2019

Evaluation of a Cognitive Training Program and its Effects on Healthy Older Adults

Nathan Jensen
Minnesota State University, Mankato

Evaluation of a Cognitive Training Program and its Effects on Healthy Older Adults

By

Nathan Jensen

A Thesis Submitted in Partial Fulfillment of the

Requirements for the Degree of

Master of Arts

In

Clinical Psychology

Minnesota State University, Mankato

Mankato, Minnesota

May 2019

May 7, 2019

Evaluation of a Cognitive Training Program and its Effects on Healthy Older Adults

Nathan Jensen

This thesis has been examined and approved by the following members of the student's committee.

Advisor
Jeffrey Buchanan, PhD

Committee Member
Sheen Chiou, PhD

Committee Member
Karla Lassonde, PhD

Abstract

As one ages, some degree of cognitive decline is expected. Despite this, declines in cognitive abilities and the possibility of dementia is a common concern among older adults. In response to these concerns, a variety of cognitive training programs have been developed that aim to improve or maintain cognitive functioning. Prior literature has shown mixed or limited findings on cognitive changes after implementation of cognitive training. This study evaluated the effectiveness of a cognitive training program designed for older adults with no to minimal cognitive decline. The current study included 18 participants who engaged in two one-hour cognitive training sessions each week for 12 weeks. Each session required participants to complete activities that targeted the following cognitive domains: attention, visual and verbal memory, visual spatial skills, processing speed and executive functioning, and language. These cognitive domains, along with depression and memory self-efficacy, were assessed prior to and immediately after completion of the program. Across participants, improvement occurred on 12 measures following participation in the cognitive training program, while stability occurred on four measures. These findings provide preliminary support for the use of a comprehensive cognitive training program for cognitively intact older adults.

Table of Contents

Introduction..…………………………………………………………………………....1
Method……..……………………………………………………………………………5
Results……..………………………………………………………………………....13
Discussion…..…………………………………………………………………...…...15
References…..………………………………………………………………....…..21
Appendix…..……………………………………………………………...…....25

Introduction

Cognitive Decline vs. Cognitive Impairment

Age-related cognitive decline is a normal aging process that involves a decrease in cognitive abilities. While there is some variability, most individuals begin experiencing age-related cognitive decline in their 50s and 60s. These decreases tend to occur in domains of fluid intelligence, which includes abilities involving problem-solving, reasoning, and manipulating new information. Cognitive domains that fall under fluid abilities include processing speed, executive functioning, and some domains of memory (e.g., immediate, semantic, episodic). On the other hand, crystallized intelligence, which is the general knowledge gained throughout life including skills and abilities learned through practice, tend to show no change as people age. Some types of memory (e.g., procedural) and language (e.g., vocabulary) are examples of crystallized abilities that tend to remain stable in late life (Harada, Natelson Love, & Triebel, 2013).

In contrast to age-related cognitive decline, cognitive impairment is not a typical aging process; it is a more severe form of cognitive decline that often falls between age-related cognitive decline and dementia. Furthermore, individuals with cognitive impairment are at an increased risk to a further decrease in cognitive functioning (Peterson, 2011). Some common manifestations of cognitive impairment can consist of memory problems, confusion, and poor problem solving skills. This distinction between cognitive decline and impairment is important as the current study includes individuals with normal age-related cognitive decline.

Age-related cognitive decline typically does not cause significant impairment in daily functioning (Salthouse, 2012). However, many older adults fear that normal declines in memory or other cognitive domains may be indicative of Alzheimer's disease or related conditions. This is not surprising given that Alzheimer's disease is one of the most debilitating and prevalent diseases in the U.S. and it is without a cure. Thus, Alzheimer's disease and memory loss in general are very common fears that many adults experience as they get older (Ostergren, 2017). In fact, 35% of older adults report that losing their memory is their top concern about aging (National Council on Aging, 2015). A solution to reducing that fear would be combating cognitive decline and impairment by developing interventions that slow cognitive decline. There are many commercially available "brain training" programs that claim to be beneficial, but have little empirical support and are marketed in such a manner as to take advantage of a vulnerable population (Simons et al., 2016). However, researchers have developed cognitive training programs that show promise in altering cognitive decline.

Cognitive Training

Cognitive training is a non-pharmacological method that aims to help older adults maximize their memory and cognitive functioning despite any cognitive decline or impairment they are experiencing (Bahar-Fuchs, Clare, & Woods, 2013). It encompasses guided practice on a standardized set of tasks that reflect cognitive functions, such as memory, attention, and problem-solving. The goal of cognitive training is to improve, or at least maintain, functioning in a given cognitive domain through practice and reinforcement of skill acquisition. The potential benefits of cognitive training are assumed to occur based on the general hypothesis that the brain is plastic throughout our lives (Hertzog, Kramer, Wilson, & Lindenberger, 2008).

Research has shown that structured cognitive training programs can results in benefits for older adults without cognitive impairment. For example, the Advanced Cognitive Training for Independent and Vital Elderly (ACTIVE; Ball et al., 2002) study tested three different cognitive interventions in improving older aged adults' cognition on daily activities, such as preparing food, driving, and managing finances. Over 2,800 cognitively intact adults ranging in age from 65 to 94 participated in this study. Participants were randomly placed in one of four groups: memory training, reasoning training, speed of processing training group, or a control group. Participants in the three intervention groups received ten one-hour long sessions over 5-6 weeks where they engaged in cognitive activities. There was also a booster training 11 months after the initial one was provided, which was delivered in four 75-minute sessions over two weeks. There was a reliable improvement for 87% of participants in the speed of processing trained group, 74% in the reasoning trained group, and 26% in the memory trained group. Reliable improvement was classified by exceeding baseline scores by one standard error of measurement.

