COGNITIVE INTERNVENTION FOR INDIVIDUALS WITH PROBABLE MCI: A PILOT STUDY

A Thesis
by
MADELYN LEIGH ELLIOTT

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APPROVED BY:

____
Kimberly C. McCullough, Ph.D.
Chairperson, Thesis Committee

____
R. Jordan Hazelwood, Ph.D.
Member, Thesis Committee

____
Angela S. Losardo, Ph.D.
Member, Thesis Committee

____
Gail S. Donaldson, Ph.D.
Chairperson, Department of Communication Science and Disorders

____
Max C. Poole, Ph.D.
Dean, Cratis D. Williams School of Graduate Studies

Abstract

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Madelyn Leigh Elliott
B.S., Appalachian State University
M.S., Appalachian State University

Chairperson: Kimberly C. McCullough, Ph.D., CCC-SLP

The dementia population has accumulated to 47 million people, creating an $818 billion global expense. Approximately 20% of people 65 and older are living with mild cognitive impairment (MCI), a pre-dementia stage of Alzheimer's disease. Cognitive intervention strategies have the potential to reduce the prevalence of dementia due to their ability to slow the conversion to frank dementia. As specialists trained in language and cognition, speech-language pathologists are uniquely positioned to identify and treat cognitive impairments. If intervention strategies could delay the onset of dementia by even five years, there could be a 57% decrease in number of people living with dementia. A single group, pre/post-test design was used. Thirty-six elders at-risk for cognitive decline participated. Eight weeks of group-based, cognitive-linguistic intervention was administered, implementing language stimulation, social engagement, and person-centered memory strategies. Measures of verbal episodic memory, linguistic comprehension and expression, mental status, and visuospatial skills were administered pre- and post-intervention. Data was analyzed using paired samples t-tests. Statistically significant differences were found of assessment measures of linguistic comprehension, linguistic expression, and visuospatial construction following the intervention. Results nearing statistical significance were found on assessment measures of verbal episodic memory. These results support the hypothesis that group-based, cognitive-linguistic intervention programs have the potential to improve cognitive-linguistic functioning. Additional research in this area is merited.

Acknowledgments

Firstly, I would like to express my sincere thanks to my advisor, Dr. McCullough for allowing me to share in her valuable and esteemed research; for her continual patience, encouragement, and immense knowledge. I have encountered few educators as gifted as Dr. McCullough, not only for her skill and expertise within her field, but for the concern, empathy, and equality with which she treats her students. I could not have been given a better advisor and mentor for my master's degree study. I will sincerely miss her support, both professionally and personally. Secondly, a sincere thanks go to the remainder of my thesis committee, Drs. Hazelwood and Losardo, for their insightful comments and encouragement as I conducted and completed my research. Finally, I would like to acknowledge both the Communication Science and Disorders faculty and staff and the Cratis. D. Williams Graduate School for offering me the resources and the education necessary to complete this study. I will forever be both proud and grateful to call myself a Mountaineer.

Dedication

To my dear parents, Paula and Jeff, and my sister, Megan—thank you for the sacrificial love, support, and encouragement that have allowed me to run towards my fears and pursue something bigger than myself. I consider it both a rarity and a treasure to love a family as I love you. To my husband, Jonathan—thank you for daily reminding me that two are better than one, and teaching me to trust that all things will be worked for good. Above all, glory to God, who has faithfully shown me that He is a good, good Father. Soli Deo Gloria.

Table of Contents

List of Tables

List of Figures

COGNITIVE INTERVENTION FOR INDIVIDUALS WITH PROBABLE MCI: A PILOT STUDY

Madelyn Leigh Elliott, M.S.

Appalachian State University

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Introduction

In 2016, there were more people in the world with dementia (World Alzheimer's Report, 2016) than with HIV (UNAIDS, 2016). The dementia population has grown to 47 million people, a growth of approximately 200,000 from the previous year (World Alzheimer's Report 2015 & 2016). The World Alzheimer's Report estimates that dementia care is an $818 billion industry, larger than that of both Apple and Google; it is projected that the disease will cost one trillion dollars globally by 2018 (2016). In the coming years, the public healthcare system will be charged with three chief components whose interactions will result in an increased need for intentional intervention: a greater number of older adults, a rising number of older adults with cognitive impairments, and a subsequently, a greater need for long-term care services equipped for their care (Gross et al., 2012). It is undeniable that cognitive impairment is on the rise and that effective cognitive intervention will be essential.

Researchers feel strongly that effective cognitive intervention strategies have the potential to reduce the prevalence of dementia, and by proxy the global healthcare costs, due to their demonstrated ability to slow the onset of cognitive aging by encouraging healthy and active lifestyles (Kueider, Bichay, & Rebok, 2014). In fact, it has been estimated that if effective cognitive intervention strategies could slow the onset of dementia by only five years, there could be a 57% decrease in the dementia population (Sperling et al., 2011). If memory abilities can be preserved, so can independence, which is an important contributor toward future healthcare demands (Gross et al., 2012). For these reasons, the value of effective cognitive intervention strategies developed using well-established empirical evidence cannot be over stated.

Mild cognitive impairment (MCI) is the middle ground between normal cognitive aging and pathologic cognitive aging associated with dementia (Pandya, Clem, Silva, & Woon, 2016). A term originally introduced in the 1980s (Reisberg et al., 1988), MCI typically describes individuals with cognitive impairment which is noticeable to both themselves and to their loved ones, yet they presently retain the ability to live and function independently. Often, these individuals will perform poorly on standardized cognitive assessments, even though independence with activities of daily living remains intact (Brum, Forlenza, & Yassuda, 2009; Petersen et al., 2014). Many patients with MCI will also present with complaints of poor prospective memory, or their ability to remember to remember (McCullough, 2014). Because of these established patterns of deficit, MCI is recognized as a pre-dementia stage of Alzheimer's disease. The internationally-recognized classification of MCI currently includes self or informant-reported cognitive complaint, objective cognitive impairment, preserved independence in functional abilities, and no diagnosis of dementia (Petersen et al., 2014).

Per the Alzheimer's Association, current research indicates that approximately 15% to 20% of people age 65 and older are living with MCI (Alzheimer's Association, n.d.). However, through population-based epidemiological studies, Gauthier and colleagues (2006) found the prevalence of MCI to be between 3% and 19% of people 65 and older. The rapidly growing prevalence of cognitive impairment associated with aging, as well as the increasing population of adults living well into old age, are the central motivators for the research and development of effective and evidenced-based cognitive intervention strategies (Kelly et al., 2014). It is agreed that a significant proportion of the population is affected by this impairment and that intervention procedures are merited.

Four different subtypes of MCI have been identified, each defined per the type and degree of memory impairment with which the patient presents. In terms of cognition, patients with MCI are classified as having amnestic MCI (a-MCI), meaning that they present with poor episodic memory, or as having nonamnestic MCI (na-MCI), where areas other than memory, specifically executive functioning, language, or visuospatial abilities, suffer (Petersen et al., 2014). In terms of the degree of impairment, patients with MCI are further classified as multiple or single domain, based on the number of cognitive domains that are affected (Petersen et al., 2014). Therefore, a patient with MCI could be classified as amnestic single domain, amnestic multiple domain, nonamnestic single domain, or nonamnestic multiple domain. Research has shown that a patient's subtype classification can inform etiology, treatment, and prognosis. In many studies, specific subtypes of MCI have demonstrated an increased likelihood of progression. Amnestic subtypes, specifically, are at an increased risk for developing Alzheimer's disease (Gauthier et al., 2006).

It should be noted that a diagnosis of MCI does not guarantee that a patient's cognitive impairment will continue to progress (Pandya, Clem, Silva, & Woon, 2016). However, it is widely accepted that these individuals are considered to have an increased risk for developing dementia or Alzheimer's disease as compared to their neurotypical counterparts (Belleville, 2008; Belleville et al., 2006; Brum et al., 2009). There is a substantial body of research aimed at calculating progression rates of MCI to dementia. However, a degree of division within the research remains. A meta-analysis including 41 studies purported the annual progression rate of MCI was approximately nine percent, with the type of MCI and the living setting of the patient influencing its progression (Mitchell & Shiri-Feshki, 2009). This same analysis also argued that less than 50% of the entire MCI population progresses to dementia. However, Gautheir and colleagues purport that more than half progress to dementia within five years (Gauthier et al., 2006). In a 15-year follow-up study conducted by Peterson and colleagues (1999), MCI progression rates were stated to be 12%. Even more considerable, the same study reported that 80% of patients who received a diagnosis of MCI had developed dementia or Alzheimer's disease within six years.

