF CONTENTS

LITERATURE REVIEW

What is Alzheimer's Disease?

Alzheimer's disease is defined as a progressive mental deterioration that can occur in middle or old age due to generalized degeneration of the brain. There are currently five million people in the United States with Alzheimer's and this number is expected to triple by 2050. It is important to understand the impact of the Alzheimer's epidemic, as it is the sixth leading cause of death in the United States and about 5.2 million people are currently living with this disease (Alzheimer's Association, 2014). This number is staggering and frightening since researchers currently do not know what causes Alzheimer's disease or how to cure or prevent it. Since there is no medication that effectively treats this disease, for now, it is important to look at factors that can help to delay the onset of this disease and combat the symptoms that are associated with it. The diffuse degradation of cortical regions that supports the different cognitive domains leads to many of the negative, and influential, symptoms on people with dementia. Most of the symptoms are in regards to their cognitive decline and social withdrawal. The cognitive decline seen in these people results in them feeling embarrassed to interact with people out of fear that they won't remember the topic of conversation or even talking to those people at a later time. Due to this withdrawal in all settings, we see that people with any type of cognitive impairment are typically forgot about and left with minimal stimulation. Since cognitive training has shown to need little staffing, these computer games could be an opportunity for those caring for people with dementia to be able to give them the stimulation they need and not be overwhelmed by the process. Also, computer game-based cognitive training in addition to drug treatments that help the memory aspect of this

disease, could help to slow or even reverse some of the aspects of the disease. If this is the case, older adults may feel more open to highly satisfying communication to help their social interaction and in the long run their cognition.

The most prominent alternative non-pharmaceutical treatment options for people with dementia that have support from research are animal-assisted therapy, doll therapy, multi-sensory stimulation therapy, and music therapy (Bernabei et al., 2013; Lykkeslet, Giengedal, Skrondal, & Storiord, 2014; Mitchell & O'Donnell, 2013; Svansdottir & Snaedal, 2006). The biggest concern researchers have for these therapies is that they don't have the lasting effects that we wish for them to have and that the antipsychotics seem to have. The newest idea for non-pharmaceutical therapies for people with mild to moderate dementia and showing symptoms of behavioral and psychological symptoms of dementia is cognitive training. Cognitive training is a set of standardized tasks designed to reflect specific cognitive functions to help improve or maintain functioning in any of these cognitive domains (Clare & Woods, 2004; Eckroth-Bucher & Siberski, 2009). Some advantages of computer game-based cognitive training is that it needs low staff involvement, has a high adherence rate due to the competitive nature of the games, and they can be changed from time to time to keep interest sparked by those playing them. While there is plentiful research about cognitive training, this research has mostly been done with healthy elders and very seldom done with people who have some sort of cognitive impairment. There is a need for more research to be done in the field of cognitive training and those with dementia, but the few results from current studies show promising results for the effects it could have on these people.

Brain Changes Due to the Disease

During the course of Alzheimer's disease, there is nerve cell death and tissue loss resulting in dramatic brain shrinkage and dramatic decreases in functioning of the person. In particular, the cortex shrivels up resulting in damage to areas involved in thinking, planning, and remembering. There is also extreme shrinkage in the hippocampus, which is the brain area associated with the formation of new memories. When looking deeper into the brain, scientists find an increased presence of beta-amyloid plaques and tangles that are causing brain cell death. Plaques are abnormal clusters of protein fragments, specifically the beta-amyloid protein that builds up between the nerve cells. When the beta-amyloid protein groups together, there is a decrease in cell-to-cell signaling at the synapses and an activation of the immune system cells which trigger inflammation and devour disabled cells. Tangles are twisted strands of a different protein that destroy a vital transport system. The transport system is typically organized in parallel strands and helps key nutrients travel to different areas of the brain. Tau is the protein that helps the strands stay straight and the tau collapses when it is twisted into these tangles. This results in the tracts disintegrating and nutrients no longer being able to be supplied to the specific brain areas (Alzheimer's Association, 2014).

It is well-documented by researchers and well-recognized by the public, that as people age, they will experience some worsening of cognitive abilities. As mentioned above, Alzheimer's disease helps to speed up the decline of these abilities, mainly through the plaques and tangles that are formed in the brain. In promising research in the area of non-pharmaceutical therapies, the idea of neuroplasticity is used to help understand that there are ways to help our cognition through external stimulation because

of the malleability of the brain. Every person's brain has this plasticity, and plasticity is understood as the ability to change structure or function in a sustained manner. Neuroplasticity does not give us the cure for this disease, but rather when a person is given the opportunity for external stimulation, we see that the brain can learn how to 'rewire' how it knows to learn what it is doing. This reorganization helps the older person's brain become more open to activating regions or increasing neural activity in task-related structures that are not typically used for the task at hand. This helps the brain grow and learn how to deal with other stressors as well, such as these behavioral or psychological issues that may arise in those with dementia. Cognitive-training programs now are looking more promising than ever because of this enhanced theory of the brain's neuroplasticity to 'rewire' the brain and help to slow down the progression of this terrible disease, as well as help to stop or prevent any symptoms within the behavioral or psychological domain (Park & Bischof, 2013)

Behavioral and Psychological Symptoms of Dementia

Traditionally, cognitive problems have been the main focus of interest in treatment and research for people with dementia, but recently there has been a shift to common non-cognitive symptoms due to the problems that are occurring for the person and their caregivers. Behavioral and psychological symptoms of dementia (BPSD) are an umbrella term coined by the International Psychogeriatric Association (Douglas et al., 2004). BPSD affects 50-80% of individuals with dementia at some point during the progression of the disease and typically at varying degrees due to diverse etiology (Treloar et al., 2010). BPSD typically includes agitation, aggression, depression, apathy, anxiety, delusions, hallucinations, sexual disinhibition, eating problems, abnormal

vocalizations, and sleep impairments. The most frequently occurring symptoms that we see in those with dementia are depression and then psychosis (Douglas et al., 2004; Treloar et al., 2010).

BPSD can have adverse consequences for persons with dementia and their caregivers. These symptoms are the most common reason for institutionalization of people who have dementia and they increase the burden and stress of caregivers (Douglas et al., 2004). It is important for doctors to look for concurrent physical illnesses that could be causing the person to act this way and then if that fails to try non-pharmacological approaches before intervening with pharmacological ones. Unfortunately, more frequently than not, we see doctors going straight to pharmacological approaches before anything else and prescribing antipsychotics or other sedative medications. Inappropriate and unnecessary prescribing of antipsychotics has become such a problem that more than 40% of people with dementia in care communities are taking them. The prescription of these medications without attempting other treatment options is of particular concern because of the substantial adverse effects associated with their use in people with dementia (Douglas et al., 2004).

Non-Pharmaceutical Therapy Options

In long-term care settings, problem behaviors were shown to increase when the person was inactive and to decrease when structured activities were offered (Cohen-Mansfield, Marx, Dakheel-Ali, Reiger, & Thein, 2010). Exploring the efficacy of such non-pharmacological approaches to intervention is important because some drugs, like antipsychotics, have been associated with limited efficacy, negative side effects, and increased mortality in persons with dementia. Additionally, according to the principles of

dementia care delineated by the American Association for Geriatric Psychiatry, non-pharmacological interventions should always be tried first. The selection of specific non-pharmacological therapies should be based on the unique characteristics of the patient, the caregiver, the availability of the therapy, the severity of the neuropsychiatric symptoms, and the likelihood that the specific symptoms will respond to the specific therapy (Cohen-Mansfield et al., 2010). Individual assessment and analysis of each person's situation is needed for this type of therapy. Even if two people with dementia are both thought to be showing agitation because of a high level of internal arousal, what helps one may be quite different from what helps the other, this would result in a 'what works for whom' approach instead of a standard approach (Woods, 2004). It is also relevant to note that, in many currently used non-pharmacological approaches; the disruptive behaviors are often not addressed directly, but are taken as an indication of underlying distress or unmet need (Douglas et al., 2004).

A number of studies have found that mental activity plays a protective role against cognitive decline, and further research is being performed to see whether there is a causal relationship between low activity levels and dementia development (Cohen-Mansfield et al., 2010). The research is providing clear evidence that memory function is improved by engagement in demanding everyday tasks (Park et al., 2014). Cognitive stimulation is also showing changes in cognitive function that were of the same magnitude as those reported in trials of acetylcholinesterase inhibitors which also lead to improvements in quality of life (Woods, 2004). Overall, persons with dementia can indeed be engaged with stimuli in non-pharmacological therapies and it is important to conduct these types of studies to continue to identify effective and safe treatments in response to the growing

prevalence of dementia so we have alternatives to these harmful antipsychotics. Understanding the relationship among the type of stimulus, cognitive function, acceptance, attention, and attitude toward the stimuli can enable caregivers to maximize the desired benefit for persons with dementia (Cohen-Mansfield et al., 2010).

Animal-Assisted Therapy

The use of animals for health purposes was introduced in the United States in 1953 as a way to improve a person's quality of life in a broader sense (Mossello et al., 2011). With this being said, human-animal interactions are becoming a focus of research in an attempt to distinguish what claims are true about how the animals can help people feel better and serve as aids to communication (Filan & Llewellyn-Jones, 2006). With regards to patients with dementia, seven out of every ten studies investigating the effects of human-animal interaction through animal-assisted therapy find favorable results for this (Bernabei et al., 2013). In particular, beneficial effects of dog contact include pleasant tactile stimulation, companionship, and non-verbal communication; which is potentially more friendly and non-judgmental than those of the best-intentioned caregivers (Mossello et al., 2011).

With the use of animal-assisted therapy, researchers are finding strong results that support its use in nursing homes with people with dementia as a non-pharmacological therapy to help with BPSD. The presence of an animal can improve quality of life, decrease agitated behaviors, and increase social interaction for people with dementia (Nordgren & Engstrom, 2014). Animals lead to positive influences in these people as researchers saw calming of agitated behaviors, positive effects on quality of social interactions and mood disturbance, improved apathy state, reduced daytime behavioral

disturbances, increased nutritional intake, reduced sadness and anxiety, increased pleasure, and increased general alertness (Bernabei et al., 2013; Filan & Llewellyn-Jones, 2006; Mossello et al., 2011; Motomura, Yagi, & Ohyama, 2004). The presence of animals significantly increased social behaviors, such as greeting other people, speaking with other people, or attending activities in the nursing home as well (Motomura et al., 2004). This therapy helped to increase people's verbal interactions and socialization and alleviated any feelings of loneliness (Bernabei et al., 2013). Also, it is a powerful social catalyst for people with dementia; the pet stimulates positive reminiscence among residents and/or between residents with visitors or caregivers (Filan & Llewellyn-Jones, 2006). Motor activity increased due to an increased attraction towards the environment and the desire to want to play with and pet the animal. As physical activity has been proven to reduce the functional decline in patients with severe dementia, animal-assisted therapy might be a potential aid also to improve the global health status of those people (Mossello et al., 2011). Interestingly, we also see physiological changes in those with dementia who interact with animals, especially dogs. Those changes seen were a lowering of blood pressure, significantly reduced heart rate, and an increase in neurochemicals associated with relaxation and bonding showing the calming effects that animal-assisted therapy has on this group of people (Filan & Llewellyn-Jones, 2006; Nordgren & Engstrom, 2014).

On the basis of these observations, researchers believe that animal-assisted therapy programs are desirable components of multidisciplinary treatments for patients with dementia and are essential to increase socialization, activity, and sense of mastery (Motomura et al., 2004). There are two very crucial components to the successfulness of

animal-assisted therapy. The therapy usually worked best when the nursing home staff was involved with the activity and encouraged the residents when they were participating with the animal. Also, resident's past interest in or ownership of animals was also very critical because it made them want to be participate in this therapy because they could reminisce about their past animals (Richeson, 2003). However, the Cochrane Collaboration Centre for Reviews and Dissemination states that "animal-assisted therapy offers promise as a psychosocial intervention for people with dementia, though further research is needed." This was stated because animal-assisted therapy research isn't finding the lasting effects they were hoping to (Nordgren & Engstrom, 2014). The hypothesis for why this is happening is that the animal-assisted therapy provided meaningful activity and when the activity was removed, the meaning they assigned to themselves was no longer there (Richeson, 2003).