Two follow-up studies examined if the benefits found in the Ball et al. (2002) study maintained over time. The 5-year follow-up found that the reasoning group had significantly less difficulty in activities of daily living, but neither the speed of processing nor the memory groups increased nor decreased in performance (Willis, Tennstedt, & Marsiske, 2014). The 10-year follow-up found that the three intervention groups reported less difficulty in daily living activities compared to the control group (Rebok et al., 2014). In addition, the speed of processing and reasoning groups maintained their levels in performance.

Another study evaluated an experimental training group in 182 cognitively intact older adults between the ages of 60-87 years old. The primary outcome measure was the Repeatable Battery for the Assessment of Neuropsychological Status (RBANS; Mahncke et al., 2006). Participants were randomly assigned to one of three groups: experimental training, active control activity, and a no-contact control group. The experimental training group worked on cognitive training exercises for an hour a day, 5 days a week, for 8-10 weeks. Participants were engaged in six different tasks, such as answering questions to short narratives or reconstructing spoken words or instructions. The active control group had the same amount of sessions, but watched an educational lecture instead. After the interventions were completed, all three groups showed an improvement in measures of memory function, but statistically significant results were only found for the experimental training group.

Tesky, Thiel, Banzer, & Pantel, (2011) evaluated a cognitive training program, called AKTIVA, which included educational sessions on age-related changes, coping strategies, and games and exercises for cognitive stimulation. Participants included 307 cognitively intact older adults who were randomly assigned in a 3-group design, with two intervention groups and a control group. Both intervention groups received training in the AKTIVA program, but the second intervention group also received a nutritional and physical education program. There were eight weekly sessions with two booster sessions four months later. Participants in both intervention groups showed significant improvement in subjective memory decline. Additionally, adults over the age of 75 showed a significant improvement on information processing speed.

A recent review investigated brain-training products developed by different companies that are marketed to older adults (Simons et al., 2016). The term “brain-training”, “brain games”, and “mental aerobics” are public-friendly terms that have similar goals as cognitive training. One example is Nintendo’s Brain Age game, which claimed that completing a few challenging exercises and puzzles a day would improve brain function. This game showed many forms of pseudoscience, including a science-like language with neurological and psychological terms to persuade the public. It is important to note that none of their information was cited and were mostly making false claims, as they showed no measureable benefits. Another example of a brain-training product is Lumosity, which supplies some challenging games that are meant to stimulate the brain and enhance cognition. The games are said to be based on well-established tasks in cognitive psychology. However, there seems to be a lack of connection between the games and research-based tasks. After examination of 132 papers that were cited by brain-training products, this review claimed that there is not sufficient evidence that brain training is effective at enhancing cognition in a natural environment (Simons et al., 2016). Many studies did not have reliable and measureable constructs or just did not fully report and analyze outcomes.

Purpose of the Study

The purpose of the current study was to expand the literature in investigating the effectiveness of cognitive training programs for older adults who fall into a cognitively intact level of functioning. One unique aspect of the cognitive training program utilized in this study is that it was a comprehensive program, meaning that it attempted to "exercise" all six primary cognitive domains (i.e., processing speed, attention/concentration, verbal memory, language, visuospatial skills, and executive functioning/problem solving). In addition, the "dose" of cognitive training was somewhat greater than other studies in terms of the number and length of cognitive training sessions. Based on prior literature, we expected to find improvements in memory and processing speed after implementation of a cognitive training program. Additionally, it was hypothesized that there would be a decline in depressive symptoms (Brum, Forlenza, & Yassuda, 2009).

Method

Participants

Participants for the current study were recruited from a senior living facility within a convent located in a small Midwestern metropolitan area in the United States. Participants were recruited by facility staff who identified residents with minimal to no cognitive impairment and may be interested in being involved in a cognitive training program. To meet inclusion criteria for the study, participants were required to achieve a score of 78 or above on the Modified Mini-Mental Status Examination (3MS; Teng & Chui, 1987) indicating mild cognitive decline to intact cognitive abilities. Participants were excluded from the study if their 3MS score fell below 78, or if they had a serious health problem or disability (e.g., visual or hearing deficits, impaired motor skills, significant language impairment) that could impair their ability to engage in cognitive training sessions.

Participants included 18 individuals that met criteria and gave consent to participate in the study. The 3MS assessed prior to the cognitive training program resulted in scores ranged from 81 to 97 (out of a possible score of 0 to 100), with an average score of 92.24 (SD = 4.63). However, one participant requested to drop out prior to completing the cognitive training program as she was having difficulty with the activities. All participants were Caucasian nuns with at least a bachelor's degree. The participants ranged in age from 71-93 years old (M = 82.82, SD = 7.30).