As previously stated, most patients with MCI, despite their frequently impaired cognition, episodic memory, and executive functions (Brum et al., 2009) will still maintain a substantial degree of cognitive abilities, making cognitive intervention strategies ideal for targeted treatment (Belleville, 2008; Brum et al., 2009; Hyer et al., 2015; McCullough, 2014). Contrary to the projected image of the media and mainstream culture, mental decline associated with old age is not inevitable, as there is evidence to suggest that it may be avoided and even reversed (Kueider et al., 2014). In fact, neurological studies of both human and animal brains support the idea that the brain remains plastic well into old age, even in the presence of MCI (Kueider et al., 2014). These cognitive abilities that are maintained give way to continued learning, cognitive growth, and the acquisition of compensatory strategies that have the potential to slow the onset or possible progression of further decline and also to improve the individual's personal perception of their cognitive abilities (Belleville, 2008). This idea of cognitive growth is supported by the neurological principle of neuroplasticity, which is the brain's ability to change. This principle serves as the theoretical basis for the clear majority of cognitive intervention strategies (Gross et al., 2012). These types of interventions are intended to enhance neuroplasticity using strategies that help individuals encode and retrieve information more effectively (Gross & Rebok, 2011; Rebok, Carlson, & Langbaum, 2007). Mentally stimulating activities utilize this maintained neuroplasticity and cognitive reserve to improve cognitive function (Hertzog, Kramer, Wilson, & Lindenberger, 2008). Repetitious and cognitively-engaging activities that make use of preserved neuroplasticity are imperative to the effective building of cognitive reserve, especially in individuals with MCI (McCullough, 2014).

Cognitive intervention strategies have gained support and popularity within the memory and cognition communities. These interventions, often referred to by several derivative names, including “cognitive training,” “cognitive stimulation,” and “cognitive rehabilitation” (McCullough, 2014), are generally aimed at cognitive stimulation with the intent of prolonging brain function and delaying decline. These three different titles for intervention can have moderately different implications with regard to the structure and strategies used. Cognitive stimulation typically includes group activities intended to increase cognition and socialization in a non-specific way. Cognitive rehabilitation involves a program that is individually tailored and focused on activities of daily living, usually specific to the individual. Finally, cognitive training teaches theoretically-motivated skills and compensatory strategies with the purpose of enhancing cognition (Clare & Woods, 2005). Cognitive training is typically based on the manipulation of maintained cognitive domains as compensation for those that are impaired, as well as the development of new domains (Belleville, 2008). Cognitive training is most often conducted in a group-oriented and standardized design (Clare & Woods, 2005), which is especially beneficial for the enhancement of quality social engagement, the importance of which will be discussed later in this paper. The intent of most cognitive intervention strategies, regardless of the terminology used, is to improve one or more cognitive domains (Clare & Woods, 2004). According to the Alzheimer’s Association, these domains can be classified into four general categories: recent memory, language, visuospatial skills, and executive functions (Alzheimer's Association, n.d.).

In terms of intervention strategies, the literature reports numerous approaches and perspectives regarding which elements specifically prove the most efficacious. However, regardless of the design or approach used, it is argued that the central purpose of every cognitive intervention program should be to produce positive effects in the areas of both cognitive *and* social wellness (McCullough, 2014). Additionally, as memory training programs and strategies have the potential to influence decisions, goal-setting, and approaches to treatment, all strategies should make use of evidence-based practice regarding program design (Gross et al., 2012). Some programs will seek to improve one area of cognition, such as attention, while others are designed to provide training in activities that encourage the use of compensatory strategies, such as rehearsal (Clare & Woods, 2004). However, programs incorporating a greater breadth of training strategies and skills are more likely to have a positive impact as there is a higher probability of enhancing a skill that is specifically useful to an individual person (Hertzog, Kramer, & Wilson, 2008). This reasoning would lead to the hypothesis that the broader the scope of the intervention, the broader the impact on the various domains of cognition. Additional research is needed before this conclusion can be more confidently reached (Gross et al., 2012). Often, the strategies used are adaptable to various levels of functioning so that the level of difficultly can be tailored to a given individual (Clare & Woods, 2004).

When memory training is a targeted goal, it is common for rehearsal, categorization, and imagery techniques, as well as concentration strategies to be implemented (Gross et al., 2012). These are considered to be internal compensatory strategies, as they are used by the person to organize and recall information. Other internal compensatory strategies could include mnemonics, rhyming, personal meaning, repetition, clustering, chunking, and clarification. For example, chunking or clustering involve "chunking" information into smaller categorical groups that are easier to remember. Many people often use this skill intuitively, such as with phone numbers by chunking numbers into two groups: the first three numbers, and the last four numbers. This strategy proves useful when memory performance is contrasted between older adults who cluster and those who do not, as it creates a more manageable quantity of material to be encoded and retrieved (Craik et al., 2011; Gross et al., 2012).

There is evidence to support the use of visualization as an internal memory strategy for aging adults (Belleville et al., 2006; Gross et al., 2012). It is proposed that these types of strategies prove especially effective (Verhaeghen, Marcoen, & Goossens, 1992) because the area of the brain that processes visual information, the occipital lobe, will not age as prominently nor rapidly as the frontal lobe (Nyberg et al., 2003), which processes executive functions.

Many cognitive training programs make use of mnemonic techniques (Gross et al., 2012), which generally use patterns, such as a letter pattern, that is intended to help with memory. In fact, in a recent systematic literature review that included fifteen individual studies of cognitive intervention programs, approximately half of the programs underscored the efficacy and value of mnemonic training approaches (Jean et al., 2010; McCullough, 2014). Additionally, several studies indicate that interventions geared towards the training of memory could generalize, leading to improvements in other areas of cognition (McCullough, 2014). For example, a randomized study conducted by Hampstead et al. (2012) evaluated the effectiveness of mnemonic training as compared to exposure therapy. It was found that mnemonics were more successful than exposure therapy, both in MCI adults and healthy older adults, and that the positive impacts for memory were still evident one-month post intervention (McCullough, 2014). However, in keeping with the previously-stated findings of Clare and Woods (2004) and Hertzog and colleagues (2008), Gross et al. reported that there was a positive correlation between the number of strategies incorporated and the demonstrated memory improvement, while no correlation was found between mnemonic strategies and memory improvements (2012).

In addition to the use of internal memory strategies, implicit instruction regarding external memory aids is usually incorporated into the program design (Gross et al., 2012). Examples of external memory aids could include calendars and personal planners, reminder and note functions of personal electronic devices, hand written notes, medication logs, contact lists including addresses and phone numbers, watches and clocks, and other devices external to the individual that serve to alleviate the cognitive burden of remembering information that could otherwise be accessed elsewhere. Essentially, the goal becomes teaching participants how to use compensatory strategies, rather than how to remember everything— simply put, working smarter, not harder.

In their review of ten cognitive intervention studies, Stott and Spector (2011) purport that programs tailored to the individual participant and their current level of cognition exhibited the most potential to impact cognitive function. When providing intervention, professionals should be aware of the individual needs of each participant, and the ways in which their cognition and the strategies being implemented will affect their level of functioning and disability, and their overall health (McCullough, 2014). Considering how each element impacts an individual is based on the International Classification of Functioning, Disability, and Health (ICF) model (World Health Organization, 2001). Personal participation, the individual's environment, the person's own body, and the disability should all be evaluated concurrently and should be considered mutually influential elements for any intervention technique to be optimally efficacious and ethical. Speech-language pathologists (SLPs) play an important role in making these judgments and evaluations (McCullough, 2014) and the American Speech-Language-Hearing Association recognizes cognition and related domains (e.g., attention, memory, problem solving, executive function) as service delivery areas within the SLP's scope of practice (ASHA, 2016). For these reasons, it is important to consider the degree to which the SLP can and will be involved in goal setting, strategy modifications, progress monitoring, and activity selection when designing and selecting intervention strategies. These considerations should be utilized in computerized and electronically-based programs, as it is more difficult to individually tailor intervention to meet the overall health needs of a person when the SLP tends to be less involved in these types of programs.