Doll Therapy

Research relating to the prevention of BPSD indicates that people with dementia have their current reality strongly linked to memories of the past. There is evidence that a person in the moderate to advanced stages of dementia will respond positively to familiar attachments related to long-term memories. Regeneration of past relationships, whether it is through the ongoing engagement with relatives, the use of a doll, soft toys, and/or a pet, provides a method of engaging in activity that conveys significance to the individual's present life (Bisani & Angus, 2013). The therapeutic use of dolls is best understood at a theoretical level from the work of John Bowlby and his attachment theory, as it explains parent fixation that is often seen in people with dementia. This fixation is seen when these people search for their parents and is often an expression of

an attachment need. People with dementia are often very insecure and are hoping to be reunited with or attached to something familiar in order to find comfort and safety. This suggests that doll therapy could be used as a potential 'anchor' for those people with dementia in a period of uncertainty. According to past research, it is important to present the doll to people with dementia and allow them to establish whether it is a baby or a toy doll and no matter how the person deems it to be, there will always be benefits to help with attachment, comfort, and activity (Mitchell & O'Donnell, 2013).

Doll therapy can be used as a therapeutic tool in response to the needs of attachment because it allows these patients to experience past emotions which have been felt in past relationships, allowing the person to be brought back to a time of comfort (Pezzati et al., 2014). In research, baby dolls were effective in eliciting different types of responses from individuals with dementia that don't normal respond too much (Tamura et al., 2001). This research reports a reduction of disturbing behaviors like being less agitated, more active, increased communication between patients and caregivers or staff, reduction in panic, improved social interaction, improved self-esteem and these people appeared happier due to the fact that the doll stimulated conversation on affective topics related to parenthood and caregiving (Bisani & Angus, 2013; Mackenzie, 2006; Pezzati et al., 2014). This is suggestive that the residents are now being given a sense of purpose or focus (Mackenzie, 2006).

Doll therapy highlights how the person with dementia shifts from requesting care and protection for themselves through vocalizations, gestures, and crying, to reassuring the doll to promote moments of peacefulness and tranquility with reductions of disruptive behaviors. It is important to remember for this therapy that it is not the activity itself,

which dictates the nature and meaning of an experience, but rather the way it is carried out. It is important not to force the doll on the person and to let them form their own opinion of it and not try to fight them on the opinion they form. It is also important that staff encourages dialogue about the doll to reverse social isolation and withdrawal (Bisani & Angus, 2013). The staff needs to make sure to regulate the relationship of the doll and the person though because there is evidence that people with dementia can become over-invested in caring for their dolls and then put the dolls interests before their own (Mackenzie, 2006). Doll therapy suggests that it represents an intervention that allows the person with dementia to build and keep a significant relational situation with the doll over time, highlighting good relational skills that are generally compromised in these people. The therapy promotes improvements in the person's ability to relate with the surrounding world and this can help those with dementia and BPSD in an institutionalized context (Pezzati et al., 2014).

The research supports doll therapy as a therapeutic intervention that may be utilized in the continuing care of some people living with dementia to meet needs for attachment and to reduce BPSD (Bisani & Angus, 2013). There are therapeutic gains associated with the use of doll therapy for people with dementia as it can be used to help to reduce a range of behavioral challenges, like anxiety, aggression and wandering. The practice of doll therapy, however, requires close scrutiny and its use should be approached with some caution. This is due to the fact that its use in people with dementia is in its infancy and must evolve and be critically evaluated before being routinely used in practice settings (Mitchell & O'Donnell, 2013).

Multi-Sensory Stimulation Therapy

The risk of sensory deprivation for those with dementia increases as they get older due to the natural course of sensory deterioration that occurs. Those that spend their time in long-term care hospitals, which tend to be unstimulating or have inappropriate stimulation, see a degree of sensory deterioration as well. Also, with the neuronal losses associated with dementia we see impaired processing of sensory stimuli which makes normal stimuli confusing (Baker et al., 2003). Multi-sensory stimulation therapy refers to a variety of techniques used to stimulate the senses in order to increase alertness and reduce agitation (Lykkeslet et al., 2014). Sensory stimulation includes auditory, visual, olfactory, tactile, taste, and kinesthetic stimulation without the need for complex intellectual reasoning (Cruz, Marques, Barbosa, Figueiredo, & Sousa, 2013; Lykkeslet et al., 2014). By stimulating all the senses it is seen that people with dementia will respond appropriately to their surroundings, communicate with others, improve mobility, improve balance, improve cognition, reduce falls, and delay the decline of performance in daily activities. Multi-sensory stimulation therapy has been found to reduce the frequency of behavior problems and apathy, improve communication, improve functional performance, improve attentiveness, and maintain or improve physical abilities (Cruz et al., 2013).

Multi-sensory stimulation therapy led to participants recalling more memories as well as being more attentive, less apathetic, less bored, more active, more relaxed, and increased communication (Baker et al., 2003; Lykkeslet et al., 2014; Spector et al., 2003). It is possible, also, that the component of social interaction in this therapy could have provided some of the positive results that the researchers found (Spector et al., 2003).

Multi-sensory stimulation therapy seems to provide opportunities for accommodating the individual person's needs and thereby establishes a person-centered perspective. An expansion of a person-centered approach with a phenomenological life world perspective may form a theoretical basis for, and a deeper understanding of, the patients' universe of meaning (Lykkeslet et al., 2014).

These findings are encouraging for the use of multi-sensory stimulation therapy because it shows that this therapeutic activity helps give the people with dementia the internal resources needed to initiate, maintain, or complete an activity. The findings suggest that structured activity programs based on multi-sensory stimulation therapy approaches can be a promising therapeutic method for people with advanced dementia. The present therapy may serve as reference to the development of future programs exploring residents' engagement aiming to increase person-centeredness of the care provided (Cruz et al., 2013).

Music Therapy

Music therapy is a psychological, social, and behavioral creative intervention in which trained therapists use music-making and words to support and enhance a person with dementia's expression of feelings, their sense of self, and their ability to connect and communicate with other people (Gold, 2013). Therapists doing one-on-one interactions with people tend to use specific tunes or sounds to obtain the goals of the therapy in individuals with BPSD (Svansdottir & Snaedal, 2006). Music therapy group programs, on the other hand, will tend to include a variety of activities such as singing, instrument playing, dance-movement, music listening, composition-improvisation, and musical games aiming to stimulate and enhance the different functional areas of older people:

physical-motor, cognitive, and social-emotional areas (Sole, Mercadal-Brotons, Galati, & De Castro, 2014). Music programs and music therapy interventions have been shown to have positive effects in decreasing people with dementia's sense of isolation and their behavioral problems like wandering, continuous crying, shouting, and agitation. It also has shown to increase their well-being and create a more positive social interaction between the people participating in the therapy (Mcdermott, Crellin, Ridder, Orrell, 2013; Sole et al., 2014; Svansdottir & Snaedal, 2006).

Although we see music therapy introduced to people with dementia in many different ways, they all have an overriding goal of creating a situation of well-being and socialization through various music proposals. Music is potentially evocative, as it stimulates memories through moments of verbalization and music facilitates the recognition of environments. It is proven, at any age, listening to music can reduce behavioral disorders, enhance mood, and enhance socialization (Raglio, 2010). This therapy involves a building of a musical relationship through listening and responding to the sounds (Mcdermott et al., 2013). All in all, music therapy aims at the establishment of a relationship and the sonorous-musical element is the means that helps to create this relationship (Raglio, 2010).

Research on music therapy has shown that it can significantly help combat BPSD. Researchers find that for those who went to music therapy as an activity had significantly fewer disturbances (Svansdottir & Snaedal, 2006). Music therapy elicits a reduction of agitation, pacing, wandering, anxiety, and depression and increased empathetic behavior. Overall there was a decrease in patients' neuropsychiatric symptoms and caregivers reported improvements in social and emotional aspects of the person with dementia

(Mcdermott et al., 2013). Music therapy also has a homeostatic effect for pressure regulation and therefore this therapy can be considered a preventative measure to brain and heart diseases (Raglio, 2010). Music therapy improved heart rate variability and decreased heart rate; it also led to an increase in melatonin, which is associated with the calming of an individual. There was also a reduction of the stress hormone, cortisol, and an increase in lymphocytes, or our bodies 'natural killers' (Mcdermott et al., 2013; Raglio, 2010).

Older adults have rated listening to music as a pleasant experience and use music to promote relaxation, decrease anxiety, and distract from unpleasant experiences. Music appears to be an activity to interact with others, share aspects of their lives, provide an opportunity to connect with a sense of spirituality, and a source of entertainment (Sole et al., 2014). Therefore it can be implied that active participation in music therapy could give people with dementia meaning to their lives as the desire for activity would be met and symptoms of meaningless activities lessened (Svansdottir & Snaedal, 2006).

Music therapy can help the person with dementia maintain a sense of identity and to recognize the environment (Raglio, 2010). An advantage of music therapy is the lack of side-effects and the significant decrease in BPSD (Svansdottir & Snaedal, 2006). Many researchers argue that 'perhaps change cannot be sustained as the dementia becomes more severe. The intervention might still be deemed worthwhile if it improved the person's quality of life, even temporarily' (Mcdermott et al., 2013).

What is Cognitive Training?

Cognitive Training, Cognitive Stimulation, and Cognitive Rehabilitation

The cognitive intervention framework is mainly a medical approach where individuals in the early stages of dementia are given cholinesterase inhibitors or antipsychotics as the primary intervention. Pharmacological interventions lead to small, limited improvements in cognition and function, appear to not affect the underlying cause of dementia, and can have significant, serious side effects. Researchers find that current non-pharmacological interventions can lead to some positive changes in cognition and behavior and seem to lack serious side effects, but also do not affect the underlying cause of dementia and their impacts don't last very long. Researchers, like Eckroth-Bucher and Siberski (2009), now suggest that cognitive skills should be the target of rehabilitative interventions to attenuate or delay age-related cognitive decline and slow the progression of the process of dementia. The logic behind this belief has been based on research, which demonstrates that most individuals with mild-to-moderate dementia are not totally amnestic and physiological plasticity remains present in the brain allowing for synaptogenesis and increased synaptic complexity. Thus, individuals with mild-to-moderate dementia continue to have the ability for new learning and memory enhancement. The current focus of research targeting cognitive skills is through cognitive training, cognitive stimulation, and cognitive rehabilitation. All three cognitive programs are intertwined, but have their unique differences (Eckroth-Bucher & Siberski, 2009).

Cognitive training involves guided practice on a set of standard tasks designed to reflect specific cognitive functions such as memory, attention, language, and executive function. It is offered in individual or group sessions or facilitated with therapist support.

Tasks are either presented in paper-and-pencil form, through the computer, or involve analogues of activities of daily living. There are a range of difficulty levels within each standardized set of tasks, which allows for a more individualized approach. This type of training tends to rest on a fundamental assumption that routine practice has the potential to improve or maintain functioning in any given domain and that these effects will generalize beyond the immediate training (Clare & Woods, 2004; Eckroth-Bucher & Siberski, 2009).

Cognitive stimulation interventions are based on the view that consistent engagement in a variety of mental activities enhances cognitive and social functioning. Evidence supports that individuals who are engaged and stimulated by activities that require the use of cognitive abilities may have less of a risk for developing dementia and a slower progression of cognitive decline. The rationale behind cognitive stimulation is that cognitive functions are not used in isolation, but rather require a sophisticated integration with other functions. Therefore this research is beneficial because it tackles aspects of under-functioning resulting from social environments that are insufficiently stimulating and rewarding (Clare & Woods, 2004; Eckroth-Bucher & Siberski, 2009).

Cognitive rehabilitation aims to help people achieve or maintain an ‘optimal level of physical, psychological, and social functioning’ in the context of specific impairments from illness. Cognitive rehabilitation is conducted in the context of a natural trajectory of change over time, so in regards to dementia, the goals would change over time to reflect the progression of impairment. Cognitive rehabilitation is an individualized approach to helping people affected with cognitive impairments, and their caregivers, work together with health care professionals to identify personally relevant goals and devise strategies

for addressing these. The emphasis is not on enhancing performance on cognitive tasks, but on improving functioning in the everyday context (Clare & Woods, 2004).

The possible value of interventions to improve memory functioning is indicated by studies of memory and learning which show that, despite the severity of memory difficulties, many aspects of memory remain relatively intact in the early stages of dementia. The interventions aimed at helping with memory difficulties may have the potential to reduce secondary problems and improve well-being for both the person with dementia and the caregivers. This has long been recognized by psychosocially-oriented clinicians and researchers, and there is a considerable tradition of cognition-focused interventions within dementia care (Clare & Woods, 2004).

Computerized Cognitive Training

Cognitive training helps to develop a cognitive profile for people with dementia, which shows that this intervention aims to build on the areas of relative strength reflected in preserved aspects of memory. Computerized cognitive training develops ways of compensating for impairments in those aspects of memory that are significantly affected in order to enhance or maintain everyday functioning and well-being (Clare & Woods, 2004). Since cognitive training is domain specific, the cognitive training software tends to be separated based on different aspects of cognition (Barnes et al., 2009). The programs used and techniques applied range from task-specific, test-sets, training batteries, and three-dimensional virtual environments (Hofmann et al., 2003). The theoretical goals of this strategy in the literature are to improve or support damaged functions in order to facilitate new learning (Grandmaison & Simard, 2003).