After the cognitive training program was completed, nurses and staff members met with each participant individually to review medical charts, including any diagnoses or medications for anxiety, depression, or chronic pain. Information from these medical charts were examined because they could impact the participants' ability to complete the *Mind Sharpener* program. Of the 17 participants that completed the study, seven had a diagnosis of depression with five of them routinely taking antidepressants. Four individuals took cholinesterase inhibitors for diagnoses of Alzheimer's disease, dementia, or mild cognitive impairment. One took an anxiolytic for anxiety. One individual took anti-inflammatory and pain reliever medication for chronic pain. Lastly, one individual is diagnosed with Parkinson's disease. Medical information was unable to be accessed for one individual as she passed away following the study. It is important to note that all participants still scored above the minimum criteria on the 3MS (a score of 78) to be included in the study.

The presence or absence of a neurocognitive disorder, however, was not an exclusion criterion. This was the case because staff reported that some individuals appeared to be a good fit for the program and met all inclusion criteria despite having a diagnosis of a neurocognitive disorder. Likewise, staff observed that other individuals appeared to be experiencing genuine cognitive decline, but for a variety of possible reasons did not have a formal diagnosis of neurocognitive disorder. Said another way, it became clear that diagnostic status was likely an imperfect indicator of the severity of cognitive impairment and because this was a pilot investigation, the researchers decided that inclusion would be based on severity of cognitive impairment as estimated by the 3MS.

Experimental Design and Procedure

A pre-post quasi-experimental design was utilized to compare the change of various cognitive assessment scores before and after the cognitive training program. Follow-up cognitive assessments were also conducted three months after the cognitive training program ended to identify if cognitive levels maintained over time without cognitive training program implementation. The cognitive training program used in this study, *Mind Sharpener™*, was developed by the New England Cognitive Center (NECC), a non-profit organization devoted to the development and dissemination of programs related to cognitive enhancement. The program was designed to be appropriate for healthy adults without documented cognitive impairment (i.e., had no diagnosis of a neurocognitive disorder). Individuals appropriate for this program also often have subjective complaints about cognitive functioning (e.g., "My memory is not as sharp as it used to be") that do not interfere with completing daily activities.

The cognitive training program included 24, one-hour classes that were delivered twice a week over a twelve-week period. Classes were delivered in a group format, with groups ranging in size from 8-10 participants. Each class included a sequence of paper-and-pencil exercises/activities related to six cognitive domains: attention/concentration, language, problem solving/executive functioning, processing speed, short-term memory, and visuospatial skills. One to two activities were completed to target each cognitive domain within every session, totaling about eight activities per session. Depending on the activity that targeted a domain for a given session, each activity ranged from 5-12 minutes long. Activities within each domain gradually increased in difficulty as the program progressed, such that exercises in the final class were significantly more challenging than exercises in the first class. Participants completed most exercises individually after the class facilitator initially demonstrated the activity. As participants completed exercises, the class facilitators approached participants and provided assistance as needed.

Activity staff at each participating facility delivered the cognitive training program. Prior to the start of the study, all activity staff were trained in the delivery of the program by an NECC master trainer. A manual/sourcebook was included with the program that provided detailed instructions concerning how to deliver all 24 classes. If any further training was required or if any questions arose, NECC staff were readily available for consultation.

After participants consented to take part in the cognitive training program, cognitive tests and other measures were administered. Pre-testing occurred within one week prior to starting the cognitive training program and post-testing occurred within one week following the completion of the program. For data to be included in the analyses, participants needed to complete at least 75% of the cognitive training program sessions.

Materials and Instruments

A battery of neuropsychological tests was administered to assess cognitive domains targeted by the cognitive training program (i.e., processing speed, verbal and visual memory, attention/concentration, language, visuospatial skills, and executive functioning). In addition, participants completed measures of memory self-efficacy and depressive mood. Lastly, although the 3MS was originally used to screen for varying levels of cognitive impairment, it was also used as a measure of global cognitive ability. In order to reduce fatigue and optimize performance, the assessment battery was broken into two, 1-hour sessions. Tables 1 and 2 include a complete listing of all the measures used to assess cognitive and non-cognitive domains.

Global Cognitive Functioning

Modified Mini-Mental State Exam (3MS; Teng & Chui, 1987)

The 3MS is a brief test that assesses global cognitive function and is commonly used to screen for dementia and mild cognitive impairment. It measures a variety of cognitive domains (e.g., attention and concentration, short-term memory, visuospatial skills, etc.) and calculates a total score ranging from 0 to 100. Low scores indicate more severe cognitive impairment and high scores indicate minimal to no cognitive impairment. The 3MS has high internal consistency ($\alpha = 0.89$) and is sensitive to discriminating individuals with dementia versus those without (.94).

Attention/Concentration

Brief Test of Attention (BTA; Schretlen, 1997)

The BTA is a measure of divided attention. For this test, participants listen to a recording that reads a series of numbers and letters in a mixed order. After each trial, participants are required to identify how many numbers (or letters) they heard. To avoid participants using their fingers as an aid to count, they are asked to keep their hands flat on the table in front of the researcher. The BTA has high reliability (α = .82 - .91) and highly correlates with other tests that measure attention (Schretlen, 1997).

Forward and Backward Digit Span (Wechsler, 2008)

The forward digit span is a test of simple attention. Participants are read a list of number aloud, and then asked to repeat them in the exact order. The first trial consists of only two numbers that are read, but each trial progressively becomes longer as participants continue to respond correctly. The test ends once participants are unable to correctly repeat two numeric lists of the same length within a trial. The backward digit span is a measure of attention and working memory. The procedure is the same as forward digit span but requires participants to repeat the numeric lists in reverse order. The combination of these digit spans is administered within the Wechsler Adult Intelligence Scale – Fourth Edition (WAIS-IV; Wechsler, 2008).