The decision to utilize group versus individual therapy design is frequently researched within the literature. There is a degree of debate and some variations within the findings, however the consensus is generally that it is wise to implement group therapy whenever possible due to the exhibited effectiveness of peer support and socialization on memory, and its potential to influence other cognitive domains (Kelly et al., 2014). Therapy designs that utilize both individual and group sessions seem to be the most advantageous across the literature (McCullough, 2014), with some studies revealing a correlation between group designs and increased memory and general well-being (Belleville et al., 2006). It would, therefore, be most productive to incorporate a multi-faceted approach to intervention design, drawing from the benefits of both group and individual therapy (Kurtz, Pohl, Ramsenthaler, & Sorg, 2009) as appropriate for the activity. Research has revealed a positive correlation between socialization and reduced cognitive impairment (Mendes de Leon, Glass, & Berkman, 2002), concluding that social engagement has the potential to protect against mental decline and the onset of Alzheimer's disease and dementia (Fratiglioni, Wang, Ericsson, Maytan, & Winblad, 2000). Kueider et al. (2014) echo this conclusion in their recent literature review, stating that while no specific training program appears to be optimally effective, it is evident that group designs with a higher number of trained strategies implemented are the most effective. Consequently, many investigators will utilize group designs for increased social opportunities (McCullough, 2014). It should be noted that in their study regarding the effects of social engagement on disability in the elderly population, Mendes de Leon et al. (2002) did not find evidence that social engagement directly slows the cognitive disease process. However, they do propose the theory that a healthy social life provides supportive resilience in the presence of cognitive decline, allowing the individual to maneuver the disease process in a way that is less limiting and detrimental to their personal life. Therefore, researchers continue to support the view that social engagement is integral to the aging brain, going as far as to refer to an active social life as a "critical aspect of successful aging" (Mendes de Leon et al., 2002). These conclusions add to the impression that a multi-faceted approach that includes a wide variety of settings and intervention strategies is most likely to prove beneficial to decrease decline in cognitive function.

Regarding the typical session timeline and format, many cognitive intervention programs will provide one 60 to 120-minute session per week, for eight to twenty-four weeks

(McCullough, 2014). Kelly et al. (2014) argue that programs that are adaptive and include at least ten therapy sessions with a long-term follow up plan have the highest chance of creating positive cognitive change that is maintained and extended to other areas of participants' personal lives. Willis et al. (2006) recommend the addition of "booster" sessions at regularly scheduled intervals following the completion of a program for increased likelihood of maintaining any cognitive gains. A study regarding the effectiveness of a cognitive intervention program conducted by Belleville et al. (2006) provided one 120-minute group session per week for eight weeks. Even though only eight sessions occurred, which is less frequent than other programs, they report statistically-significant improvements in the areas of delayed list recall and face-name-recognition.

Contrary to what one might think, previous literature reviews have revealed that longer session length and/or the duration of the program are not positively correlated with efficacy (McCullough 2014). In fact, a meta-analysis conducted by Gross et al. (2012) reports that treatment results were not enhanced by any particular strategy, by the age of the participants, or by the session length. Rather, it appears that there are four key elements that prove more salient in terms of program quality. These four elements are outlined in a paper discussing intervention programs and MCI: (1) using repetition-based interventions that specifically target cognitive domains that were identified during initial assessment, (2) supplying direct training of strategies and functional skills, such as memory strategy training and mnemonics, (3) educating participant about healthy aging and brain habits (e.g. the importance of exercise, diet, and cognitive stimulation), and (4) providing an element of socialization that strategically supports cognitive engagement (McCullough, 2014).

With regard to measuring the efficacy of various designs and approaches, one very encouraging conclusion is supported by the literature: all meta-analyses and literature reviews report positive advances due to cognitive intervention programs and underscore their budding value in the world of dementia and MCI prevention and disability (McCullough, 2014). It should be established that all techniques worthy of the label “reliable” should be founded on theoretically valid, evidence-based schema, and address the question of ecological validity (Belleville, 2008). In addition, all techniques should consider each individual’s preserved and impaired abilities, in accordance with the WHO ICF framework, and assess the ways in which their participation and overall impact on well-being (Belleville, 2008). When these considerations are addressed, various approaches to program design have proven effective and productive (McCullough, 2014).

Prior research points persuasively to the conclusion that memory training is beneficial for older adults within our communities (Gross et al., 2012). While research is not conclusive in terms of which cognitive training programs prove most efficacious regarding cognitive maintenance and impairment prevention, it does demonstrate cognitively stimulating activities decrease dementia risk (Kueider et al., 2014), and preserve mental sharpness (Jak, Seelye, & Jurick, 2013). More specifically, cognitive training techniques have the potential to provide critical gains to cognitive vitality in both normal and disordered aging brains (Belleville, 2008). The changes that occur in response to intervention are shown to persist even after the intervention program has concluded (Ball et al., 2002; Hyer et al., 2015). In fact, some studies report that training outcomes can result in group performance emulating that of unimpaired elderly populations (Brum et al., 2009). The literature supports that the best intervention outcomes are achieved when stimulation is introduced to patients still in the early stages of cognitive decline and MCI, as they still retain sufficient neuroplasticity for the learning and implementation of skilled intervention strategies (McCullough, 2014).

The Advanced Cognitive Training for Independent and Vital Elderly (ACTIVE) study, an important investigation of training interventions in 2,832 older adults, found that memory and problem-solving training resulted in a seven to fourteen-year reversal of cognitive aging when applied to the normally-aging brain (Ball et al., 2002). These effects persisted five years post-training. Additionally, findings show that the stage at which the intervention program is initiated appears play a role with regard to treatment efficacy. Research has purported that cognitive training is most beneficial in the younger elderly MCI population and with those that were less impaired (Belleville, 2008). These findings bear an important realization that there is value in early intervention, and communicate the importance of proactive, as opposed to reactive, training measures.

As previously stated, programs that are comprehensive or multifactorial in nature demonstrate the highest degree of impact (Floyd & Scogin, 1997; Hyer et al., 2015; Rebok, Carlson & Langbaum, 2007). This means programs that train that more cognitive and memory areas demonstrate the most success. The areas that are trained generally aim to aid overall neural plasticity by use of strategies for the encoding and retrieval of information (Gross & Rebok, 2011; Rebok et al., 2007; Verhaeghen et al., 1992). In their study of cognitive training to improve working memory, Hyer et al. (2015) report that most studies note advances in the targeted task (e.g. Borella, Carretti, Riboldi, & De Beni, 2010), and some report these gains transferring to further tasks (e.g. Jaeggi et al., 2010). A meta-analysis by Zehnder and colleagues (2009) reported positive training effects in the areas of paired associate learning, immediate recall, and delayed recall (Martin, Clare, Altgassen, Cameron

& Zehnder, 2011; Zehnder, Martin, Altgassen & Clare, 2009). McCullough (2014) reports that the literature points to benefits in the areas of processing speed and attention, as well as language abilities, which demonstrate the most improvements. Benefits related to objective memory (Gross et al., 2012), as well as self-rated subjective memory (Floyd & Scogin, 1997), have been recorded.

A study of working memory plasticity in the elderly population conducted by Li et al. (2008) reported improvements to episodic and working memory as a result of cognitive training. Current literature argues that there is a positive correlation between declines in working memory and overall age-related decline (Hyer et al., 2015). The same study reports and cites extensive findings from other literature related to the generalizations of working memory training to other areas of cognition, including but not limited to speed of processing (Ball et al., 2002), attention (Borella et al., 2010; Smith et al., 2009), reading comprehension (Chein & Morrison, 2010), and cognitive control (Klingberg, Forssberg, & Westerberg, 2002). These findings beg the question whether cognitive interventions that train working memory could be optimally effective by generalization to broader cognitive domains. A study of working memory and transfer conducted by Chein and Morrison (2010) provided evidence of multiple domain transfer. Additionally, it has been shown that working memory training can improve reading abilities, even in younger college-aged populations, supporting the theoretical model of working memory training for the general enhancement and preservation of cognition (Chein & Morrison, 2010).

Interestingly, Gross et al. (2012) question the implications of identifying specific memory strategies. The authors suggest the potential of strategy identification to result in the overlooking of self-generated, idiosyncratic or hybrid techniques that are individually effective on a case-by-case basis. They argue that the importance of experienced clinical judgment and a patient's unique desires, strengths, and areas of impairment should not be sidelined because of the evidence. This valuable point related to the WHO ICF framework (2001), which considers all disabilities and associated ramifications on an individual's participation.

To assess the efficacy of a given cognitive intervention program or strategy, assessments of cognition and or neurophysiology are typically administered pre-and post-intervention with the hope of demonstrating that the test group will display maintenance, or better yet, improvement, when compared to the control group (Clare & Woods, 2004). Improvement can also be measured based on whether there is growth on a cognitive task, the ability to apply training techniques to tasks within the same and/or different cognitive areas, and/or generalization of advances to someone's (Kelly et al., 2014; Klingberg, 2010; Martin, Clare, Altgassen, Cameron, & Zehnder, 2011). Some argue that measures of efficacy should be centered more on changes to personal life, such as instrumental activities of daily living (IADLs) (Acevedo & Loewenstein, 2007)— cooking, using the computer and telephone, running errands, etc. Some studies incorporated this concept by evaluating progress by considering activities of daily living (ADLs) (Belleville et al., 2006), such as bathing, toileting, and dressing as outcome measures. However, the use of activities of daily living as a measurement for progress and efficacy of interventions could be limiting when participants with normal cognition or MCI are involved, as these areas would be cognitively maintained.