Mounting research evidence in the area of neuroplasticity indicates that novel experiences, such as cognitive training, can increase brain activity and trigger neurochemical processes that maintain and encourage dendrite growth and synaptic complexity (Eckroth-Bucher & Siberski, 2009). Computer game-based cognitive training has the advantage of individualizing the treatment on the basis of the person's neuropsychological pattern, in order to stimulate the damaged areas. It is specifically targeted to support rehabilitation of cognitive areas and everyday functions (Cipriani, Bianchetti, & Trabucchi, 2006; Talassi et al., 2007). Past experiences, expertise, and cognitive status will all play important roles in understanding tasks that provide optimal challenge to an individual and have the potential to effect change in neural structure or function (Park & Bischof, 2013).

Computer game-based cognitive training is very feasible for older adults as well because it is more cost-effective and can reach special populations all over who may have limited access to transportation (Kueider, Parisi, Gross, Rebok, & Brucki, 2012). It is implied that it will be very important for individuals to enjoy the training tasks they are performing over the long term so that the behavior can be sustained and benefits managed. Consistent enjoyment by the participant could be the biggest challenge for this type of intervention because it is found that it can be turned into a dreaded obligation instead of a pleasurable and stimulating activity (Park & Bischof, 2013). Finally, there are several characteristics of cognitive training programs that are desirable. First, cognitive training via practicing computerized tasks needs to be both intensive and extensive in order to have the potential to improve cognitive functioning at some general level. Second, training should comprise several different tasks. Whether these tasks

should target one or several abilities and which abilities should be targeted are questions that can only be answered by future experimental intervention studies. As a third important feature, it is important to include immediate feedback within the training program to satisfy participants' need for information about training progress and foster their self-concept by making this progress transparent (Schmidek, Bauer, Lovden, Brose, & Lindenberger, 2010). It is suggested that cognitive change can only occur when a task or environment consistently makes demands on core cognitive processes like speed, working memory, episodic memory, and reasoning (Park & Bischof, 2013). Effectiveness of cognitive training in improving cognitive and functional performance of patients affected by dementia is still greatly debated and there is no definitive evidence available yet (Cipriani et al., 2006). There needs to be more rigorous testing on older adults doing cognitive training to establish the true efficacy of these programs. Computerized training programs have the opportunity to capitalize on the increasing prevalence of personal computers among older adults and the increasing number of older adults who could improve cognitive function and delay cognitive decline in later life (Kueider et al., 2012).

Results of Cognitive Training for Healthy Older Adults

The Alzheimer's Association estimates that if the onset of Alzheimer's disease could be delayed by 5 years due to successful interventions, this would result in a 50% decrease in Alzheimer's diagnoses (Park & Bischof, 2013). Many studies have provided evidence that cognitive training can lead to cognitive gains in healthy older adults and these gains can be maintained for several months (Peretz et al., 2011). These gains tend to be seen in different single domains that can add up to a larger overall gain in cognition,

but the specific skills for each domain do not have a generalized benefit (Peretz et al., 2011; Thompson & Foth, 2005). These gains tend to lead to less risk of serious decline in cognitive status and health-related quality of life and any gain acquired tends to be sustained for several months after the completion of the cognitive training (Backman, 1992; Peretz et al., 2011; Smith et al., 2009).

There is considerable evidence that loss of cognitive function, and especially loss of memory abilities, is a widespread concern among older adults. Research is concluding that intellectual decline in the sixties and seventies can be slowed down, halted, or even reversed through cognitive training interventions (Thompson & Foth, 2005). Personalized, computerized cognitive training provides great cognitive benefits for healthy older adults. Also, findings in the literature are suggestive that individuals who suffer from cognitive decline might expect even greater benefits from personalized cognitive training (Peretz et al., 2011).

Results of Cognitive Training for Those with Mild Cognitive Impairment and Dementia

There are relatively few randomized, controlled trials of cognitive training interventions for elders with mild cognitive impairment who are at a risk of developing dementia, and even fewer randomized, controlled trials of cognitive training interventions for elders with dementia (Barnes et al., 2009). There are four features of cognitive training approaches that yield positive results in those with dementia: the training is based on skills that are relatively well preserved in dementia, rather than on skills that are grossly impaired; the training programs are fairly extensive; the caregivers are involved in the training; and the retrieval process is strongly supported (Backman, 1992; Clare &

Woods, 2004). In support of cognitive training, a recent meta-analysis found that these programs could produce cognitive and functional enhancement that is sustained after the completion of training, in some cases for periods of time substantially longer than three months (Zelinski et al., 2011).

In past research, people with mild cognitive impairment significantly improved in areas of working memory, psychomotor learning, constructive apraxia, and long-term visuospatial memory (Cipriani et al., 2006; Talassi et al., 2007). People with mild dementia showed a significant improvement in global cognitive status and semantic verbal fluency and a significant reduction of depression and anxiety symptoms after training. This data demonstrates that an individualized computer-based program produces different effects according to a patient's diagnosis; in dementia subjects, training strengthens the effect of pharmacological treatment and in mild cognitive impairment it improves specific cognitive areas. Programs of non-pharmacological therapy that provide a comprehensive and uniform stimulation on cognition, behavior, and functionality, produced long-term mood and cognitive benefits in mild cognitive impairment and delayed the conversion in dementia (Talassi et al., 2007).

Cognitive training also led to stability on cognitive measures, like the mini-mental status exam, and showed that since dementia is a progressive decline, no actual improvement, but rather cognitive stability could mean that the training was successful (Backman, 1992; Eckroth-Bucher & Siberski, 2009; Park & Bischof, 2013). Nonetheless, the ability to find effective techniques that will slow the process of aging deterioration is almost certainly more important than the demonstration of short-term improvements in cognitive function. Slowing decline of the aging mind is both an economic and quality of

life issue that is central to controlling spiraling health costs as well as providing for the emotional well-being of both older adults and their families (Park & Bischof, 2013). Cognitive training also found that through its course people saw an improved perception of their own memory capabilities and this helped them to have confidence and use memory strategies that they normally wouldn't (Barnes et al., 2009; Rapp, Brenes, & Marsh, 2002). In conclusion, this investigation supports the view that, similar to non-cognitively impaired, those with mild cognitive impairment and dementia can learn and maintain cognitive and functional abilities from the use of a cognitive training software. The positive findings add support to the idea that consistent stimulation of memory, language, attention, and other cognitive skills through training can potentially be useful for slowing cognitive decline associated with aging and with a memory-impairing disease process. There is currently no pharmacological treatment that has been proven effective in prevention or curing dementia, so, cognitive training techniques, which present no toxic effects, must continue to be researched for their possible preventative and palliative therapeutic value (Eckroth-Bucher & Siberski, 2009).

Conclusions About Cognitive Training

The literature on cognitive training consistently advises that these programs for adults should take account of the needs, interests, and preferences of participants (Dustman, Emmerson, Steinhaus, Shearer, & Dustman, 1992; Thompson & Foth, 2005). Based on the evidence reviewed, cognitive training interventions improved reaction time, processing speed, working memory, executive function, memory, visual spatial ability, and attention (Kueider et al., 2012). Also, the perceived changes in everyday cognitive functioning and psychological well-being were positive and generally of high magnitude.

Although they may not necessarily be directly related to gains in objective performance, these improvements in self-concept may have important long-term effects on cognitive functioning, at least for older individuals experiencing any type of cognitive decline (Schmiedek et al., 2010). Finally, research found that cognitive training appeared to enhance hippocampal function and it also found that there was an increased hippocampal activation that was associated with better performance on neuropsychological testing for those with mild cognitive impairment (Rosen, Sugiura, Kramer, Whitfield-Gabrieli, & Gabrieli, 2011)

These results suggest that training programs incorporating intensive practice, focus on perceptual speed and accuracy, use adaptive algorithms, and emphasize attention and reward may represent a promising class of cognitive training approaches that will exhibit generalization and thus may be effective at countering age-related cognitive decline (Smith et al., 2009). Therefore it remains critically important to study the effects of specific cognitive interventions, especially in high-risk elders, since it is found that cognitive-training warrants positive results and is feasible in older people with mild cognitive impairment and dementia (Barnes et al., 2009). This research also stresses that the theory of neuroplasticity is supported for this type of therapeutic intervention (Mahncke et al., 2006).

Importance of Social Interaction

A poor or limited social network increases the risk of dementia by 60%. A social network typically consists of availability of network resources, contact with resources, and perceived adequacy of support (Fratiglioni, Wang, Ericsson, Maytan, & Winbald, 2000). For many, when they are diagnosed with dementia, they often see that their social

interactions with their network are no longer the same. They feel misunderstood, disrespected, and excluded from many interactions. The person with dementia losses their sense of self and research is finding that those who are treated poorly socially after a diagnosis will see a faster decline in cognitive impairment and abilities. Coining this series of events was Steven Sabat and Rom Harre who called it 'malignant social psychology.' They explain that selves are socially and publicly presented and can be lost, not because of the disease, but because of the ways others view it and treat those who have it. People with dementia will tend to avoid social interaction because their identity is threatened and because they are afraid of the negative responses of others. This increases their anxiety as the person is not only trying to manage the manifestations of their dementia, an actual medical diagnosis, but also find ways to try and protect and preserve any part of their personal and social identity (MacRae, 2011).

Social integration may help to preserve memory through several mechanisms. One possible mechanism is physical health; research strongly implicates vascular conditions such as diabetes, unmanaged hypertension, and stroke in the etiology of dementia. Social integration may reduce the onset of such conditions and help to ameliorate their consequences through distinct neurohormonal pathways and behavioral modifications. Social ties may create pressure, either through explicit reminders or implicit behavioral norms, to take care of oneself. Another possible mechanism is through cognitive aspects of social interactions; by presenting complex cognitive and memory challenges, social interactions may enhance cognitive reserve, improve compensation in response to neurophysiologic decline, and increase resilience after neuronal injury. Finally, contacts

with friends and loved ones may provide a greater sense of purpose and emotional validation that has direct neurohormonal benefits as well (Ertel et al., 2008).

In the past few decades, researchers have explored the relation between social integration and different health aspects. The research has all concluded that social support helps a person to remain healthy for longer. This is true for dementia and Alzheimer's disease as well, as the risk for these disease were lowered in those were who were highly involved in social activities and increased in those who lived alone or who had no friends or family. Also, even if one has infrequent contact with their network, as long as those times of contact were satisfying, than the risk for the disease was not increased (Fratiglioni et al., 2000). The magnitude of social networks, or something related to social networks, provides some type of cognitive reserve, which reduces the deleterious effect of Alzheimer's disease pathology on cognitive abilities in old age. Therefore, it is possible that aspects of cognitive processing that allow people to develop and maintain social networks might also provide a reserve against the development of cognitive impairment despite the accumulation of Alzheimer's disease pathology (Bennett, Schneider, Tang, Arnold, & Wilson, 2006).

Social networks have been related to a reduced risk of death as well and a reduction of other adverse health outcomes in older adults (Bennett et al., 2006). In research, it has been stated that poor social networks affect the immune system. Since dementia, both degenerative and vascular types, have large inflammatory components to them it is possible to trace a connection linking social support, immune system, depression, and inflammation in a brain with dementia (Fratiglioni et al., 2000). Research also finds that social networks can modify disease pathology for dementia, as those with poor social

networks saw an increase in neurofibrillary tangles compared to those with strong networks who saw less neurofibrillary tangles at death (Bennett et al., 2006).

There are many factors that contribute to how a person experiences dementia, but the most important factors behind this are the nature of their social interactions and their relationships with others. The findings from a number of recent studies provide us with an understanding of how a supportive social context can enhance the lives of people with dementia. Families play the most crucial role in facilitating social involvement, as they can help the person retain a feeling of connection, construct a sense of meaning, and help them sustain their identity. Family members are the most influential sources of identity validation for those with dementia as they confirm any questions they could have about it. Overall, the access these people have to others' support, as well as encouragement on relationships and identity helps diminish the negative impact dementia can have on a person (MacRae, 2011).