Language

Boston Naming Test (BNT; Kaplan, Goodglass, & Weintraub, 1983)

The BNT is a test of visual confrontation naming and using language to retrieve object identification. This test requires participants to view 30 pictures of objects displayed one after the other and name the object. A semantic and phonemic cue is provided to the participants if they are unable to identify the object. This test has strong test-retest reliability and is highly correlated with measures of verbal fluency (Harry & Crowe, 2014).

Controlled Oral Word Association Test (COWAT; Benton & Hamsher, 1989)

The COWAT is a test of verbal fluency. In this test, participants are given one minute to state aloud as many words possible that begin with a certain letter. Proper nouns and suffix variations of a word (e.g., bed, beds, bedding) are not scored. In the pre-testing phase, the letters F and S are used in two separate trials. In the post-testing phase, the letters A and P were used. This test has strong test-retest reliability and is highly correlated with other neuropsychological assessments (Benton & Hamsher, 1989).

Memory

Brief Visuospatial Memory Test-Revised (BVMT-R; Benedict, 1997)

The BVMT-R is used to assess visual memory. Participants are provided with a pen and blank sheet of paper. After being shown a display of six figures for 10 seconds, they are asked to draw the figures the best they can and where each figure was positioned on the display. Three trials are completed requesting immediate recall of the display. After 20-25 minutes, a delayed recall portion is conducted, where participants are asked to draw the figures without seeing the display this time. Finally, a recognition trial is administered where participants are shown more figures one at a time and are asked to identify if each figure was or was not part of the original display. The BVMT-R has high test-retest reliability and highly correlates with other tests that measure learning and memory (Benedict, Schretlen, Groninger, Dobraski, & Shpritz, 1996).

Hopkins Verbal Learning Test - Revised (HVLT-R; Brandt & Benedict, 2001)

The HVLT-R is a test used to measure verbal memory. During this test, participants are read a list of 12 words and then immediately asked to repeat back as many as they can remember in any order. Three trials are completed requesting immediate recall of the list. To assess delayed memory recall, the participants are asked to say as many words as they can remember 20-25 minutes later after not hearing the list again. Lastly, a recognition trial is conducted where participants are read a longer list of words and asked to identify if the words were or were not on the original list. The HVLT-R is highly correlated with other verbal memory tests and is sensitive to discriminating individuals with varying levels of cognitive decline and impairment (Brandt & Benedict, 2001; Shapiro, Benedict, Schretlen, & Brandt, 1999).

Processing Speed

Trail Making Test Part A (Reitan & Davison, 1974)

Trail Making Test Part A is a test used to measure cognitive processing speed. For this test, participants are provided with a pen and a piece of paper containing numbers 1 through 25 in circles that are randomly scattered across the page. Participants are asked to start at the number 1, draw a line from 1 to 2, 2 to 3, and so on until they reach the end. In addition, they are requested to complete the task as fast as possible. Before starting the test, participants are provided a sample sheet with numbers 1 through 8 to ensure understanding. If an error is made during the task, the researchers would point out the error and guide the participants to the last correct position. This test is commonly used to detect brain dysfunction and is sensitive to detecting varying levels of cognitive decline and impairment (Llinàs-Reglà et al., 2017).

Executive Functioning

Trail Making Test Part B (Reitan & Davison, 1974)

Trail Making Test Part B is very similar to Part A but measures executive functioning and cognitive flexibility. Rather than participants drawing lines from number to number, they are required to alternate between numbers and letters. They are asked to draw a line from 1 to A, A to 2, 2 to B, B to 3, and so on until they reach the end. All other aspects between Parts A and B are the same. Part B may be more sensitive to cognitive differences that Part A as it requires participants to switch between two ways of thinking, known as set-shifting (Rasmusson, Zonderman, Kawas, & Resnick, 1998).

Visuospatial Skills

Visual Puzzles (Wechsler, 2008)

This is a test of visuospatial reasoning as it requires participants to mentally rotate and manipulate 2-D shapes. In this task, participants are shown a puzzle made up of a combination of three small shapes. Participants are required identify the three shapes that make up the puzzle from six selective options. Each trial progressively becomes more difficult, and in later trials, figures must get mentally rotated to form the puzzle. This test is administered as part of the Perceptual Reasoning Index within the WAIS-IV (Wechsler, 2008).

Other Measures

Cognitive Failures Questionnaire (CFQ; Broadbent, Cooper, FitzGerald, & Parkes, 1982)

The CFQ contains 25 items that assess participants' perceptions of their memory. Participants were asked how frequent minor cognitive errors occur in everyday life (e.g., forgetting faces or names, forgetting an appointment, etc.). The CFQ has high test-retest reliability and is positively correlated with other measures of memory self-report (Broadbent, Cooper, FitzGerald, & Parkes, 1982).

The Patient Health Questionnaire-9 (PHQ-9; Kroenke, Spitzer, & Williams, 2001)

The PHQ-9 contains nine items that assess the frequency and severity of recent depressive symptoms (e.g., under or overeating or sleeping, thoughts about failing others, etc.). The PHQ-9 has high internal reliability ($\alpha = 0.89$), high test-retest reliability, and is sensitive to discriminating varying levels of depression (Kroenke, Spitzer, & Williams, 2001).