In addition to the traditional measures of efficacy outlined above, there is growing evidence that neural biomarkers and brain imaging can illustrate physical, tangible evidence of the effectiveness of an intervention program (Belleville & Bherer, 2012; Hampstead et al., 2011; van Paasschen et al., 2013). These biomarkers include increased brain metabolism, cortical thickness, and density of white matter tracts (Belleville & Bherer, 2012; Engvig et al., 2010). Belleville et al. (2011) studied the efficacy of direct strategy training in individuals with MCI using the findings of fMRI procedures. The investigators used a small group design of four to five participants in 2-hour sessions once per week for six weeks. Strategies based on mnemonics, encoding, and retrieval tasks were employed, which were shown to produce significant changes in the areas of the brain associated with memory. The study concluded that the areas of the brain that were specifically targeted showed explicit improvement as measured by increased activation in the frontal, temporal, and parietal lobes. Astonishingly, the improvements that were seen normalized the brain activity of the MCI participants to match that of their cognitively normal peers. These findings also support the utilization of direct strategy training for increased efficacy in intervention design.

While evidence strongly suggests that cognitive stimulation strategies can delay and even reverse the effects of MCI and abnormal cognitive aging, the generalization of these results to dementia and Alzheimer's disease should be applied cautiously. Currently, there is little to no evidence to support the effectiveness of cognitive training as a prevention for Alzheimer's disease and or dementia (Clare & Woods, 2005; Kueider et al., 2014). Additional research with these populations is needed.

While persuasive evidence exists regarding the efficacy of specific cognitive training strategies, as well as cognitive interventional in general, Belleville (2008) emphasized the current need for additional research on the subject. Kueider et al. (2014) echo this call, highlighting the lack of research related to intervention approaches, and appealing for thorough standards for evaluation and investigation. Rebok et al. (2007) noted the demand for additional research on the effectiveness and generalization of training programs and strategies in regard to geography, population demographics, and age. Specifically, exploring the effectiveness of cognitive intervention programs in the MCI population (Brum et al., 2009).

The scarcity of research on the effectiveness of cognitive intervention programs and encouraging evidence in the literature of many within the field have served as motivation to pursue the present investigation. A thorough review of the literature related to cognitive impairment and intervention strategies reveals that as people age, their cognitive abilities are often impaired. There is an extensive body of research to support the advent of group-based, cognitive-linguistic intervention programs and their ability to slow the onset and progression of cognitive impairments. Therefore, the purpose of this study is twofold. First, the cognitive and linguistic changes of a group of seniors at risk for cognitive impairments will be evaluated to determine if "at-risk" seniors demonstrate difficulty with cognition and language. Second, it will be determined if these same seniors demonstrate cognitive-linguistic improvements after cognitive-linguistic training techniques have been administered in the form of the LEAP-COG program.

The LEAP-COG program is a therapeutic, group-based cognitive-linguistic intervention curriculum that provides language stimulation, education, active social engagement, and patient-centered strategies intended to enhance general cognitive function and overall mental health. LEAP-COG is evidence-based, founded on neuroscience-supported methodology designed to both capitalize on neuroplasticity and build cognitive reserve with the intention to delay or prevent further cognitive decline. This present investigation is a pilot study for the LEAP-COG program. The curriculum was developed by

Kimberly McCullough, Ph.D., CCC-SLP, a professor of speech-language pathology at Appalachian State University, in collaboration with Kathryn Bayles, Ph.D., CCC-SLP, a Professor-Emerita at Arizona State University as well as an internally-recognized expert in the area of cognitive-communication disorders associated with dementia.

Methods

Participants

Participants were recruited in central Arkansas. Participation was voluntary and based on participants self-identifying as at risk for cognitive impairment, noticing "changes" to their cognition, or wishing to enhance or preserve their present cognitive abilities. All participants were fully informed of the purpose of the study and gave written informed consent. Institutional Review Board (IRB) approval was obtained from the local university with which the researchers were affiliated. All assessments and interventions were conducted at a senior citizen center and an assisted living facility in the area.

Thirty-six participants completed the study protocol: 27 females and nine males. A case history was obtained to gather information concerning age, family history, medical history, and educational background from each participant. Information was provided independently by the participants. All participants spoke English as a first language, were literate, and reported no history of alcohol/drug abuse or previous neurologic or psychiatric disorder. Additionally, all passed the *Arizona Battery for Communication Disorders of Dementia (ABCD)* (Bayles & Tomoeda, 1993) speech discrimination, visual perception, visual field, agnosia, and literacy screening tasks in order to screen for potentially confounding sensory impairments. Participants' ages ranged from 61 to 98 years old, with an average age of 80 years. Thirty-two identified their race as White, three identified as Black, and one identified as Asian. *Mini Mental State Exam (MMSE)* (Folstein, Folstein, & McHugh, 1975) scores ranged from 21 to 30, with 88.9% of the participants scoring a 26 or higher. All participants had completed a high school degree or higher, with nearly half (47.2%) having completed some college or a bachelor's degree. Ten participants had completed graduate degrees. Participant demographics are summarized in Table 1.

Table 1: Demographic Information of Participants

Variable	Category	Frequency N (%)
Age	61-69	5 (13.9)
	70-79	10 (27.8)
	80-89	17(47.2)
	90-99	4 (11.1)
Sex	Female	27 (75.0)
	Male	9 (25.0)
Race	White	32 (88.9)
	Black	3 (8.3)
	Asian	1 (2.8)
Years of Education	12	9 (25.0)
	13-16	17 (47.2)
	>16	10 (27.8)
MMSE*	21-25	4 (11.1)
	26-29	18 (50.0)
	30	14 (38.9)
**Mini Mental State Exam* (Folstein, Folstein, & McHugh, 1975)		

Data collection, assessment, and intervention procedures were conducted by trained graduate students and faculty members in the speech-language pathology program at the aforementioned university in central Arkansas. All data was anonymized by assigning each participant a number prior to recording information. Once assessment and intervention procedures were completed, all data was recorded and sent to participating colleagues at a university in Western North Carolina. Assessments were then rescored by the present investigator to ensure accuracy. Data was recorded, analyzed, and interpreted by colleagues at this university.

Assessment

Preliminary testing was conducted to establish each participant's baseline cognitive-linguistic function. Assessment was completed within the first two weeks of the study, with each session lasting approximately 60 minutes. Each participant completed a LEAP-COG-developed quality of life questionnaire comprised of items evaluating sleep quality, stress levels, memory, physical activity level, nutrition, social engagement, and general satisfaction. The *Mini Mental State Exam (MMSE)* (Folstein et al., 1975) and eight subtests of the *Arizona Battery for Communication Disorders of Dementia (ABCD)* (Bayles & Tomoeda, 1993) were used for formal assessment.

The *Mini Mental State Exam (MMSE)* (Folstein et al., 1975) is a cognitive screening tool used to briefly screen the level of potential cognitive impairment. Administration is brief, taking approximately 10 minutes. Thirty total points are possible. Questions are intended to screen temporal and spatial orientation, verbal memory, visuospatial construction, linguistic expression, linguistic comprehension, and calculation abilities. Those who scored less than the single cutoff score of 24 were considered to be abnormal.

The *Arizona Battery for Communication Disorders of Dementia (ABCD)* (Bayles & Tomoeda, 1993) is a standardized, comprehensive assessment of cognition and language. It consists of 14 subtests that evaluate verbal episodic memory, language comprehension, language expression, visuospatial skills, and mental status. Subtests are standardized independently, and therefore can be administered individually or collectively. Likewise, results can be interpreted as an overall score, or as scores on individual subtests. Eight subtests were selected from the domains of verbal episodic memory, language comprehension, language expression, and visuospatial construction. These eight subtests were selected due to previous research that has shown them to be particularly sensitive to the cognitive-linguistic hallmarks of mild cognitive impairment specifically (McCullough & Bayles, 2017). Two selected subtests assessed verbal episodic memory (Story Retell—Immediate and Story Retell—Immediate), two assessed language comprehension (Repetition and Following Commands), three assessed language expression (Generative Naming, Confrontation Naming, and Concept Definition), and one assessed visuospatial construction (Generative Drawing). The distribution of subtests among these four domains is summarized in Table 2. It should be noted that the *ABCD* is not an assessment of intelligence, and therefore the administered tasks should not pose a challenge for those that are cognitively healthy and typical. As participants reported no history of concomitant neurological and psychiatric disorders, variables related to additional neurological differences should not have confounded the participants' test performance.