Creating ways of maintaining involvement in meaningful activity and encouraging and facilitating the ability of people with dementia to use their remaining intact abilities to their fullest potential, enables these people to preserve dignity, sustain a sense of autonomy and maintain identity. The necessary resources is all that it takes to help these people to still find meaning and purpose in life (MacRae, 2011). Therefore it is suggested that interventions are targeted at structuring and creating diverse opportunities for learning and interactional enrichment and engagement through meaningful, goal-directed communication and social interaction. Such an approach is warranted for individuals with profound impairments in memory and learning where memory function will not be

restored and extends to populations where there is progressive deterioration (Duff, Gallegos, Cohen, & Tranel, 2013)

Cognitive training that encourages people' motivation for self-improvement through social interaction are based on five principles: the activities should be enjoyable and comfortable for people; therapists should praise the people naturally to motivate them; the activities should be associated with empathetic two-way communication to make people feel valued and safe; therapists should encourage the people to play "social roles" to restore self-worth; and errorless learning based on brain-activating rehabilitation should be adopted wherever possible (Yamaguchi, Maki, & Takahashi, 2011).

Posit Science & Brain Plasticity-Based Computer Games

Posit Science is a computer game-based cognitive training program that is based on the principles of brain plasticity and was created by the Posit Science Corporation in San Francisco, California (Barnes et al., 2009; Smith et al., 2009). The idea behind this program is based on the concept of neuroplasticity. Aging and diffuse brain changes from mild dementia can lead to decreased perceptual processing and reduced cognitively rich interactions with the environment. This leads to negative changes in the brain, also known as negative plasticity and this is the opposite of neural changes due to learning, or positive plasticity. The idea of Posit Science products is to use the competitive nature of computer games to engage individuals in these games that are specially designed to exercise specific domains within the brain in an adaptive form The adaptive games are aimed at enhancing the speed and accuracy of brain-processing, and has been demonstrated to improve memory performance in healthy elderly and mild cognitive

impairment participants, possibly because the games are enhancing the function of the medial temporal lobe (Rosen et al., 2011).

Two studies implemented training protocols to improve multiple cognitive abilities using a program designed by Posit Science for eight to ten weeks. In both studies, training improved measures of processing speed, auditory memory, and attention. Additionally, training improved several other areas including verbal memory, delayed word recall, and working memory. However, this cognitive training did not appear to affect episodic memory (Kueider et al., 2012).

Objectives

The primary objective of this study is to find if there is a difference in game play and cognitive outcomes in people with high and low social interaction who play the computer-based cognitive training game program. I am hoping that through these training sessions, I can find what games were the most effective, how I can reshape games to be more effective, and find out how participants really felt about playing these games. A secondary objective of this study is to see if there is a possibility that computer-based cognitive training games could be used as a non-pharmacological therapy to help fight the BPSD in those with mild to moderate dementia.

Using the cognitive training, specifically the Posit Science program, and an aspect of high one-on-one social interaction, I expect to find a decrease in the BPSD and a stability of cognitive impairment during the time of training through the theoretical idea of neuroplasticity. Through playing these games, I hope to see that participants will be less socially withdrawn and more involved in not only my games, but in their external environments. Through my interactions, I expect to be able to recommend what games

from the Posit Science website are the most feasible for those with mild to moderate dementia and hopefully be able to suggest to other researchers what training games would be best to keep investigating in larger studies. Further, I hope to give suggestions on how to make these games more approachable to an older population and give ideas about how they can be made more accessible for them to use ("Brain Exercises, Brain Training – BrainHQ from Posit Science", 2014).

METHODOLOGY

Hypotheses

I will be looking for engagement effect differences between two groups differing in social interaction during game play. Specifically, I am looking for training effects on game performance measures and neuropsychological assessment scores that may differ across the social interaction groups. I am also looking for differences across games in terms of rates of refusal, degree of attentiveness, and range of attitudes. The hypotheses for this study is as follows:

Hypothesis 1. I predict that the games that are least liked by and less engaging for participants will produce a lower mean game than those that are very well liked and are more engaging for the participants.

Hypothesis 2. Those who do the cognitive training with low social interaction during the sessions will see no change in their BPSD symptoms, while those who do the cognitive training with high social interaction will see a decrease in the intensity of the symptoms associated with whatever BPSD they show or show no more symptoms at all.

Hypothesis 3. Those who do the cognitive training and have low social interaction will see stability in their cognitive status, and stability in their game scores. Those who do the cognitive training and have high social interaction will see stability in their cognitive status, and their games score will improve slightly throughout the weeks trained. When referring to stability, this study will only be looking at the stability in the course of the weeks that the participants will be doing the training.

Hypothesis 4. Testing to see if games differ significantly in terms of percent of attempted training sessions completed.

Hypothesis 5. The participants in the low social interaction group and the caregivers associated with those participants will see no change in their quality of life score, while those participants in the high social interaction group and the caregivers associated with those participants will see an increase in their quality of life score.

Participants

Participants were recruited from the Coltrane L.I.F.E. Center in Concord, North Carolina. At this site, ten people with mild to moderate dementia were enrolled to participate in the study and randomly assigned to either the high or low social interaction groups. The staff at the site gave a list of names of people who might be good for the study based on the inclusion criteria presented to them about the MoCA and NPI. After this, ten caregivers and participants were contacted to obtain consent and all agreed to participate. All participants partook in twelve training sessions over a 23 to 54 day range, with the average amount of days between sessions being 34.8. Only eight of the participants finished the twelve sessions training though, and the participants who dropped out of the study were also dropped from data analyses. The average age of the participants that completed the study was 82.3, ranging from 76 to 89. There were six females and two males, all of these participants were Caucasian. Finally, the average number of years of education was 12.5, and this ranged from 8 to 16 years. Each participant presented at least one of the behavioral and psychological symptoms of dementia from the NPI. It was desired to have a confirmed diagnosis of dementia or Alzheimer's from a doctor, but only six of these ten participants had this medical diagnosis. The Montreal Cognitive Assessment (MoCA) was used to determine which people, identified by the staff and who agreed to participate, were included in and

excluded from the study. The score on this assessment can range from 0 to 30, but for this study participants had to score between 12 and 20 to be eligible. The range of MoCA scores at pre-assessment was 12-16 so no participants had to be excluded from the study. The results from the MoCA found that two of the participants had mild dementia and six of the participants had moderate dementia. The Institutional Review Board at the University of North Carolina Charlotte approved all study procedures and all subjects and caregivers had to provide a written informed consent.

Cognitive Training

All cognitive training was performed at the Coltrane L.I.F.E. Center. The computer based game play was all through the Posit Science (2015) website. The theoretical basis of these games is neuroplasticity and in relation to this theory, researchers have found that these games can yield significant training effects in healthy aging samples. There were twelve cognitive training sessions and each session included four games from the different domains offered. Each session was approximately 25 to 30 minutes long and each participant completed the games within 23 to 54 days. The high social interaction group saw a wide range of communication between themselves and the researcher. They were asked questions about their day, about their past, about their future plans, about the games, etc. Anything they wanted to talk about was talked about and in great detail. The low social interaction group was asked five questions throughout the session and their conversation was as limited as much as deemed to be appropriate. They were asked to rate on a scale of one to ten how they were feeling in the beginning and then again at the end. They were asked to rate on the same scale how they felt about the games and also how they felt about their experience playing the games for that day with

the researcher. Finally, they were asked which game was their favorite and which was their least favorite. While most of the sessions went this way for the low social interaction group, some people with dementia like to just talk and stopping them can cause issues so if they did decide to talk to the researcher during this, the responses were limited.

The cognitive training games were placed into three groups to divide which cognitive domains were focused on each day and to make sure a variety of domains were trained. The participants played one of the groups of games each day and each group consisted of four games. The cognitive domains being trained were attention, brain speed, intelligence, memory, navigation, and people skills. The first group of games were: scene crasher which is for memory, divided attention which is for attention, recognition which is for people skills, and hawk eye which is for brain speed. The second group of games that were: mind bender which is for intelligence, mental map which is for navigation, face-to-face which is for people skills, and double decision which is for attention. The final group of games were: to-do list which is for memory, eye for detail which is for brain speed, card shark which is for intelligence, and optic flow which is for navigation. Each game was played four times by each participant. The games also have different amounts of trials and levels, as the levels for these training games are customized to the person's abilities based on how they perform. Every game, except to-do list, was based on visual imagery techniques. These techniques are associated with improvements in encoding, consolidation, and recall capacities in everyday environments (Grandmaison & Simard, 2003).

It is traditional to look for far transfer of cognitive training effects to outcome measures that are different than the materials and tasks involved in the cognitive training procedure. We used the MoCA and RBANS measures to assess far transfer of training effects as these standard tests of cognitive function differ greatly from the Posit Science gaming experience. There was also a near transfer measure to assess effectiveness of game experience, this sort of a manipulation check was used to make sure the game are effective at inducing specific skill learning in people with dementia.

The games created by Posit Science are adaptive, as they try to keep the player in a range of performance where they are not operating error free and not making so many errors that they will halt the game play. This game adaptivity is argued by the game developers to be the optimally challenging region of game play that is likely to maximize reversal of negative brain plasticity effects of age and dementia. There is a threshold parameter used in each game to modulate the game play difficulty to maintain optimal game play. This average threshold was recorded and analyzed for each game for each training session.

Table 1: Lists the groups of games that will be used on different days for the participant's sessions. It also shows what cognitive domain is associated with each game, the trials per game, and the levels per game as well. The trials refer to how many rounds are within each level of the game. The levels will adjust to how the participant does on the previous level.

	Cognitive Domain	**Trials per game**	**Levels per game**
Day One			
Scene Crasher	Memory	20	6
Divided Attention	Attention	100	2
Recognition	People Skills	20	6
Hawk Eye	Brain Speed	35	2
Day Two			
Mind Bender	Intelligence	75	6
Mental Map	Navigation	10	6
Face-To-Face	People Skills	20	6
Double Decision	Attention	30	4
Day Three			
To-Do List	Memory	10	2
Eye For Detail	Brain Speed	18	6
Card Shark	Intelligence	35	9
Optic Flow	Navigation	25	3

Methods of Data Collection

Both groups will have pre- and post-assessments. The pre-assessments will be before any training begins and will consist of the Montreal Cognitive Assessment (MoCA), the Repeatable Battery for the Assessment of Neuropsychological Status (RBANS), the Quality of Life- Alzheimer's Disease Scale (QoL-AD), the Neuropsychiatric Inventory (NPI), and a brief health/ background questionnaire (Cummings, 1997; Duff et al., 2008; Nasreddine et al., 2005; Thorgrimsen et al., 2003). The post-assessments will include everything just mentioned except for the questionnaire.

Montreal Cognitive Assessment (MoCA)

The MoCA measures cognitive status by having different domain subscales measured for an overall score. It is found to have good internal consistency yielding a

Cronbach alpha of .83 and content validity is established for this scale and there is also high test-retest reliability as this coefficient yielded a value of .966. The MoCA also has good sensitivity (MCI- 90%, dementia- 100%), specificity (MCI and dementia- 87%), positive predictive values (MCI and dementia- 89%), negative predictive values (MCI- 91%, dementia- 100%), and interrater reliability. On the MoCA there are eight sections, each being for a different cognitive domain. The first section measures visuospatial/ executive by having participants do a smaller version of the trail-making test, copying a cube, and drawing a clock. The next section is naming and here participants have to name three different animals. The following section is memory where the participants have to repeat five words back to the researcher after they have been told them. They are given two trials to remember these words and are told to remember them because the words come up again later in the assessment. The following section is attention; here participants are tested on digit span, target detection using tapping, and a serial subtraction task. Following this section is language where participants have to repeat two syntactically complex sentences and complete a fluency task of stating words that start with F. The next section is abstraction and here participant have to tell how two different pairs of objects are related. Finally, orientation to time and place is evaluated in the last section. A score of 26 or better means that the participant is cognitively intact, a score range of 15-26 typically means someone has mild dementia, a score range of 7-14 typically means someone has moderate dementia, and anything less than 7 typically means someone has more severe dementia (Nasreddine et al., 2005).

Repeatable Battery for the Assessment of Neuropsychological Status (RBANS)

The RBANS is used to see cognitive deficits in people, as well as show what specific domain has that specific deficit. This assessment was found to have good convergent validity, good positive predictive values, good negative predictive values, and good test-retest reliability as it yielded a coefficient of .8. Sensitivity was found to be 84% and specificity 97%. The designers argued for a five-factor scale structure that would provide scoring across five broad cognitive domains; immediate memory, visuospatial/ constructional, language, attention, and delayed memory; as well as an overall scaled score. However, based on the work of Duff et al. (2006), researchers failed to find the theoretical five factor structure intended by the test designers in large samples of healthy aging and mild cognitive impairment populations to be helpful, instead a two-factor solution, memory and visuospatial, seemed to be best for this battery of twelve subtests. Based on this work I used raw test scores, not scaled to age or education level, and computed total raw scores (sum of all twelve subtest scores), memory raw scores (sum of list learning, list learning recall, list recognition, story memory, and story recall subtests), and visuospatial raw scores (sum of figure copy, line orientation, and coding subtests). These three scores, and the additional MoCA scores are the primary outcome measures of cognitive training effects on cognitive function.