Results

A repeated measures ANOVA was calculated for the seven participants that participated in pre-, post-, and follow-up measures. Bonferroni post-hoc comparisons were then conducted for each measure to make pairwise comparisons between pre-, post-, and follow-up measures. Mauchly's Test of Sphericity indicated that the assumptions of sphericity for the measures of Letter Fluency (COWAT), $\chi^2(2) = .274$, $p = .039$, and Delayed Verbal Fluency (HVLT), $\chi^2(2) = .174$, $p = .013$, had been violated. For these measures, a Greenhouse-Geisser correction was used to determine significance. Results for this analysis can be found in Table 3. Overall, the model showed significance for verbal recognition (HVLT) and visuospatial skills (Visual Puzzles). Verbal recognition displayed differences between pre- and post-measurement whereas visuospatial skills displayed differences between pre- and follow-up measurement.

Effect sizes (Cohen's d) were also calculated to estimate the clinical magnitude (i.e., clinical significance) of the differences between pre- and post-intervention measures. Means, standard deviations, and effect sizes of pre-, post-, and follow-up intervention measures can be found in Tables 4-6. Comparing pre- to post-measures for all 17 participants, large effect sizes were found for the following cognitive domains: immediate verbal recall ($d = 1.10$) and verbal recognition ($d = 0.93$). Moderate effect sizes were found for the following cognitive domains: divided attention ($d = 0.51$) and delayed verbal recall ($d = 0.61$). Small effect sizes were found for the following cognitive domains: global cognitive functioning ($d = 0.36$), working memory ($d = 0.28$), processing speed ($d = -0.36$), executive functioning ($d = -0.39$), immediate visual recall ($d = 0.37$), delayed visual recall ($d = 0.35$), visual recognition ($d = 0.27$), and visual-spatial skills ($d = 0.24$). Finally, no meaningful effect sizes were found for the following cognitive domains: simple attention ($d = 0.12$) and both measures of language abilities ($d = -0.13$, $d = 0.05$). In addition, there was a small effect size on the non-cognitive measure of depression (*d* = -0.26), but no effect size for memory self-efficacy (*d* = -0.09).

Comparing post- to follow-up measures, large effect sizes in the positive direction were found for the following cognitive domains: simple attention (*d* = 0.80) and visual-spatial skills (*d* = 1.01). Small effect sizes in the positive direction were found for the following cognitive domains: global cognitive functioning (*d* = 0.22), one measure of language (*d* = 0.42), and delayed visual recall (*d* = 0.27). No meaningful effect sizes were found for the following cognitive domains: divided attention (*d* = 0.02), working memory (*d* = 0.00), one measure of language (*d* = 0.12), immediate visual recall (*d* = 0.19), visual recognition (*d* = 0.00), immediate verbal recall (*d* = -0.01), delayed verbal recall (*d* = -0.17), processing speed (*d* = -0.13), and executive functioning (*d* = 0.05). A small effect size in the negative direction was found for verbal recognition (*d* = -0.27), suggesting decline. In addition, there was a moderate and small effect size in the positive direction for the non-cognitive measures of depression (*d* = -0.63) and memory self-efficacy (*d* = -0.20).

Discussion

In summary, results of this study suggest that the cognitive training program modestly improves functioning in most cognitive domains immediately after training. Twelve cognitive measures (including global cognitive functioning) showed at least small effect sizes from pre- to post-treatment. In contrast, three cognitive measures showed no detectable change. For the two non-cognitive domains measured, depression showed a small improvement, and memory self-efficacy showed no change.

Concerning performance on specific cognitive domains, several findings from this study were consistent with those from previous studies on cognitive training. For example, measures of processing speed (Trails A) and executive functioning (Trails B) both showed small improvements, a finding consistent with previous research which found that a 10-week cognitive training intervention improved speed of processing (Ball, et al., 2002).

In addition, measures of verbal memory (HVLT) showed meaningful changes as immediate verbal recall and verbal recognition showed large improvements, while delayed verbal recall showed a moderate improvement. Previous research has also found modest improvements in verbal memory associated with cognitive training (Ball et al., 2002; Gross et al., 2012). Findings from the current study, however, were more robust than previous research. The positive findings regarding verbal memory may be due to the nature of the cognitive training program used in this study. For example, there is a relatively high "dose" of verbal memory exercises in that there are 24 classes and approximately 25% (15 minutes) of each class involved verbal memory exercises. Furthermore, the verbal memory exercises stimulate real life memory tasks. Similarly, measures of visual recall, visual recognition, and delayed visual recall (BVMT-R) all showed a small improvement, a finding consistent with prior literature on the impacts of cognitive training on visual and general memory functioning (Ball et al., 2002; Gross et al., 2012).

Of the six cognitive domains that were assessed, language was the only domain that did not show statistically or clinically significant improvement from pre- to post-measurement. Both measures of language (COWAT & BNT) resulted in no meaningful differences in scores from pre- to post-intervention. One possible explanation for this finding is that "language" is a very broad construct that consists of a variety of both fluid and crystallized abilities (Harada, Natelson Love, & Triebel, 2013; Hayden & Welsh-Bohmer, 2011). Therefore, the instruments used in this study to measure language abilities may not have accurately assessed the specific language skills that were targeted by the cognitive training classes. For example, the cognitive training program includes a variety of language exercises that require different skills, some of which are not measured by the COWAT or the BNT. Furthermore, given that the cognitive training program includes several different language exercises, relatively little practice is devoted to specific skills measured in this study (i.e., confrontation naming and verbal fluency). In order to determine if the program positively affects language functioning, future research should utilize additional instruments that more precisely measure the language skills that are practiced as part of the program.