Table 2: Cognitive Domains Assessed by the Selected *ABCD* Subtests

Verbal Episodic Memory	Language Comprehension	Language Expression	Visuospatial Construction
Story Retell—Immediate	Repetition	Generative Naming	Generative Drawing
Story Retell—Delayed	Following Commands	Confrontation Naming	
		Concept Definition	

Intervention

Following preliminary testing, participants engaged in the LEAP-COG's therapeutic, group-based cognitive-linguistic intervention curriculum for eight weeks. This group therapy curriculum provides language stimulation, education, active social engagement, and patient-centered strategies intended to enhance general cognitive function and overall mental health. The content of the LEAP-COG intervention program is based on neuroscience-supported methodology designed to both capitalize on neuroplasticity, and build cognitive reserve with the intention to delay or prevent further cognitive decline. The curricular features include: (1) cognitive stimulation activities with graduated difficulty, (2) direct and indirect training, (3) cognitive wellness education, including diet, exercise, sleep, stress reduction, and mindfulness training, (4) active social engagement, (5) client-centered strategies to enhance memory, language, attention, and executive function, (6) weekly homework to consolidate learning, (7) objective and subjective measures of progress, and (8) booster sessions four and eight weeks post program for the transfer of training. LEAP-COG is comprised of ten sessions designed to last 90 to 120 minutes, and two follow up “booster” sessions; however, the curriculum allows for modification to suit different timelines or individual needs. The general LEAP-COG session format progresses as follows: (1) welcome/ice breaker for five minutes, (2) agenda overview and goal setting for five minutes, (3) cognitive fitness education for 15 minutes, (4) relaxation and mental control exercises for ten minutes, (5) cognitive-linguistic stimulation for 30 minutes, (6) active social engagement for 20 minutes, (7) personalized practical strategies for 15 minutes, and (8) homework assignments for five minutes.

Following the eight-week treatment period, assessment resumed. The formal assessments used in the preliminary phase were re-administered (*MMSE* and *ABCD*). Results were analyzed and interpreted using descriptive statistics to determine the effectiveness of treatment.

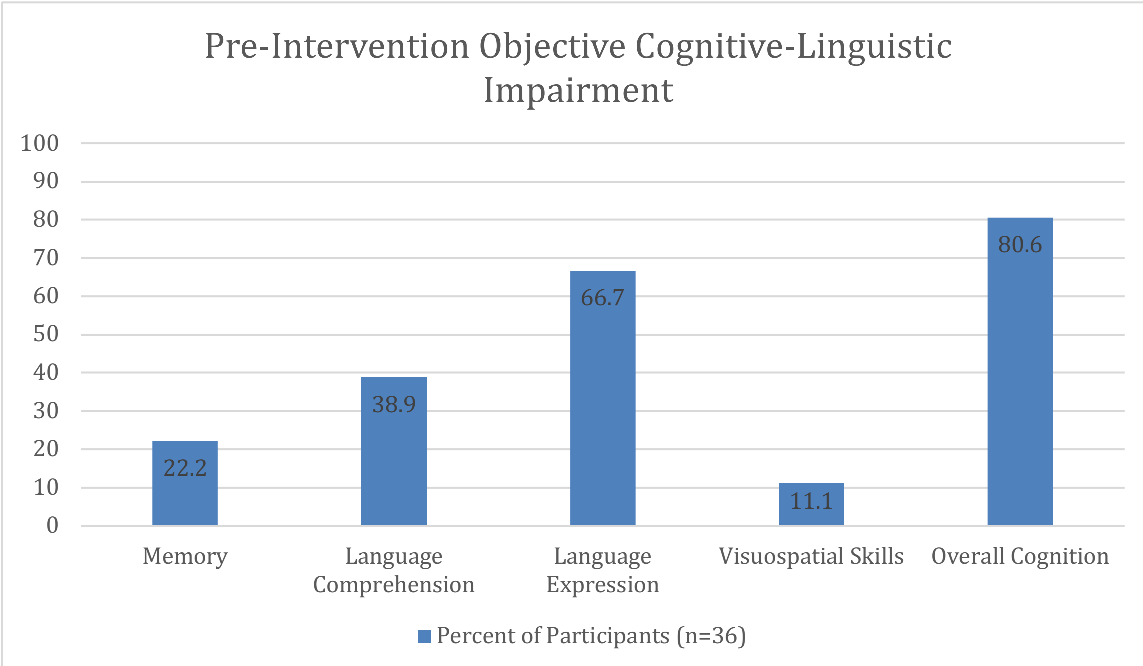
Results

Research Question 1

A single group, pre/post-test experimental design was used. Research Question 1 was addressed to determine the degree to which the participants were experiencing cognitive-linguistic impairment: “Will seniors at risk for cognitive impairment demonstrate deficits in cognition and language as determined by performance on a standardized cognitive-linguistic assessment?”

Results are summarized in Figure 1.

Figure 1: Pre-Intervention Objective Cognitive-Linguistic Impairment



It was determined that 22.2% (n=8) of participants presented with an impairment of memory, as determined by an impaired score on one or both *ABCD* subtests of memory (Story Retell—Immediate and Story Retell—Delayed). Thirty-nine percent (38.9%, n=14) presented with an impairment of language comprehension, as determined by an impaired score on one or both corresponding *ABCD* subtests (Following Commands and Repetition). Sixty-seven percent (66.7%, n=24) were determined to have an impairment of language expression, as determined by an impaired score on one or more corresponding *ABCD* subtest (Concept Definition, Generative Naming, and Confrontation Naming). Eleven percent (11.1%, n=4) were determined to have an impairment of visuospatial skills as determined by an impaired score on the corresponding *ABCD* subtest (Generative Drawing). Finally, 80.6% (n=29) of participants presented with an impairment of one or more assessed domain (memory, language comprehension, language expression, and visuospatial skills) as determined by an impaired score on one or more of the eight administered *ABCD* subtests previously named. Therefore, it was concluded that in addition to being at risk for cognitive impairment due to self-reported cognitive complaint, the majority of participants additionally presented with an objective cognitive impairment in one or more domain of cognition.

Research Question 2

Data was analyzed using paired samples t-tests. Statistical outliers were identified and removed from the data set prior to all statistical analysis. Paired samples t-tests were conducted for pre and post-test group means for the *MMSE*, and all eight administered *ABCD* subtests: Story Retell—Immediate, Following Commands, Repetition, Generative Naming, Confrontation Naming, Concept Definition, Generative Drawing, and Story Retell—Delayed. Alpha level was set to 0.05 for all t-tests. A p-value that was ≤ 0.05 was determined to be statistically significant.

The results of paired samples t-tests were as follows:

MMSE: There was not a statistically significant difference in the scores for pre-test (M=29, SD=1.3) and post-test (M=29.03, SD=1.42) conditions; $t(32) = -0.2$, $p = 0.85$. The null cannot be rejected.

Story Retell—Immediate (Verbal Episodic Memory)*:* There was not a statistically significant difference in the scores for pre-test (M=13.53, SD=2.48) and post-test (M=13.97, SD=2.24) conditions; $t(33) = -1.08$, $p = 0.29$. The null cannot be rejected.

Following Commands (Language Comprehension)*:* There was not a statistically significant difference in the scores for pre-test (M=8.64, SD=0.64) and post-test (M=8.5, SD=0.7) conditions; $t(35) = 0.96$, $p = 0.34$. The null cannot be rejected.

Repetition (Language Comprehension)*:* There was a statistically significant difference in the scores for pre-test (M=65.74, SD=7.72) and post-test (M=68.79, SD=5.36) conditions; t(33) = 0.96, p = 0.01. The null can be rejected.

Generative Naming (Language Expression)*:* There was not a statistically significant difference in the scores for pre-test (M=8.69, SD=2.45) and post-test (M=9.23, SD=2.54) conditions; t(34) = -1.05, p = 0.30. The null cannot be rejected.

Confrontation Naming (Language Expression)*:* There was not a statistically significant difference in the scores for pre-test (M=19.46, SD=0.74) and post-test (M=19.68, SD=0.55) conditions; t(27) = -1.8, p = 0.08. The null cannot be rejected.

Concept Definition (Language Expression)*:* There was a statistically significant difference in the scores for pre-test (M=47.13, SD=10.11) and post-test (M=53.78, SD=5.37) conditions; t(31) = -3.80, p = 0.00. The null can be rejected.