Within the immediate memory subtest, there is a list learning component, as well as a story memory component. The visuospatial/ constructional component tests participants by having them copy a figure and assess lines orientations. The following section is language and here participants are tested by having to name different pictures and having to list words from a category. The following section tests attention by looking

at participant's digit span and having them code symbols to numbers. The last section is delayed memory and here participants had to recall the list they were told earlier, recognize the words from the list out of a group of randomly ordered words, recall the story they were told earlier, and finally recall the figure they drew. The age norms are provided to scale the cognitive domain scales by the participant's age. However, in this study the raw total test scores in combination to summed memory and visuospatial raw scores were used. The RBANS has a two-factor scale structure so a computed raw test score for all participants on all subtests for both assessments was done to get a total score. We also added the scores from some of the memory tests together to get a memory sub-score, as well as some of the scores from some visuospatial processing tests to get a visuospatial sub-score. In conclusion, only three RBANS scores per participant were assessed (Dong et al., 2013; Duff et al., 2008).

Quality of Life-Alzheimer's Disease Scale (QoL-AD)

The QoL-AD scale is used to assess quality of life in people with dementia. It was found to have excellent internal consistency yielding a Cronbach alpha of .82. The scale has good construct, concurrent, convergent, divergent, and group validity, good test-retest and interrater reliability, and is sensitive to change. This scale asks thirteen questions to participants and caregivers to rate the different aspects about their or their loved ones life on a scale of poor, fair, good, or excellent. The questions are in regards to physical health, energy, mood, living situation, memory, family, marriage, friends, self as a whole, ability to do chores around the house, ability to do things for fun, money, and life as a whole. After the questions were answered, the responses were transformed into numbers to get an overall idea of quality of life measures. The scale instructs to give an answer of

poor a score of one and an answer of excellent a score of four. This shows that higher numbers are desired for this scale. For this study, the scale was answered by the participants, the caregivers, and an additional time by caregivers, but in regards to how they view their loved one's quality of life (Thorgrimsen et al., 2003).

Neuropsychiatric Inventory (NPI)

The NPI is used to assess psychopathology found in dementia patients. It is found to have high content validity and an acceptable level of concurrent validity. This assessment has a strong interrater reliability as the coefficient yielded is 93.6-100%. In the NPI, caregivers answer questions about the behaviors they see in their loved one. There are twelve sections each in regard to a specific symptom. The symptoms questioned are delusions, hallucinations, agitation/ aggression, depression/ dysphoria, anxiety, elation/ euphoria, apathy/ indifference, disinhibition, irritability/ lability, aberrant motor behavior, sleep and nighttime behavior disorders, and appetite/ eating changes. The caregiver is asked an initial question about the specific symptom and if they say that their loved one does not experience this symptom, then the next symptom is questioned. If they say their loved one does experience this symptom, a following subset of questions is asked about the specifics of the symptom, as well as the frequency, severity, and the distress the caregiver feels because of this symptom (Cummings, 1997).

Observational Measurement of Engagement

Finally, there was a qualitative aspect as well to the data, as field notes were taken during the cognitive training sessions. The Observational Measurement of Engagement tool will be used to analyze sessions. Cohen-Mansfield and her team have added considerable information about the understanding of the process of engagement. They

defined engagement as a person's being occupied with external stimuli, particularly as it combats apathy. Their model identifies five engagement outcome measures including (1) rate of refusal to engage with the stimulus, (2) duration of involvement, (3) attention to the stimulus, (4) attitude toward the stimulus, and (5) actions toward the stimulus. The Observational Measure of Engagement (OME) is widely used as a pencil–paper observational tool in which the observer records duration of perceived engagement and intensity of attention using a Likert-type of rating (Davis & Shenk, 2014). The cognitive training research is designed to measure the engagement of people with dementia in these games. As their engagement levels are crucial to the outcome effects of the cognitive training and the other outcome measures. The interrater reliability for the OME was 84% for the engagement outcome and 92% for the action variables (Cohen-Mansfield, Dakheel-Ali, & Marx, 2009). The qualitative tool used for this study was based off of the OME designed by Cohen-Mansfield and her team. The scale took into account rate of refusal, time in game play, degree of attentiveness, range of attitudes, as well as activity during the games which included talked about the games, talked to the games, distracted, and disruptive. Finally, the tool also helped to record who the participant talked to and how frequently and the content of the remarks that they made during the sessions. At the conclusion of all sessions, these notes were transformed into Likert-scaled numbers and analyzed. All assessments were conducted and assessed by myself with help from my chair and committee.

Table 2: Lists the assessments that will be given to the participants and in the order that they will be given as well. The health questionnaire will not be a part of the post-assessment, only pre-assessment. The table lists how long each assessment should take and also what exactly each one is assessing.

	Time needed to complete (in minutes)	What is being tested by the assessments?
Assessments (in order to be given)		
Montreal Cognitive Assessment (MoCA)	10	General cognitive status assessment testing visuospatial/ executive, naming, memory, attention, language, abstraction, delayed recall, and orientation.
Health Questionnaire	10	Background information and health status.
Neuropsychiatric Inventory (NPI)	10-20	Assessing if behavioral or psychological symptoms are present, and if so there frequency, severity, and distress caused.
Quality of Life-Alzheimer's Disease (QoL-AD)	10	Overall quality of life for person with Alzheimer's and overall quality of life for caregiver.
Repeatable Battery for the Assessment of Neuropsychological Status (RBANS)	30-45	Detailed cognitive status assessment testing; immediate memory, visuospatial/ constructional, language, attention, delayed memory.
Observational Measurement of Engagement	n/a	Duration of perceived engagement and intensity of attention.

Methods of Data Analysis

There are multiple ways to measure the data collected from the participants. The first things compared are games scores and progress between the high social interaction and low social interaction groups. There also was post-assessment score comparisons between these groups as well. Theses scores were compared using two independent group t-tests that tested the hypotheses about the difference in mean values on the pre- and post-assessment scores between and within high and low social interaction groups. A mixed-model analysis of variance was used to assess differential change from pre- to post-training across two social interaction groups. This model is used because of the inclusion

of two independent variables of group and assessment. The group variable is a between subjects variable where the assessment variable is a within subjects variable. Since there is a grouping independent variable and a repeated measure variable, the mixed model analysis of variance has been deemed the most appropriate for statistical analysis of data. There was also a qualitative analysis to the field notes being taken. This analysis looked for themes in behavioral patterns and through the Observational Measurement of Engagement assessment tool, there are frequencies to look at in regards to how the sessions went and how the participants felt while playing the games.

Limitations

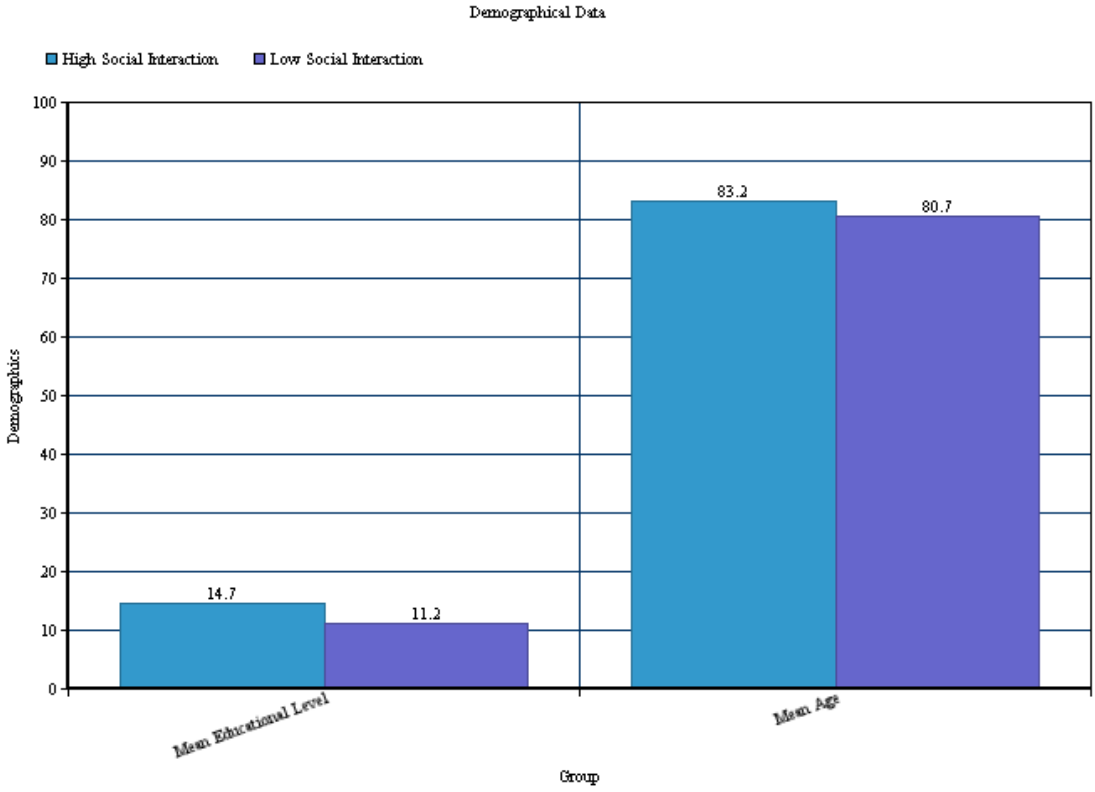
This research has an explanatory study design. There is not much information in the literature about using cognitive training in those with mild to moderate dementia, especially not about any behavioral or psychological outcome that is possible based on this training for these people as well. There is also very little about how people score on these games, let alone how those with dementia score on them. The limitations of this study design are the small sample size and there are a limited number of resources for this project, which affected how long the training could be performed and this could restrict the ability to see a true effect from the cognitive training.

RESULTS

Quantitative Analysis

Ten participants were enrolled from February to March 2015. The ten participants had a mean age of 83 years at baseline (range: 74-95) and a mean of 12 years of education (range: 8-16); there were two males and eight females. Figure 1 presents the mean age and educational level for participants. Participants were randomly assigned to the different social interaction groups, leading to five in the high social interaction group and five in the low social interaction group. Nine participants were Caucasian and one was African-American. The high social interaction group had a mean score of 13 on the MoCA, where the low social interaction group had a mean score of 13.3 on the MoCA ($t(4)=.27$, $p=.79$). Also, the high social interaction group had a mean score of 23.6 on the NPI and the low social interaction group had a mean score of 10 on the NPI ($t(4)=.82$, $p=.44$).

Figure 1 shows the mean educational level and mean age for the participants by which interaction group they were assigned and only took into account those who successfully completed the training.



Eight of the ten participants (80%) successfully completed the cognitive training protocol; both of the participants that dropped out were in the low social interaction group. The first participant who dropped out was a Caucasian woman and the youngest in the group of participants. She had the highest score on the MoCA of 17 and had the second to smallest score on the NPI of 3. The second participant who dropped out was an African American woman and the oldest in the group of participants. She scored just below the average on the MoCA where she got a 12 and had the lowest score on the NPI of 1. Both participants educational level was below the average. The first participant dropped out of the study midway through session six because she said the games were too fast and stressful for her to handle. The second participant dropped out of the study

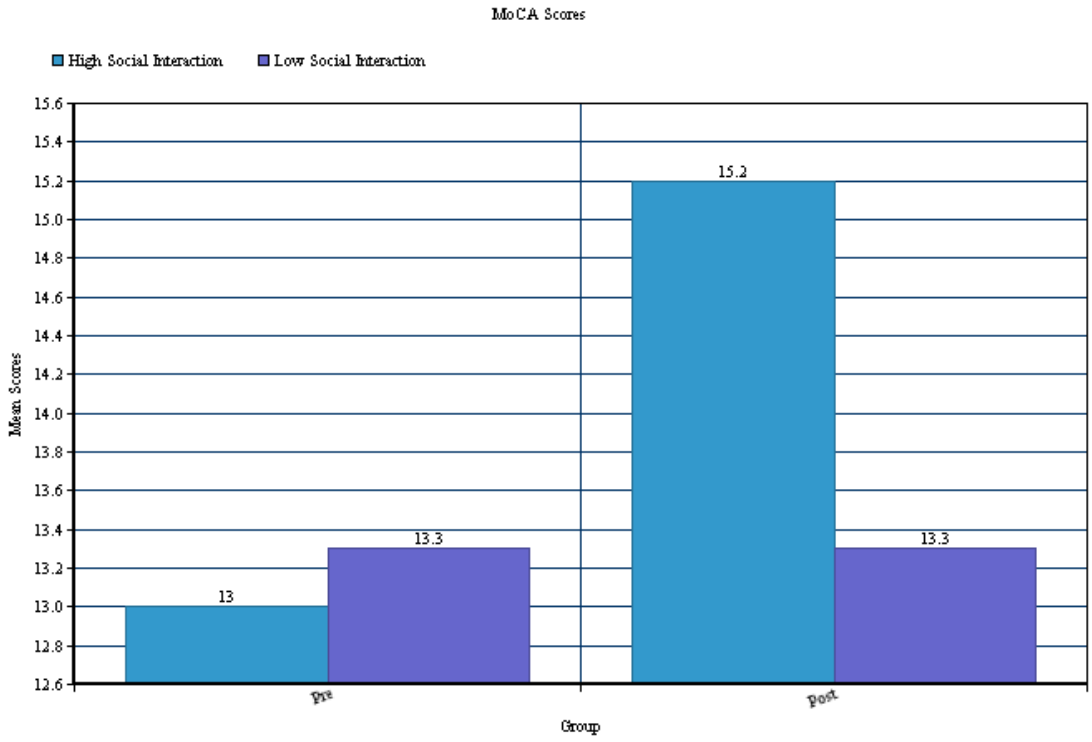
after session seven because she believed the games to be brainwashing her. The five high social interaction group participants took a mean of 31.2 (range: 23-43) days to progress through the training where the three low social interaction group participants took a mean of 40.6 (range: 28-54) days to progress through the training ($t(4)=1.33$, $p=.23$).