Results on measures of non-cognitive domains were mixed. For example, reports of depressive symptoms as measured by the PHQ-9 showed small improvement. Results of the current study suggest that cognitive training may have a beneficial effect on mood, which is consistent with a study done by Brum, Forlenza, & Yassuda (2009). This relationship may be due to a general increase in activity, increased socialization, or perhaps improvements in perceptions of cognitive functioning. Unfortunately, no changes in memory self-efficacy were found in this study between pre- and post-measurement, indicating that participants did not reliably notice changes in their own memory functioning following participation in the program. Previous research, however, has found positive changes in memory self-efficacy resulting from participation in cognitive training programs (Rapp, Brenes, & Marsh, 2002). It is possible that using a measure of self-efficacy related to broader cognitive functioning, as opposed to memory only, would have produced different results.

Mixed results were found in individuals' ability to maintain benefits from the cognitive training program for the 3-month follow-up assessment. Simple attention, visuospatial skills, and depression continued to improve between post- to follow-up assessment. On the other hand, verbal recognition showed a small decline between post- to follow-up measurement. All other measures showed no changed between post- to follow-up. Overall, results indicated that gains between pre- to post-measurement were maintained over the three-month period of no program implementation. However, it is important to highlight that some domains varied in change, such that future research should continue to investigate effects of a follow-up measurement.

Limitations and Future Directions

While the findings of the current study were encouraging, limitations of the study must be acknowledged. Some of these limitations were related to the participant sample. For example, the sample used in this study was considerably homogenous given that all participants were Caucasian nuns that were highly educated (bachelor's degree or higher). Therefore, generalizing the results of this study to the broader population of healthy older adults is limited. In addition, the sample size of the study was relatively small (N = 17). Future research should include larger and more diverse samples.

Another limitation is that follow-up data was collected for only seven participants. This study collected data from two different implementations of the *Mind Sharpener* program that were conducted in consecutive years. The first year of implementation did not include follow-up assessment, while the second year did. It would have been beneficial to include follow-up assessment for the first implementation as well to increase the power of the repeated measures analysis. It is important to note that all other factors remained as consistent as possible between the two implementations (e.g., population, location, program facilitators, time of implementation). Furthermore, no significant group differences were found between the two years of program implementation for any of the pre- and post-measures.

Other limitations concerned the assessment process. For example, the testing battery required approximately 75 minutes and was completed on two different days in order to prevent fatigue. Testing sessions typically occurred on consecutive days, but occasionally were separated by two days. In addition, the two testing sessions did not always occur at the same time of day due to unpredictable schedules of participants and researchers. Furthermore, pre- and post-testing were not always conducted at the same time of day for each participant. These differences in terms of the timing of assessment could have resulted in unwanted variability in test scores that were unrelated to the effects of the cognitive training program. For example, it is recommended that cognitive testing occur during morning hours given that cognitive functioning of older adults tends to deteriorate as the day continues (Blatter & Cajochen, 2007). However, assessments for all participants were completed within the same week, and within a week of the start and completion of the cognitive training program. Finally, the longer-term benefits of the program were not assessed. It is highly recommended that future research attempt to adhere to a more consistent testing schedule and to include follow-up testing to assess the possible long-term benefits of the program.

Lastly, the fact that the study lacked a control group represents a significant limitation. Having a control group would be very beneficial in allowing the ability to differentiate between changes that occurred from the cognitive training program and changes that occur naturally in healthy older adults that do not participate in the program. Future studies will need to incorporate non-intervention control groups as well as active control groups (e.g., groups participating in other activities that provide cognitive and social stimulation such as book clubs) to more definitively determine if the cognitive training program is responsible for changes in cognitive functioning that were observed in this study.

Conclusion

The findings of the current study provide preliminary support for the use of a cognitive training program for cognitively-intact older adults. Small to large improvements were observed on most measures of cognitive functioning and small improvements in depressive symptoms were also found between pre- to post-measurement. These results are encouraging, particularly considering that the participants already had high levels of cognitive functioning before the program began, allowing minimal room for improvement. However, mixed results were found from post- to follow-up measurement. Some domains displayed a continued improvement or maintenance of gains, while others showed a slight decline to full return to baseline levels. The cognitive training program utilized in this study has many strengths as it targets six cognitive domains (i.e., was comprehensive), could be completed in one-hour sessions (i.e., were not overly cumbersome compared to similar cognitive training programs), were well-received by participants, and the facilitators reported liking the program. However, additional research with larger samples, appropriate control groups, and the ability to maintain benefits is needed before making more definitive conclusions about the efficacy of this cognitive training program.

References

Alzheimer's Association. (2019). 2019 Alzheimer's disease facts and figures report. *Alzheimer's Association*. Retrieved from https://www.alz.org/alzheimers-dementia/facts-figures

Bahar-Fuchs, A., Clare, L., & Woods, B. (2013). Cognitive training and cognitive rehabilitations for mild to moderate Alzheimer's disease and vascular dementia (review). *The Cochrane Library, 2013*(6), 1-103. doi: 10.1002/14651858.CD003260.pub2

Ball, K., Berch, D. B., Helmers, K. F., Jobe, J. B., Leveck, M. D., Marsiske, M., Morris, J. N., Rebok, G. W., Smith, D. M., Tennstedt, S. L., Unverzagt, F. W., & Willis, S. L. (2002). Effects of cognitive training interventions with older adults: A randomized controlled trial. *The Journal of the American Medical Association*, *288*(18), 2271–2281.