Generative Drawing (Visuospatial Construction)*:* There was a statistically significant difference in the scores for pre-test (M=12.84, SD= 1.34) and post-test (M=13.32, SD=0.94) conditions; t(30) = -2.18, p=0.04. The null can be rejected.

Story Retell—Delayed (Verbal Episodic Memory)*:* There was not a statistically significant difference in the scores for pre-test (M=13.52, SD=2.11) and post-test (M=14.15, SD=2.24) conditions; t(32) = -1.84, p = 0.07. The null cannot be rejected.

In addition to parametric tests, average change in score was calculated for the *MMSE* and the 8 *ABCD* subtests in order to determine what percent of participants improved their baseline score. Graphs reporting these results can be found in Figures 2-10. These results are summarized as follows:

MMSE: 25.7% increased; 48.6% maintained; 25.7% decreased

Story Retell—Immediate: 50.0% increased; 16.7% maintained; 33.3% decreased

Following Commands: 13.9% increased; 58.3% maintained; 27.8% decreased

Repetition: 63.9% increased; 11.1% maintained; 25.0% decreased

Generative Naming: 52.8% increased; 5.5% maintained; 41.7% decreased

Confrontation Naming: 34.3% increased; 54.3% maintained; 11.4% decreased

Concept Definition: 68.6% increased; 5.7% maintained; 25.7% decreased

Generative Drawing: 29.4% increased; 58.8% maintained; 11.8% decreased

Story Retell—Delayed: 50.0% increased; 13.9% maintained; 36.1% decreased

Figure 2: Post-Intervention Results: *MMSE*

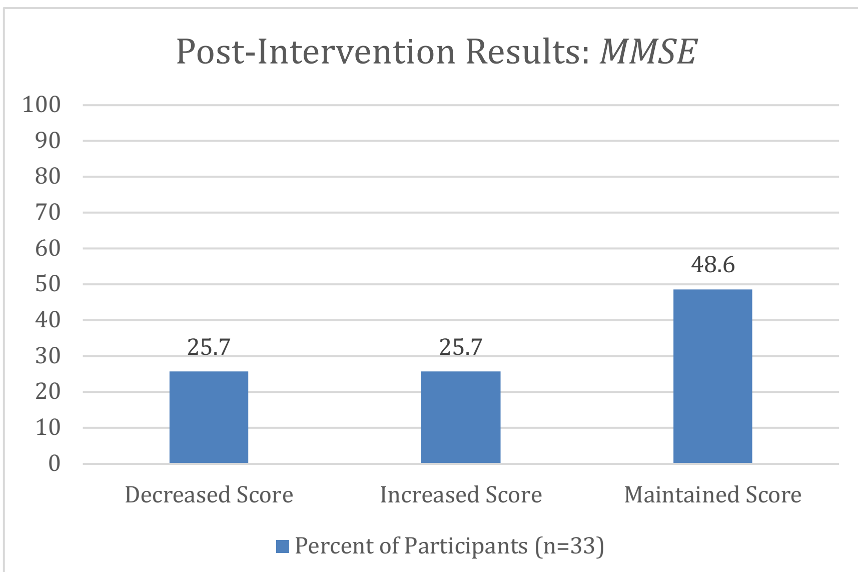


Figure 3: Post-Intervention Results: Story Retell— Immediate