Game Training Analyses

To assess game training effects on cognitive, behavioral, and psychological and social functioning, as well as quality of life, scores on the MoCA, RBANS, NPI, and QoL-AD were entered in to separate two groups (high vs. low researcher interaction) by two assessment (pre- vs. post-training ANOVAs. Post-hoc training effects for each group were assessed by paired-samples t-tests.

Overall Cognitive Function. Figure 2 presents the pre- and post-training assessment means for the participants MoCA scores. For the MoCA the mean scores of the high researcher interaction group increased from pre ($M=13.0$) to post ($M=15.2$) training assessment. The low researcher interaction group mean scores on the MoCA remained exactly the same, pre ($M=13.3$) to post ($M=13.3$) training assessment. The interaction of group and assessment had no significance ($F(6)=4.254$, $p=.085$). In a post-hoc t-test analysis, the high researcher interaction group produced statistical significance ($t(4)=3.77$, $p=.02$), but the low researcher interaction group did not see a statistically significant training effect ($p=1.0$).

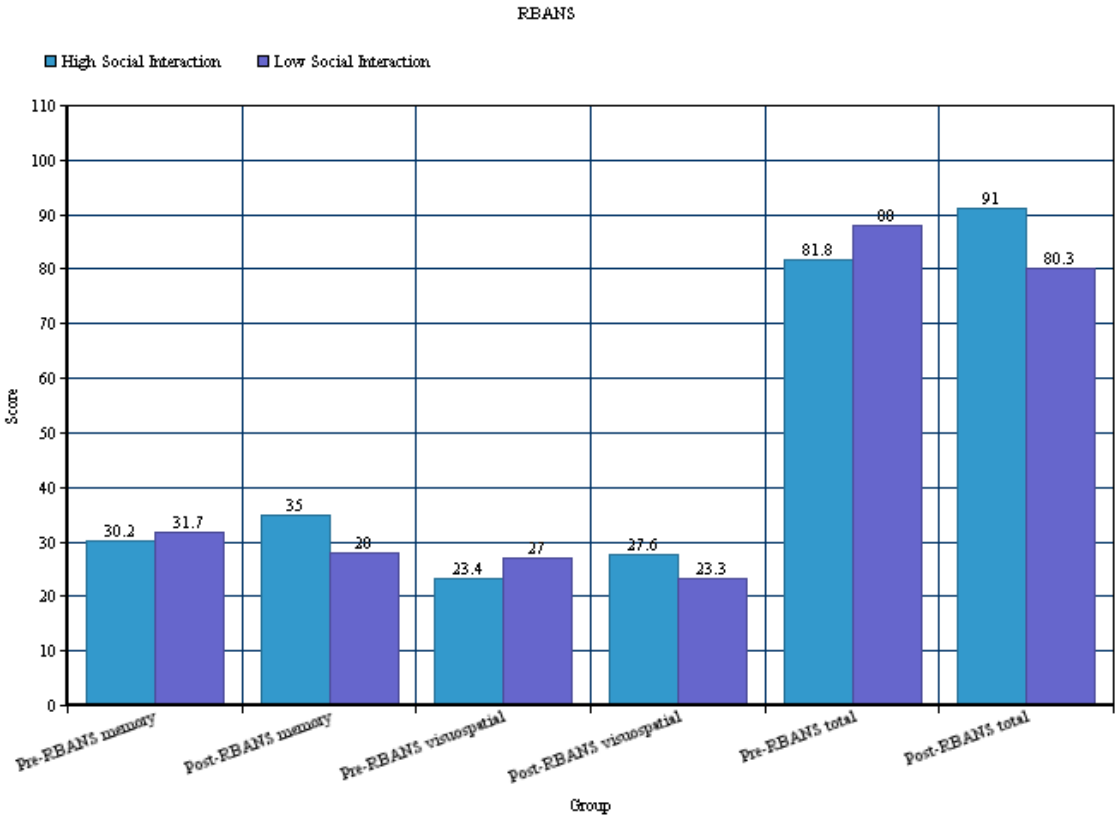
Figure 2 shows the differences in mean MoCA scores from pre- to post-assessment for high and low social interaction groups.



Cognitive Domains. The raw, un-scaled, scores from the twelve subtests of the RBANS were combined into a memory raw score, visuospatial raw score, and total raw score for analysis. Figure 3 presents the pre- and post-training assessment means for the participants each of these raw scores. The RBANS memory scores found that participants in the high researcher interaction group saw an increase in scores from pre (M =30.2) to post training assessment (M =35.0). The low researcher interaction group saw a decrease in their RBANS memory scores from pre (M=31.7) to post (M =28.0) training assessment. The interaction of assessment was significant ($F(6)=18.614$, p=.005). There were no significant main effects of group (p>.05) However, the post-hoc t-tests of the training effect for RBANS memory scores for each researcher interaction group failed to

reach statistical significance ($t(4)=2.42$, $p=.073$, $t(2)=4.16$, $p=.053$). The RBANS visuospatial scores found that participants in the high researcher interaction group saw an increase in scores from pre (M =23.4) to post assessment (M =27.6). The low researcher interaction group saw a decrease in their RBANS visuospatial scores from pre (M =27.0) to post (M =23.3) assessment. However, none of these differences were statistically different. There were no significant main effects of group or assessment (all p's>.05). Also, neither of the post-hoc t-tests of assessment effects in each group were significant (all p's >.05). Finally, the RBANS total scores found that participants in the high researcher interaction group saw an increase in scores from pre (M=81.8) to post assessment (M=91.0). The low researcher interaction group saw a decrease in their RBANS total scores from pre (M=88.0) to post (M=80.3) assessment. None of these differences were statistically different as there were no significant main effects of group or assessment (all p's>.05). Also, neither of the post-hoc t-tests of assessment effects in each group were significant (all p's >.05).

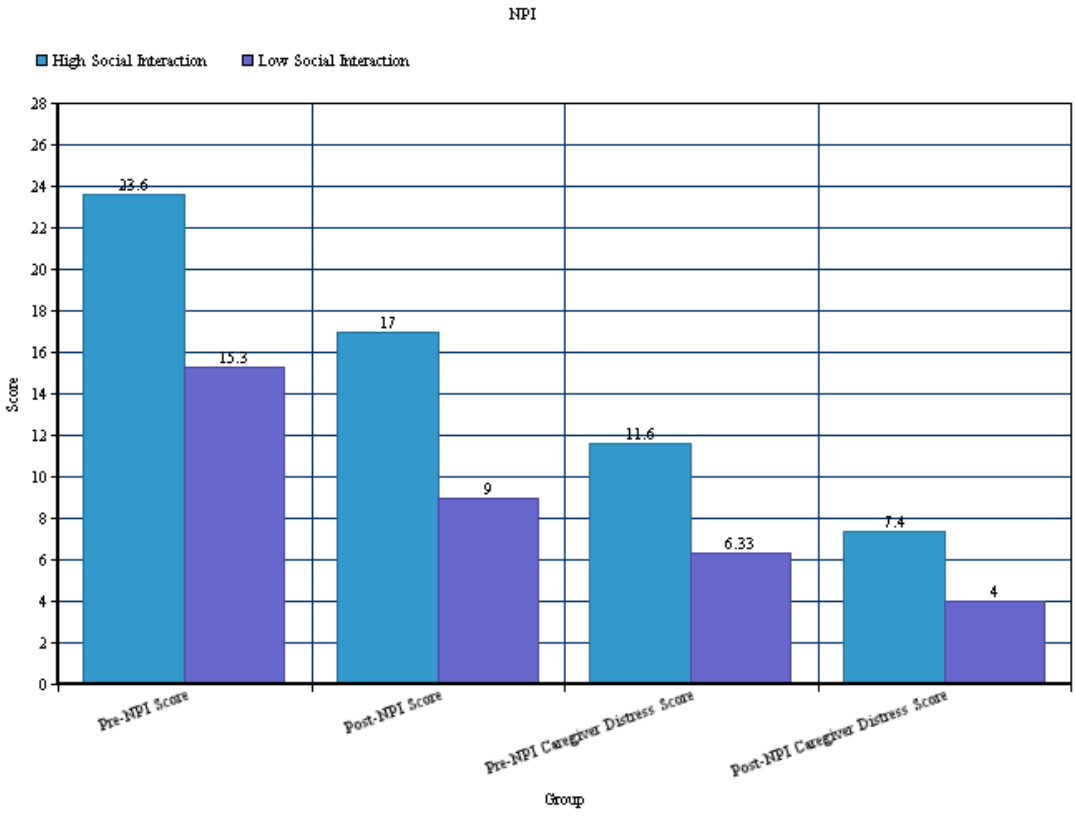
Figure 3 shows the differences in mean RBANS memory, visuospatial, and total scores from pre- to post-assessment for high and low social interaction groups.



Behavioral and Psychological Symptoms. Figure 4 presents the pre- and post-training assessment means for the participants NPI scores for the participants and the NPI caregiver distress scores. For the NPI the mean scores, the high researcher interaction group mean decreased from pre (M =23.6) to post (M =17.0) training assessment. The low researcher interaction groups mean scores also decreased from pre (M =15.3) to post (M =9.0) training assessment. The overall change in NPI score from pre to post training assessment (M =6.5) shows that there has been overall improvement in the behavioral and psychological status of all of the participants ($F(6)$= 6.034, p=.049). There were no significant main effects by group (all p's>.05). Also, neither of the post-hoc t-tests of assessment effects in each group were significant (all p's >.05).

For the NPI caregiver distress scores, the means scores for the high researcher interaction group decreased from pre (*M*=11.6) to post (*M* =7.4) training assessment. The mean scores for the low researcher interaction group decreased from pre (*M*=6.33) to post (*M*=4) training assessment. These scores were not found to be statistically significant after ANOVA or post-hoc t-test analysis (all *p*'s >.05).