Benedict, R. H. B., Schretlen, D., Groninger, L., Dobraski, M., & Shpritz, B. (1996). Revision of the brief visuospatial memory test: Studies of normal performance, reliability, and validity. *Psychological Assessment, 8*(2), 145-153. doi:10.1037//1040-3590.8.2.145

Benton, A. L. & Hamsher, K. (1989). *Multilingual Aphasia Examination*. Iowa City, Iowa: AJA Associates.

Brandt, J. & Benedict, R. H. B. (2001). *Hopkins Verbal Learning Test*. Lutz, FL: Psychological Assessment Resources.

Broadbent, D. E., Cooper, P. F., FitzGerald, P., & Parkes, K. R. (1982). The cognitive failures questionnaire (CFQ) and its correlates. *British Journal of Clinical Psychology, 21*, 1-16. doi:10.1111/j.2044-8260.1982.tb01421.x

Brum, P. S., Forlenza, O. V., & Yassuda, M. S. (2009). Cognitive training in older adults with Mild Cognitive Impairment: Impact on cognitive and functional performance. *Dementia & Neuropsychologia, 3*(2), 124-131. doi:10.1590/s1980-57642009dn30200010

Harada, C. N., Natelson Love, M. C., & Triebel, K. (2013). Normal cognitive aging. *Clinics in Geriatric Medicine*, *29*(4), 737–752. http://doi.org/10.1016/j.cger.2013.07.002

Hayden, K. M., & Welsh-Bohmer, K. A. (2011). Epidemiology of cognitive aging and Alzheimer's disease: Contributions of the Cache County Utah Study of Memory, Health and Aging. *Behavioral Neurobiology of Aging Current Topics in Behavioral Neurosciences,* 3-31. doi:10.1007/7854_2011_152

Hertzog, C., Kramer, A.F., Wilson, R.S., & Lindenberger, U. (2008). Enrichment effects on adult cognitive development: Can the functional capacity of older adults be preserved and enhanced? *Psychological Science in the Public Interest, 9*, 1–65.

Kroenke, K., Spitzer, R.L., & Williams, J.B. (2001). The PHQ-9: Validity of a brief depression severity measure. *Journal of General Internal Medicine, 16* (9), 606-613. doi: 10.1046/j.1525-1497.2001.016009606.x

Mahncke, H. W., Connor, B. B., Appelman, J., Ahsanuddin, O. N., Hardy, J. L., Wood, R. A., … Merzenich, M. M. (2006). Memory enhancement in healthy older adults using a brain plasticity-based training program: A randomized, controlled study. *Proceedings of the National Academy of Sciences of the United States of America*, *103*(33), 12523–12528. 10.1073/pnas.0605194103

National Council of Aging. (2015). The 2015 Untied States of aging survey: National findings. Retrieved from https://www.ncoa.org/wp-content/uploads/USA15-National-Fact-Sheet-Final.pdf

Ostergren, J. E., Heeringa, S. G., Mendes de Leon, C. F., Connell, C. M., & Roberts, J. S. (2017). The influence of psychosocial and cognitive factors on perceived threat of Alzheimer's disease. *American Journal of Alzheimer's Disease & Other Dementias, 32*(5), 289-299. doi: 10.1177/1533317517714552

Petersen, R. C. (2011). Mild cognitive impairment. *The New England Journal of Medicine, 364*(23), 2227-2234.

Rebok, G. W., Ball, K., Guey, L. T., Jones, R. N., Kim, H., King, J. W., . . . Willis, S. L. (2014). Ten-year effects of the advanced cognitive training for independent and vital elderly cognitive training trial on cognition and everyday functioning in older adults. *Journal of the American Geriatrics Society, 62*(1), 16-24. doi: 10.1111/jgs.12607

Reitan, R. M., & Davidson, L. (1974). *Clinical neuropsychology: current status and applications*. Washington DC: VH Winston.

Salthouse, T.A. (2012). Consequences of age-related cognitive declines. *Annual Review of Psychology, 63*, 201-226.

Schretlen, D. (1997). *Brief test of attention*. Lutz, FL: Psychological Assessment Resources.

Simons, D. J., Boot, W. R., Charness, N., Gathercole, S. E., Chabris, C. F., Hambrick, D. Z., & Stine-Morrow, E. A. L. (2016). Do "brain-training" programs work? *Association of Psychological Science in the Public Interest, 17*(3), 103-186. doi:10.1177/1529100616661983

Tesky, V. A., Thiel, C., Banzer, W., & Pantel, J. (2011). Effects of a group program to increase cognitive performance through cognitively stimulating leisure activities in healthy older subjects: The AKTIVAstudy. *GeroPsych: The Journal of Gerontopsychology and Geriatric Psychiatry, 24*(2), 83-92. doi:10.1024/1662-9647/a000035

Wechsler, D. (2008). *Wechsler adult intelligence scale: Fourth edition WAIS-IV*. New York: The Psychological Corporation.