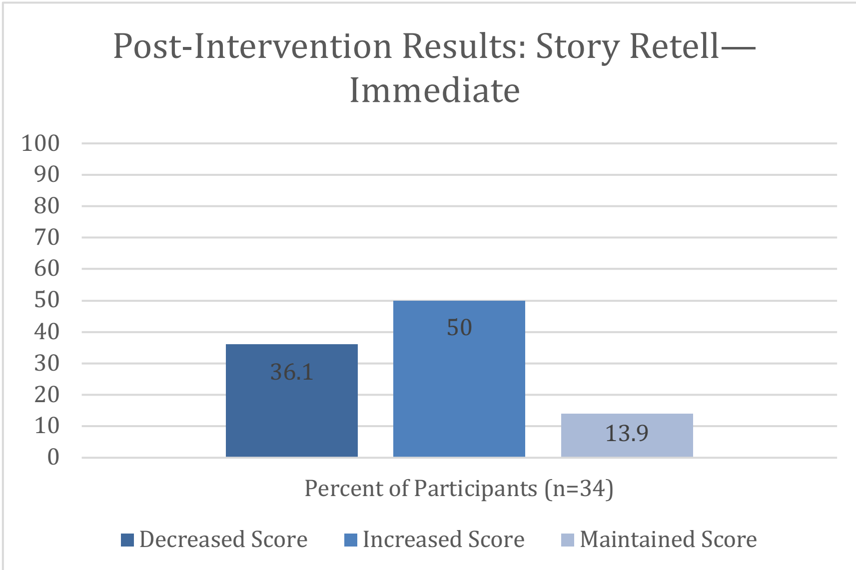


Figure 4: Post-Intervention Results: Following Commands

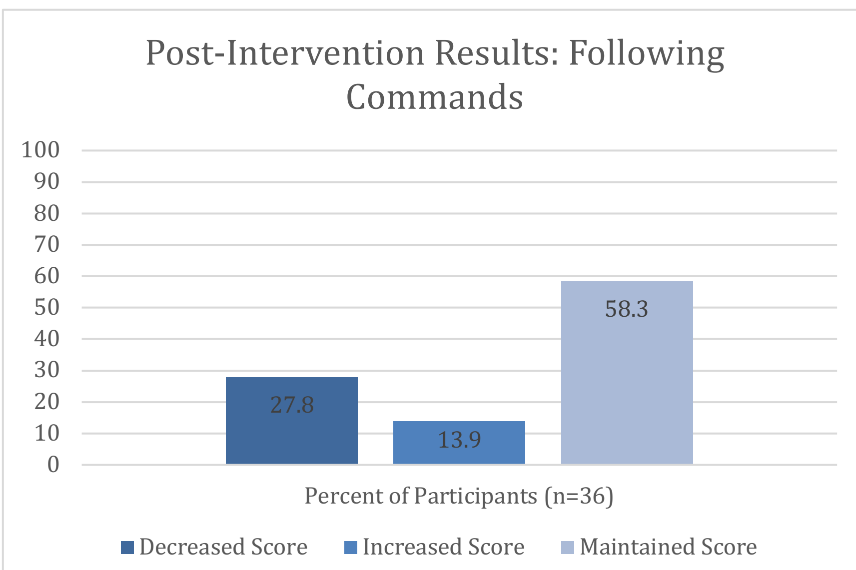


Figure 5: Post-Intervention Results: Repetition

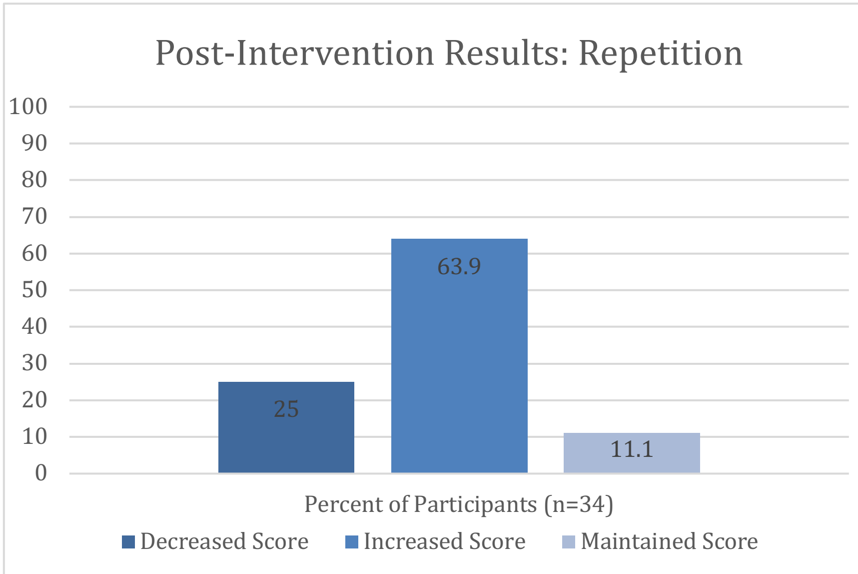


Figure 6: Post-Intervention Results: Generative Naming

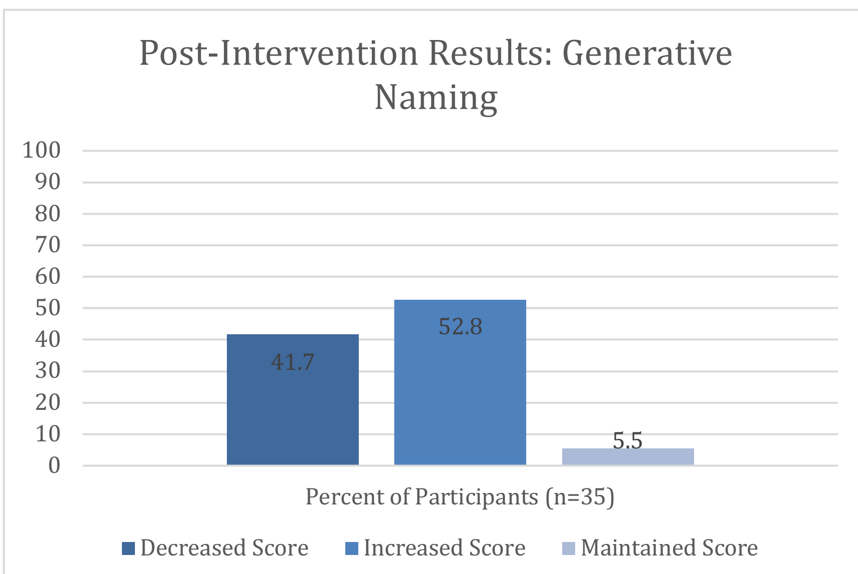


Figure 7: Post-Intervention Results: Confrontation Naming

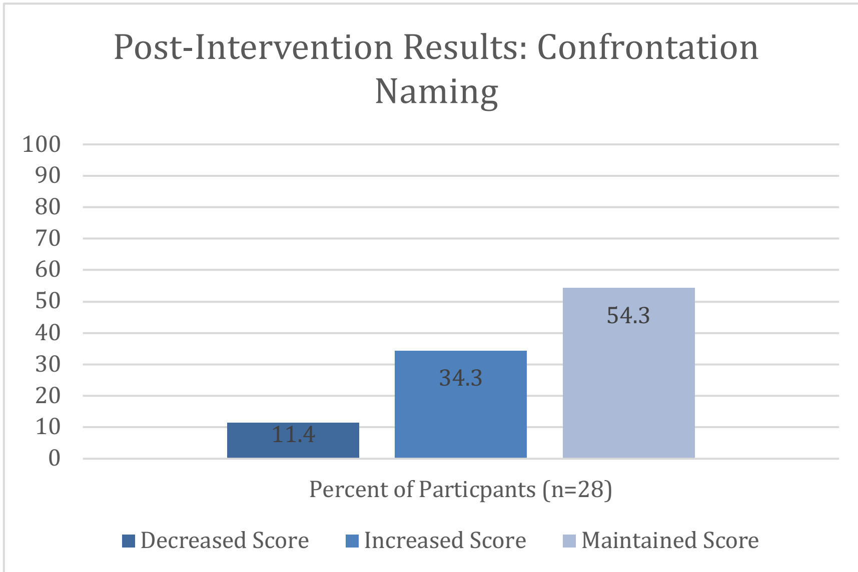


Figure 8: Post-Intervention Results: Concept Definition

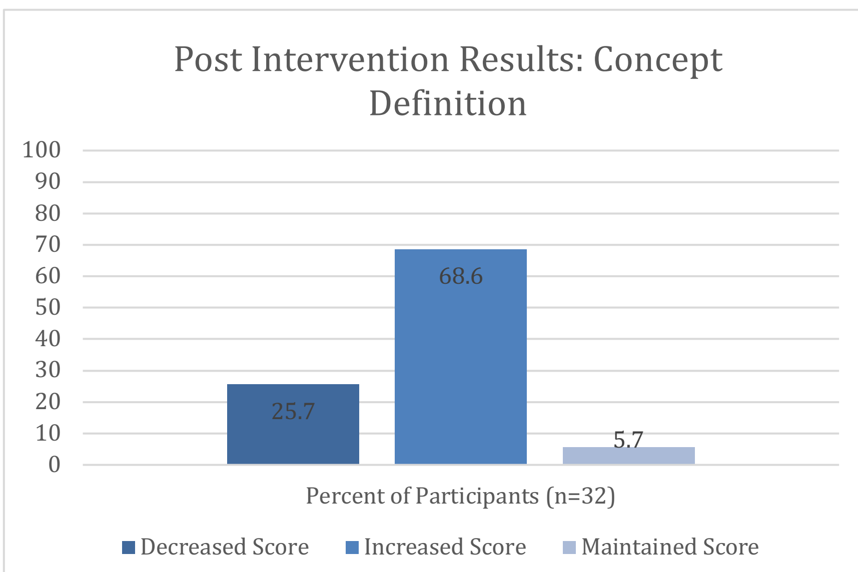


Figure 9: Post-Intervention Results: Generative Drawing

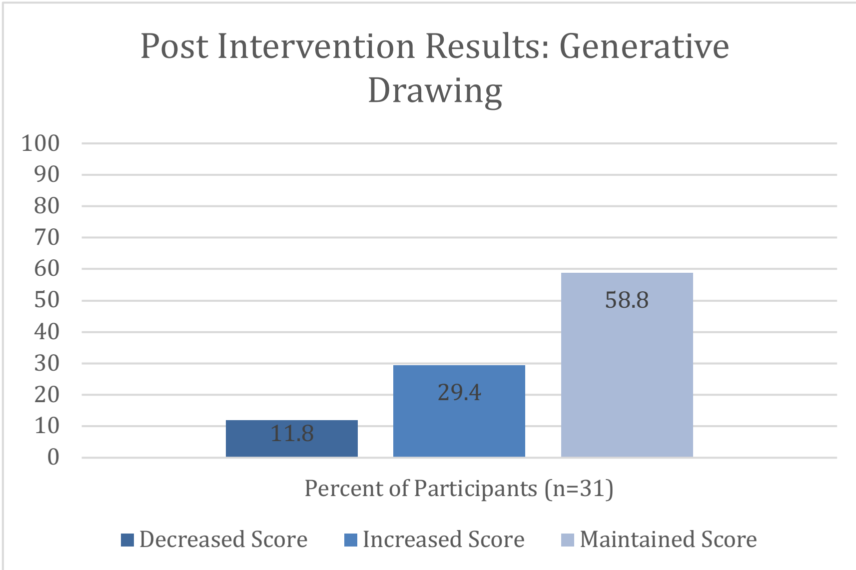
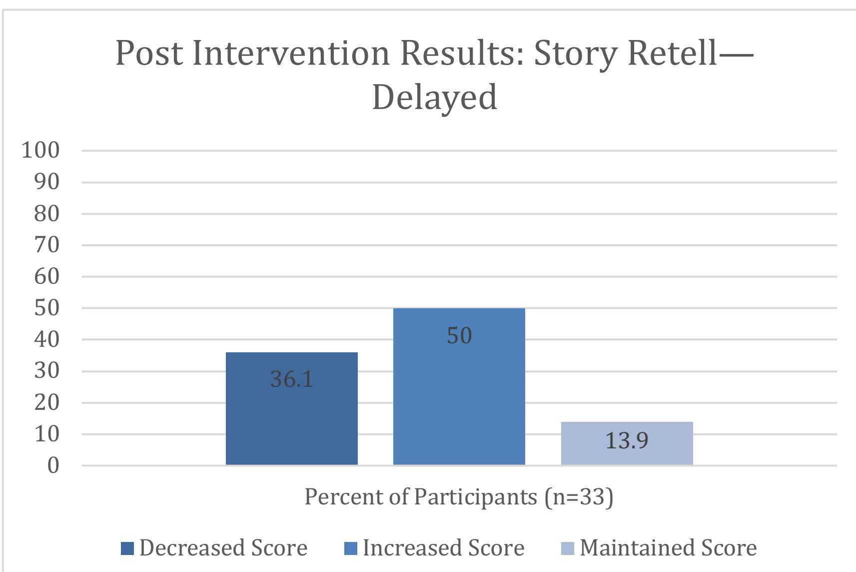


Figure 10: Post-Intervention Results: Story Retell—Delayed



Participants were asked to complete a self-reported quality of life questionnaire pre and post intervention related to attention, sleep quality, memory, social life, nutrition, and other elements of general health. It was found that the design and format of the questionnaires resulted in confusion and incomplete responses among participants. It was deemed that this data was not reliable, and therefore these questionnaires were not analyzed further. However, qualitative data was collected related to participants' self-reported generalization of intervention strategies. Upon completion of the program, participants completed a Likert scale (1-10) on which they rated how likely they were to generalize LEAP-COG techniques in the future, ranging from Very Unlikely (1-2), Unlikely (3-4), Neutral (5-6), Likely (7-8), and Very Likely (9-10). Results were as follows:

Very Unlikely: 0.0%

Unlikely: 0.0%

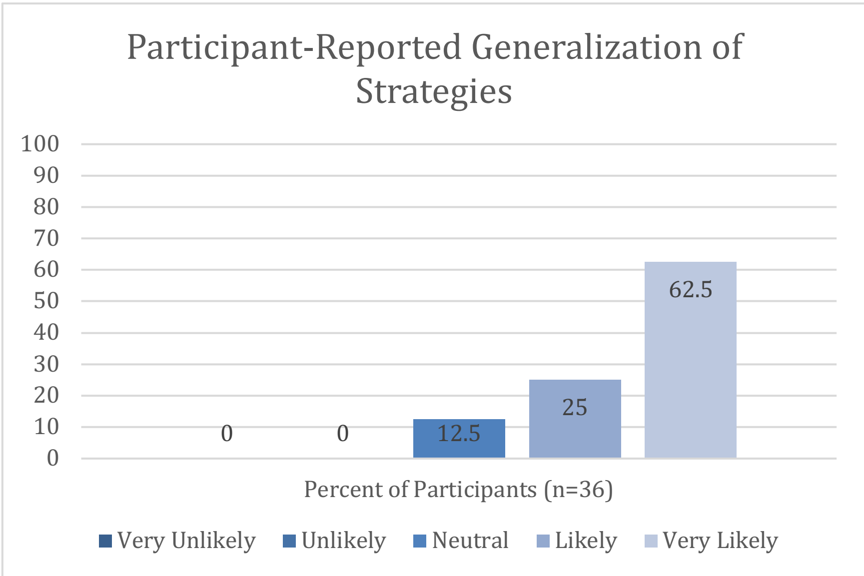
Neutral: 12.5%

Likely: 25.0%

Very Likely: 62.5%

These findings are summarized in Figure 11.

Figure 11: Participant-Reported Generalization of Strategies



Discussion

Statistically significant differences were found on three *ABCD* subtests: Repetition, Concept Definition, and Generative Drawing. These results suggest that language comprehension, language expression, and visuospatial skills were significantly improved following participation in group-based, cognitive-linguistic intervention program. Results nearing statistical significance were additionally found on two *ABCD* subtests: Confrontation Naming and Story Retell—Delayed. These results suggest that positive improvements in memory function and language expression were seen following participation in the same program. As the aforementioned areas are all constructs of global cognition, it can be stated that significant cognitive improvements were seen on primary assessment measures following participation in cognitive intervention, results that are supported by recent studies of similar nature (Belleville et al., 2018; Mendoza Laiz, Del Valle Díaz, Rioja Collado, Gomez-Pilar, & Hornero, 2018; Savulich et al., 2017; Sherman, Mauser, Nuno, & Sherzai, 2017).

It should be noted that the descriptive statistics conducted during data analysis measured *improvements* in scores following completion of the intervention program. However, the degree to which participants *maintained* their baseline level of functioning is salient. As previously discussed, cognitive-linguistic interventions seek to both improve and maintain cognitive abilities; therefore, it should be considered that while statistically significant improvements were not reported in all subtests, many participants maintained baseline performance. The percentage of participants that maintained or improved their baseline scores following the program are as follows: *MMSE*= ~74%, Concept Definition=

~74%, Following Commands= ~72%, Generative Naming= ~58%, Repetition= ~75%, Confrontation Naming= ~89%, Generative Naming= ~72%, Story Retell—Immediate= ~67%, and Story Retell—Delayed= ~64%. Therefore, the majority of participants maintained or improved their baseline score for all nine assessment measures, regardless of statistical significance. Some might argue that the assessment and intervention periods were not long enough to reasonably expect participants to demonstrate decline from baseline. However, due to the fact that there was a percentage of participants that did decline within the assessment and intervention period, it can be argued that decline can be demonstrated in this amount of time in a percentage of the population.

The degree to which participants reported the intention to generalize learned strategies upon completion of the program was encouraging and speaks to the positive impact that that participants felt the intervention had on their cognitive health. Approximately 88% of participants reported that they were either likely or very likely to continue to apply learned intervention strategies. As previously discussed, individuals with probable MCI are generally self-aware of their cognitive abilities, making them capable of self-monitoring their abilities and the effectiveness of intervention strategies. Therefore, nearly all participants reporting that they were either likely or very likely to continue to apply intervention strategies contributes to the merit and of the observed positive results and their potential for longevity. Similar generalization results were seen in a study conducted by Belleville et al. (2018), who report sustained improvements and generalization of learned strategies persisting over a six-month period following cognitive training.

Several limitations of this study exist as a natural byproduct of the experimental design. First, due to the lack of a control group, the single-group pretest/posttest design of this study does not allow the researchers to eliminate environmental effects such as the passing of time, test/retest effects, which limits the external validity of the study. It cannot be definitively said that the improvements observed in the areas of linguistic expression, linguistic comprehension, and visuospatial construction were not confounded by external factors. Second, ~89% of participants self-identified as white, and all participants spoke English as a first language. Nearly half of the participants (47.2%) had 13-16 years of education, meaning a high school diploma with the addition of one to four years of post-secondary education. Therefore, the studied population was neither culturally nor linguistically diverse and was highly educated. As education is neuroprotective and builds cognitive reserve, the participants' mean education may have influenced pre- and post-intervention cognitive-linguistic function. However, mean age was 80, and advanced age is a known risk factor for MCI (Keyimu, Zhou, Miao, & Zou, 2015). While educational status may have influenced cognitive-linguistic abilities positively, advanced age had the potential to have a negative influence. These factors should be taken into consideration. Finally, the intervention and assessment period were short.

These results can only be applied and discussed in terms of studied population and participants and cannot be generalized to the public at large at this time without further study. While the results of this study are supported by a solid literature base, discretion should be used when generalizing the results at hand. It is recommended that further study of the LEAP-COG program be conducted with the incorporation of a control group to control for the potential of confounding external variables such as time. Additionally, researchers and participants provided constructive feedback regarding ways in which the program could be fine-tuned for increased user-friendliness and cohesiveness. For example, the subjective quality of life questionnaires that were previously mentioned were deemed confusing and poorly organized by researchers and participants alike. These observations contributed to these questionnaires being deemed unreliable for statistical analysis due to unreliable responses that at times could not be interpreted. It is recommended that these elements of the program be streamlined and made more user-friendly before future study is conducted.

Conclusions

Seniors "at-risk" for cognitive impairment demonstrated impaired cognition and language as determined by their performance on a standardized cognitive-linguistic assessment. Statistically significant differences were found in assessment measures of language comprehension, language expression, and visuospatial construction following participation in a cognitive-linguistic intervention program. Near statistically significant differences were found in assessment measures of verbal episodic memory. These results suggest that language and visuospatial skills were significantly improved following participation in the group-based, cognitive-linguistic intervention program, LEAP-COG.

These results support the hypothesis that group-based, cognitive-linguistic intervention programs, such as LEAP-COG, have the potential to maintain and improve cognitive-linguistic functioning by encouraging socially, communicatively, and neurologically healthy lifestyles, results that support previously-conducted literature. Additional research is both merited and necessary in order to deepen the understanding of the impact of cognitive-linguistic intervention on the cognitive abilities of elders at risk for impairment and decline.

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Vita

Madelyn Leigh Elliott was born in Olathe, Kansas in 1994 to Paula and Jeff Sharp. Her family moved to Greensboro, North Carolina in 1998. She graduated from Caldwell Academy in 2012, a classical, Christian school in the area. In 2012, Mrs. Elliott entered Appalachian State University as a freshman. In May of 2016, she was awarded a Bachelor of Science in Communication Science and Disorders and a minor in Spanish.

Mrs. Elliott began her graduate study at Appalachian State University that same year. She was the recipient of the Lovill Fellowship awarded by the Cratis D. Williams School of Graduate Studies. The Lovill Fellowship is the highest academic award given to a single entering graduate student each year. She served two academic years as a Graduate Research Assistant Mentee (GRAM) to Dr. Kim McCullough, assisting with the research that prompted this thesis study. Mrs. Elliott won 1st place in ASU's annual Three Minute Thesis (3MT) competition in the fall of 2016 and went on to represent the university as a finalist in the 3MT competition at the Conference of Southern Graduate Schools in Annapolis, Maryland. Mrs. Elliott received her Master of Science in Speech-Language Pathology in May of 2018. She represented the graduate students of the Beaver College of Health Sciences as the student commencement speaker during her graduation ceremony. She currently resides in North Carolina with her husband, Jonathan.