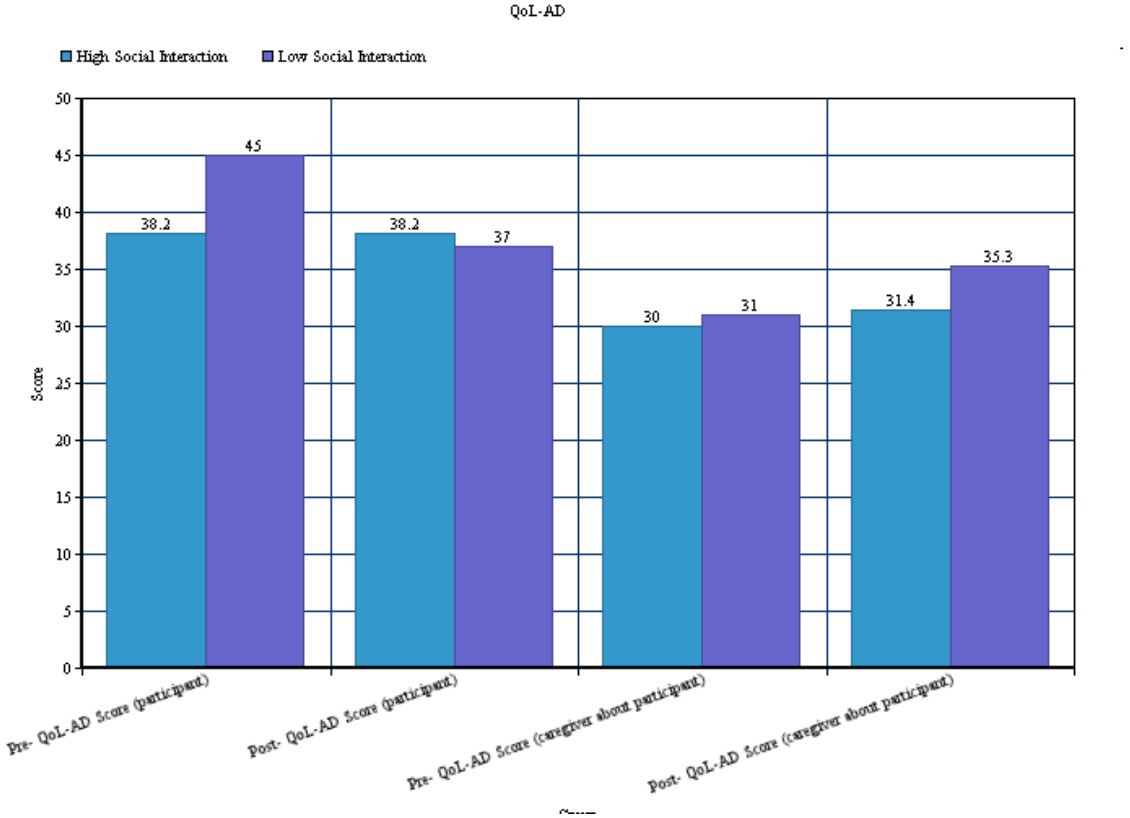
Figure 4 shows the differences in mean NPI and mean NPI caregiver distress scores from pre- to post-assessment for high and low social interaction groups.



Quality of Life. There were three parts to the QoL-AD scale; the first rating was by the participant about their life, the second rating was by the caregiver who rated the participant's life, and the last rating was by the caregiver about their own life. Figure 5 presents the pre- and post-training assessment means for the participants QoL-AD ratings of themselves and the caregiver ratings of the participant quality of life. The QoL-AD

rating by the participants found that participants in the high researcher interaction group saw stability in their quality of life scores from pre (*M*=38.2) to post (*M*=38.2) training assessment. The low researcher interaction group saw a decrease in their quality of life scores from pre (*M*=45.0) to post (*M*=37.0) training assessment. QoL-AD ratings by participants from pre- to post-training were significant, ($F(6)=9.73$, $p=.021$), and the interpretation of this main effect is modified by a significant group by assessment interaction ($F(4,2)=9.73$, $p=.021$). Post-hoc t-tests revealed a significant decrease in mean QoL-AD score from pre- to post-training ($t(2)=13.86$, $p=.005$) for the low researcher interaction group, but not for the high researcher interaction group ($p>.05$). The QoL-AD rating by the caregivers about the participant's lives found that participants in the high researcher interaction group saw an increase in their quality of life scores from pre (*M*=30.0) to post (*M*=31.4) training assessment. The low researcher interaction group also saw an increase in their quality of life scores from pre (M=31.0) to post (*M*=35.3) training assessment. QoL-AD ratings by caregivers about participants from pre- to post-training was significant, ($F(6)=18.61$, $p=.005$), and the interpretation of this main effect is modified by a significant group by assessment interaction ($F(4,2)=4.87$, $p=.069$). Post-hoc t-tests revealed a significant increase in mean QoL-AD score from pre- to post-training ($t(2)=4.91$, $p=.039$) for the low researcher interaction group, but not for the high researcher interaction group ($p>.05$). The QoL-AD rating by the caregiver about their own life found no statistically significant main effects, interaction, or post-hoc comparisons (all p's$>.05$).

Figure 5 shows the differences in mean QoL-AD rating scores by the participant and by the caregiver about the participant from pre- to post-assessment for high and low social interaction groups.



Game Play Performance. Each game on the Posit Science website is adaptive in difficulty and attempts to keep the player at a certain difficulty parameter, which is also known as a threshold. Each of the twelve games chosen for the study was played by each participant four times and each day the participant would play four games. The threshold was recorded for session one and four for each participant. A twelve paired samples t-test was performed and it found that five of the games led to significantly improved mean thresholds ($p<.05$). These games were to-do list ($p=.014$), eye for detail ($p=.034$), card shark ($p=.003$), optic flow ($p=.008$), and mind bender ($p=.013$). Since each game has a unique scale for its threshold parameter, the threshold parameters were rescaled for those five significant games to yield any possible significant practice effects. The mean z-scaled threshold parameter was calculated for this for the five games for each participant

in session one and four. These results were then placed into a two group by two sessions ANOVA. There was no significant main effect of group or interaction found (both p's>.05), but there was a significant effect of session ($F(1, 6) = 24.492$, p=.003). This indicates an overall significant practice effect that did not differ significantly across groups.

Qualitative Analysis

Engagement During Game Play

Qualitative field notes were taken at each session for every participant in the study. Part of the note sheet included rate of refusal, which recorded whether the participant wanted to start each game or not, the degree of attentiveness, and the range of attitudes. These three note sections were transformed into Likert-scaled results to be analyzed. From this analysis, we saw that participants were hesitant to begin games 3.39% of the time, meaning they were ready to begin the games 96.61% of the time. Out of the 240 high researcher interaction sessions, there were 8 times when the participants were hesitant yielding a percentage of 3.33. Out of the 144 low researcher interaction sessions, there were 5 times when the participants were hesitant yielding a percentage of 3.47. This shows that those in the low researcher interaction group were slightly more hesitant to start the games when compared to the high researcher interaction group.

The degree of attentiveness was rated based on the participant's abilities and performance on the pre-assessment. The degree of attentiveness spanned from 1-note attentive, 2-somewhat attentive, 3-attentive, and 4-very attentive. Where a person with moderate dementia would need to try much harder to reach a certain degree of attentiveness than someone with mild dementia. Therefore it could be said that a Likert-

rating of 4 for someone with moderate dementia may only be a 2 for someone with mild dementia. In regards to attentiveness, data was analyzed in percentages. In regards to all of the participants, out of 384 sessions, there were 4 times they were not attentive (1.04%), 52 times when they were somewhat attentive (13.54%), 135 times when they were attentive (35.16%), and 193 times when they were very attentive (50.26%). Out of the 240 sessions that the high researcher interaction group completed, .83% of the time they were not attentive, 10.83% of the time they were somewhat attentive, 36.25% of the time they were attentive, and 52.08% of the time they were very attentive. This is compared to the 144 sessions that the low researcher interaction group completed, 1.39% of the time they were not attentive, 18.06% of the time they were somewhat attentive, 33.33% of the time they were attentive, and 47.22% of the time they were very attentive. This shows that those in the higher researcher interaction group were more likely to be attentive than the lower researcher interaction group.

The range of attitudes was spanned from very negative-1, negative-2, somewhat negative-3, neutral-4, somewhat positive-5, positive-6, and very positive-7. The average score for the high researcher interaction group (M=5.87) was lower than the low social researcher group (M=6.06) with the average attitude score being 5.94. This shows that participants were overall happy while playing the games, but through my observations, I believe environmental influences affected these scores as well. One participant in the high researcher interaction group broke her arm in between sessions nine and ten and this lowered her attitude score. Another participant in the high researcher interaction group had an attitude score that was low because her anxiety affected what she said and on multiple occasions she said, “I’m going to die.” Finally, another participant in the high

researcher interaction group's attitude score greatly increased from session one to session twelve showing that she needed to feel comfortable with me and be able to trust me before she would open herself up. I believe this was even more shown when the researcher had someone helping her at session nine and the participant shut down and this extremely lowered her attitude score for that day.

Posit Science Game Analysis

During all of the games, I noted interactions between the participant and myself and the participants and the computer. This helped to identify barriers to the games and it helped to establish how involved this group of people can be with the games and if they enjoyed them, as well as establish the games feasibility.

Divided Attention

This game worked with the attention domain in cognition for these participants. The participant with vascular dementia could not do this game at all; she really struggled with paying attention to it. Those with moderate dementia had a hard time paying attention for all of the rounds as it seemed too long for them. It was way too fast for them to keep up with as well. One participant tried to push the keys herself to answer the questions, but her reaction time was too slow for the game, even when it was at its slowest speed. Those with mild dementia could do this game and could do it well. They seemed to really enjoy it and there was even laughing when it would get harder and faster.

There were some patterns noted during game play in all participants. There was four times when the participants said the game was okay, one time when the participant said they liked the game, and one time when the participant said they didn't like the

game. There were six occasions when they said the game was too fast and there were fifteen occasions when the participants didn't understand the game or needed a repetition of directions. There were three times when participants commented on the colors or objects presented on the screen and three times when they stopped paying attention altogether and became very distracted. One time a participant started falling asleep at the end of the game. Finally, there were two times when a participant showed a behavioral and psychological symptom.

Double Decision

This game also worked with the attention domain in cognition for these participants. The dual directions for this game were slightly too complex for those with mild dementia and very complex for those with moderate dementia. Participants could typically always identify the vehicle or find the sign, but they couldn't seem to be able to do both very often.

There were some patterns noted during game play in all participants. There were four people who said they didn't like the game and one said it was okay. Ten people doubted themselves and needed reassurance throughout the game. Eight made comments about the vehicle, like "that's a Ford truck," and eight made comments about the sign that said 66. There were five occasions where the participants needed reminder of the directions or didn't understand them and six times when they said the game was too quick.

Eye for Detail

This game worked with the brain speed domain in cognition for these participants. Those with mild dementia seemed to be able to do the game with ease and seemed to

enjoy this game most of the time. Those with moderate dementia seemed to need reminder of directions frequently for this game and slightly struggled with it. They seemed to enjoy the game as well though.

There were some patterns noted during game play in all participants. There were four times when the participants said they didn't like the game and four times when they said they did like the game. There were twelve occasions where participants needed reassurance or doubted themselves. There were six times when they commented on the flowers or butterflies and four times when they said it was too fast. There were three times when they needed a reminder of the directions and one time when a participant became distracted. Finally, there was one occasion where a participant showed a behavioral and psychological symptom.

Hawk Eye

This game also worked with the brain speed domain in cognition for these participants. All participants could do this game and all participants seemed to enjoy it. The only participant who claimed to struggle with this game is the one who is blind in one eye.

There were some patterns noted during game play in all participants. In this game, there were three times when the participants said the game was okay and one time when they said they liked it. There were seven times when they said the bird flashed too fast and three times when they needed the directions repeated. There were eleven times where they doubted themselves and needed reassurance. Finally, there were thirteen times when the participants commented on the bird and actually believed it to be present. One participant said the birds are flying all over the place, the birds went to heaven, that the

birds have to watch out for an airplane, and that the bird landed on a treetop. Another participant wanted to put the bird in the toilet, said the bird was flying over our heads, that the bird was in the dump, and that the bird is going away.

Card Shark

This game worked with the intelligence domain in cognition for these participants. All of the participants seemed to be able to do this game with a slight struggle when there only one card flip involved. When there was more than one flip of the cards, all participants struggled with the game and couldn't quite grasp the directions. If the game was a bit slower, I feel that the participants would have been able to do better on this game and better grasp the concept of it.

There were some patterns noted during game play in all participants. One participant said they liked the game, two participants said they didn't like the game, and two said that the game was okay. Three participants said the game was too fast and three needed reassurance throughout play. Two laughed at the cards and four made comments about them. Nine participants couldn't understand the game and need repetition of directions and three showed a behavioral and psychological symptom.

Mind Bender

This game also worked with the intelligence domain in cognition for these participants. All participants could not do this game. The dual directions were way too complex for everyone, it was way too fast, and way too long in duration. The researcher had to keep trying to give directions though the whole game, but they couldn't quite grasp them. They tended to pick one part of the direction and answer the questions in that

regards. Also, one level of this game had participants play rock, papers, scissors; and not one of the participants had ever played this game before.

There were some patterns noted during game play in all participants. Two participants commented that they didn't like that game and one said it was okay. Five commented on the numbers or objects in the game and one laughed at it. Twelve had specific times of asking for the directions again commenting that the game was too confusing for them. Finally, eight needed reassurance because they doubted themselves while playing the game.

Scene Crasher

This game worked with the memory domain in cognition for these participants. For those with moderate dementia, this game flashed the objects too quickly and didn't really give them a chance to really scan the area and remember what they were seeing. For those with mild dementia, this game was a challenge, but they could do it. There weren't many changes in scores for all participants, but it seemed that the mild dementia participants just didn't get enough right in a row to raise their score. For all participants, this game was also a little too long for them and they almost always needed a reminder of the directions.

There were some patterns noted during game play in all participants. There were four occasions when participants said the game was okay, there were two occasions when they said they liked the game, and there were three times when they said they didn't like the game. There was seventeen times where participants needed reassurance because they doubted themselves. There was also thirteen times were participants didn't understand the

directions or needed them repeated. Finally, there were four different occasions where a participant presented one of their behavioral and psychological symptom.

To-Do List

This game also worked with the memory domain of cognition for these participants. All participants seemed to be much more attentive during this game when compared to the others. This is thought to have happened because there was always someone speaking to them, giving them the directions of what they were to do. All of the participants could do level one of this game with ease, but those with moderate dementia struggled with any higher level.

There were some patterns noted during game play in all participants. Five participants said they liked the game, one said it was okay, and one said that they didn't like it. Five laughed during it and six needed reassurance. Finally, three presented a behavioral and psychological symptom during game play. An example of this is that one participant thought children were poking her and another was concerned that they had to get back to work.

Mental Map

This game worked with the navigation domain of cognition for these participants. In this game there were multiple levels and the higher the level, the more complex the directions. All participants could answer correctly at level one, but after level one all participants could not quite understand what the game was asking them to do. It seemed that reminder of directions was always necessary for this game.

There were some patterns noted during game play in all participants. There were three participants that said the game was okay and two that laughed during it. One

presented a behavioral and psychological symptom and twenty needed reassurance because they doubted themselves. There also was nine times where participants commented on the pictures. One participant wanted to throw the no eating sign out, another said that people use fire for heat, another said the person in the picture escaping the fire better get out quickly, another said that the people walking were going to fall off the screen.

Optic Flow

This game also worked with the navigation domain of cognition for these participants. The dual directions of this game was too complex for the participants so the researcher just had them identify the shape to be found and not find the animals. All of the participants could find the shapes with ease. Sometimes redirection was needed because the animals would distract participants. Also, sometimes they would find the object on the sign where it was presented, instead of the area following when they were supposed to. The quality of this game seemed quite poor. When the participants would do well and the game would speed up, once an answer was picked the game would freeze and mark their answer as wrong even if it was right.

There were some patterns noted during game play in all participants. There were two times when participants said they liked this game, two times when they said they didn't like this game, and one time when they said it was okay. There was five times when they needed reassurance and three times when they needed the directions repeated. There was one time when a participant presented a behavioral and psychological symptom. Finally, there were fifteen times when the participants commented on the vehicles or animals. Examples of these comments are when the participant said she liked

diamonds and another said they'd only find the diamond if she could keep it. Some more examples are when the participant said she wanted a red car, another said she still wish she had her car so she could drive better, and another commented that drivers in this game are driving like his wife who drives too fast.

Face to Face

This game worked with the people skill domain of cognition for these participants. All of the participants seemed to enjoy the expression on the faces, but sometimes the expressions were a little distracting for the participants, especially those with moderate dementia. Sometimes, the researcher even had a hard time distinguishing emotions on the faces and felt this was a unfair disadvantage for any participant.

There were some patterns noted during game play in all participants. There was one time when the participant said they liked the game and two times when they said it was okay. There were two times when the participants laughed during the whole game and six times when they needed reassurance because they doubted themselves. There were four times when directions needed to be repeated because they were consistently answering wrong for multiple questions in a row. Finally, there were twenty-six times where participants commented on the faces. Some examples were that one participant said she liked the face because he was "cream like her," another said that person's face looked so mad that she could eat someone, another said "he's got ugly teeth, but a pretty smile," and finally another called the faces name like "the old cowboy."

Recognition

This game also worked with the people skill domain of cognition for these participants. All participants tended to enjoy the game, as both those with mild to

moderate dementia could do the game because there was no time issue and the directions were not too complex. The only issue with this game is that sometimes when a peripheral face was shown, the researcher could not even identify the frontal view of the face that matched with it.

There were some patterns noted during game play in all participants. There were three occasions where participants said the game was okay and two occasions where they said they didn't like the game. Reasons for not liking the game included that it made them tired, that it was hard, and that it was too confusing. There were five times when the participants laughed at the games. On eleven different occasions, participants commented on the faces in the game. An example of what they would say is, "that's a strange face." There were fourteen times where the participants needed reassurance because they doubted themselves and seven times when they needed directions repeated or didn't understand the directions. Finally, there were two times when a participant showed a behavioral and psychological symptom.

DISCUSSION

The effects of cognitive training are not well established for those people who have any type of cognitive impairment. Researchers are beginning to explore this and are finding hopeful results and with this study we have found some more of these positive and encouraging results. The first thing to point out is that the only participants to drop-out were from the low social interaction. This could have just been by chance, but it also could have been because they weren't happy with the amount of interaction that was happening at their sessions. Also, it took the participants in the low social interaction group much longer to complete all twelve sessions than it took the participants in the high social interaction group. This also could have been by chance, but it also could have been because they weren't as motivated to do the games again because of the little amount of interaction that was happening at their sessions.

Most of the quantitative results of this study were not very significant because of the low sample size, therefore it was very important to look at mean scores and compare them to see changes between groups. The mean score on the MoCA from pre to post increased for the participants in the high social interaction group. The mean score on the NPI decreased, as well as the NPI caregiver distress score. The high social interaction group participant's rating of their quality of life remained the same, where the caregiver's rating of the participant's quality of life increased. The RBANS memory, visuospatial, and total score increased from pre to post assessment as well. The mean score on the MoCA from pre to post remained the same for the participants in the low social interaction group. The mean score on the NPI decreased, as well as the NPI caregiver distress score. The low social interaction group participant's rating of their quality of life

decreased, where the caregiver's rating of the participant's quality of life increased. The RBANS memory, visuospatial, and total score decreased from pre to post assessment as well.

These results can have a lot of implications. In regards to the cognitive assessment tools, both assessments saw an increase in score from pre to post assessment for the high social interaction group. The strongest effect was seen in the RBANS memory scores for both high and low social interaction groups. The ANOVA results found significant training effects by group and post-hoc t-tests found significant effects for both the high and low social interaction group meaning that the effects were probably not due to chance for this domain. Since the visuospatial score results were not significant, it could be assumed that the results for the cognitive assessment tools is probably due to the social interaction and not due to the training. In regards to the NPI results, all participants saw a decrease in frequency and severity of symptoms; one even rid all symptoms in this domain. Caregivers also felt less distressful from pre to post-assessment. Since there was a significant finding using the ANOVA in regards to the training effects in all participants, it can be concluded that these results are probably a product of the computer game-based cognitive training. It was not expected for caregiver's quality of life to increase during the study since it was not an intervention that was directly impacting them so it was not surprising when there were no significant findings. The results in regards to the participant's quality of life rating can be understood in many different ways. The high social interaction group participant's saw stability in quality of life. This could be due to the fact that they know that they struggled with the games and that they know they are both physically and mentally declining, but since there was more positive

social interaction in their life they felt that this helped to outweigh those negative consequences and keep their quality of life score consistent. The low social interaction could have felt those same feelings about playing the games and knowing they are declining, but since they didn't have as much positive social interaction they felt that their quality of life was not as good as before. Finally, the increase in scores of the caregivers' ratings of the participant's quality of life could mean that they actually did see an improvement or it could be due to the placebo effect, as maybe they though the game play was really helping their loved one's functioning even if didn't.

The qualitative results that were transformed into Likert-scaled ratings found that participants in the low social interaction were slightly more hesitant to start the games than those in the high social interaction group. It also found that the low social interaction group was less likely to be attentive than the high social interaction group. Finally, it found the low social interaction group was slightly more positive than the high social interaction group, but this could be attributed to external factors.

Thresholds significantly changed for five of the twelve games, but there was no difference for researcher interaction groups for those five games in terms of near transfer of learning to specific game related skills for these games. This suggests that computer game-based cognitive therapy holds promise for low intensive implementation by staff members. Within these five games, we saw that three of them were pretty well liked by the qualitative results analysis. To-do list, eye for detail, and optic flow tended to be favored, where mind bender and card shark were not with the main reason being because they were too fast.

The three most frequent patterns in the game play that were noted during the interactions were a need for a reminder or re-explanation of directions, reassurance because of self doubt, and comments about the objects within the game. Some other patterns frequently seen were that the games were too fast, that the participants were distracted, and that they laughed a lot. These qualitative notes show that the participants can do these games, but that it is necessary to have someone there encouraging them and reminding them of the task at hand.

In regards to the hypotheses, there was none that were fully confirmed by this research. The first hypothesis was not confirmed, as two of the games with significant game scores were not well liked. Although the participants would try harder on games they liked it didn't always translate to higher scores. The second hypothesis was partially confirmed as the low social interaction group did see a decrease in the intensity of their BPSD and this was not predicted. The high social interaction group also saw a decrease in the intensity of their BPSD and this was predicted. The third hypothesis was not confirmed. The low social interaction group saw a decrease in their cognitive status, where the high social interaction group saw stability on their cognitive status scores on the MoCA and an increase on their RBANS cognitive status scores. Both groups' threshold scores saw no real significant difference. The fourth hypothesis saw no difference in percent of attempted training sessions completed. Finally, the fifth hypothesis had a partial confirmation. The low social interaction group saw a decrease in their quality of life and it was predicted they would see stability. It was also predicted their caregivers would rate the participant's quality of life the same for this group, but the scores revealed that the caregivers saw an increase in quality of life for the participants.

The participants in the high social interaction group were predicted to see an increase in their quality of life, but their scores revealed stability. It was also predicted their caregivers would rate the participant's quality of life higher from pre- to post- assessment and this was confirmed.

This topic is very important for us today because the Alzheimer's Association estimates that if the onset of Alzheimer's disease could be delayed by 5 years due to successful interventions, this would result in a 50% decrease in Alzheimer's diagnoses (Park & Bischof, 2013). The implications from this study can successfully say that computer game-based cognitive training could be an intervention that helps to delay the onset or delay the progression of Alzheimer's. Some ideas for future research are as follows. The first being that there is a need for future research to look at whether cognitive training effects, changes on social behavior scale, and quality of life rating changes following computer game-based cognitive training translates into observable changes in behavior of cognitively impaired individuals with other residents and with staff. The second being that there needs to be new technology that takes into consideration those with dementia. I would suggest that the games should be made accessible through a touch screen or something like an iPad because all of the participants in this study could not figure out the mouse, but they could and would touch the computer screen to indicate their answer. The third is that there needs to be a study that uses the games that were well liked in addition to some different games not used to see if the same results are found. Fourth, a study needs to be done that involves more participants with all the different types of dementias to see game-play and assessment differences via diagnosis because one thing recognized in this study is that the person

diagnosed with vascular dementia had a much harder time with the games when compared to the other participants. The fifth idea is that there needs to be sessions where video or audio recording is done so that there can be a better understanding of exactly how the participants felt about the games during the sessions via direct quotes from them. Finally, a last idea would be to have a study where the participants play this game while hooked up to some sort of brain imaging device to see what parts of the brain seem to be activated during game play and if there really are any brain changes.

There are some limitations to this study that need to be mentioned. The biggest limitation is the number of participants that were recruited and additionally the differential dropout in the groups. There is a very limited amount of people who want to be in a research project that is this demanding and it is very hard to recruit people who can be in this study due to their vulnerability. The small population size limits the results strength. Although we were as random as possible, there was very little randomization of participants into their groups, which restricts the ability to determine whether findings are due to chance or lack of power even with multiple rounds of statistical analysis. Even with some strong results that were found, it is suggested that a larger study is warranted to confirm all of these results. Since I was the game trainer for both groups in the study, as well as the outcome measure assessor at pre- and post- training assessment, there could be some bias in the results. Finally, the last limitation is the length of the cognitive training. There was a very short time frame available to conduct this research and the limited resources available affected how long the project could be run. Due to the short length of the study, we could have missed some results that would have been seen if the participant's had gotten the full potential capacity of the training.

This study set out to determine the effectiveness of computer game-based cognitive training on cognitive, behavioral, psychological, and social function as well as quality of life for people who have mild to moderate dementia in an assisted living day-care setting. We set out to see how much interaction from some sort of a caregiver is necessary to effectively engage the participants in the gaming experience, as well as to see if the games were even possible for this population. It was found that those who had a higher social interaction with the researcher saw better results in regards to their cognitive status, BPSD, and quality of life. This transformed into possibly better social functioning as well since the caregiver did think that the participant's quality of life was improving. The low social interaction group did not see as promising results as they only saw a positive change in their BPSD. All participants could do these games, but with reminder of directions and reminder of the goals of the game. That being said, these games are only feasible for this population and would work best for them in a setting where they could play the games and interact with another person who could help them with directions and etc. Alzheimer's disease affects millions of people every year and it is important to find ways to help both the population diagnosed with this horrible disease and the loved ones who are trying to care for them. Any new intervention that can possibly improve both parties quality of life is worthwhile for future experimentation and I believe that future research should follow up with these results from the study.

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