Willis, S. L., Tennstedt, S. L., & Marsiske, M. (2006) Long-term effects of cognitive training on everyday functional outcomes in older adults. *The Journal of the American Medical Association, 296*(23), 2805-2814. doi: 10.1001/jama.296.23.2805

Appendix

Table 1

Measures of Cognitive Functioning

Cognitive Domain	Instrument
Attention	Forward & Backward Digit Span (Wechsler, 2008) Brief Test of Attention (Schretlen, 1997)
Visual Memory	Brief Visuospatial Memory Test – Revised (Benedict, 1996)
Verbal Memory	Hopkins Verbal Learning Test (Brandt & Benedict, 2001)
Visual Spatial Skills	Visual Puzzles (Wechsler, 2008)
Processing Speed & Executive Functioning	Trail Making Test Part A & B (Reitan & Davison, 1974)
Language	Controlled Oral Word Association Test (Benton & Hamsher, 1989) Boston Naming (Kaplan, Goodglass, & Weintraub, 1983)

Table 2

Measures of Non-Cognitive Domains

Non-cognitive Domain	Instrument
Depression	Patient Health Questionnaire-9 Observer Version (Kroenke, et al., 2002)
Memory Self-Efficacy	Cognitive Failures Questionnaire (Broadbent, Cooper, FitzGerald & Parkes, 1982)

Table 3

Repeated Measures ANOVA of Cognitive and Non-Cognitive Assessment between Pre-, Post-, and Follow-up Measurement

Measure	$F(2, 5)$	p	η^2
Global Cognitive Ability (3MS)	2.255	.200	.274
Divided Attention (BTA)	2.325	.193	.281
Simple Attention (Forward Digit Span)	5.366	.057	.563
Working Memory (Backward Digit Span)	.880	.470	.133
Language (Boston Naming)	.264	.778	.074
Language/Executive Functioning (COWAT)	1.605	.252	.203
Immediate Visual Recall (BVMT-R)	.432	.671	.089
Delayed Visual Recall (BVMT-R)	.572	.598	.103
Visual Recognition (BVMT-R)	.131	.880	.062
Immediate Verbal Recall (HVLT)	3.287	.123	.377
Delayed Verbal Recall (HVLT)	4.723	.067	.473
Verbal Recognition (HVLT)	11.263	.014	.868
Processing Speed (Trails A)	.278	.769	.075
Processing Speed/Executive Functioning (Trails B)	1.154	.387	.160
Visuospatial (Visual Puzzles)	6.642	.039	.655
Perception of Memory (CFQ)	.954	.446	.140
Depression (PHQ-9)	3.306	.122	.379

Table 4

Pre- and Post-Intervention Means and Standard Deviations, and Effect Sizes

Measure	Pre		Post		Cohen's d	Interpretation
	M	SD	M	SD		
Global Cognitive Ability (3MS)	92.24	4.63	94.00	5.65	0.36	Small Effect
Divided Attention (BTA)	5.76	2.51	6.94	2.41	0.51	Moderate Effect
Simple Attention (Forward Digit Span)	8.71	1.69	8.88	2.15	0.12	No Effect
Working Memory (Backward Digit Span)	8.18	2.19	8.71	1.96	0.28	Small Effect
Language (Boston Naming)	24.88	2.74	25.00	2.98	0.05	No Effect
Language/Executive Functioning (COWAT)	27.12	7.73	26.35	11.10	-0.13	No Effect
Immediate Visual Recall (BVMT-R)	14.47	7.72	16.06	7.55	0.37	Small Effect
Delayed Visual Recall (BVMT-R)	5.82	3.43	6.59	3.55	0.35	Small Effect
Visual Recognition (BVMT-R)	5.00	1.37	5.29	1.31	0.27	Small Effect
Immediate Verbal Recall (HVLT)	19.41	4.23	23.18	4.68	1.10	Large Effect
Delayed Verbal Recall (HVLT)	6.29	2.69	8.12	2.29	0.61	Moderate Effect
Verbal Recognition (HVLT)	9.47	1.38	10.29	1.49	0.93	Large Effect
Processing Speed (Trails A)	50.35	20.85	43.94	16.07	-0.36	Small Effect

Processing Speed/Executive Functioning (Trails B)	126.94	46.46	114.88	47.71	-0.39	Small Effect
Visuospatial (Visual Puzzles)	10.71	2.52	11.41	2.69	0.24	Small Effect
Perception of Memory (CFQ)	34.94	13.10	34.00	12.36	-0.09	No Effect
Depression (PHQ-9)	5.47	4.30	4.59	4.47	-0.26	Small Effect

Table 5

Post- and Follow-up Intervention Means and Standard Deviations, and Effect Sizes

Measure	Post		Follow-up		Cohen's d	Interpretation
	M	SD	M	SD		
Global Cognitive Ability (3MS)	94.00	5.65	95.29	6.13	0.22	Small Effect
Divided Attention (BTA)	6.94	2.41	7.00	2.89	0.02	No Effect
Simple Attention (Forward Digit Span)	8.88	2.15	10.71	1.98	0.87	Large Effect
Working Memory (Backward Digit Span)	8.71	1.96	8.71	0.95	0.00	No Effect
Language (Boston Naming)	25.00	2.98	25.43	4.35	0.12	No Effect
Language/Executive Functioning (COWAT)	26.35	11.10	31.00	11.15	0.42	Small Effect
Immediate Visual Recall (BVMT-R)	16.06	7.55	17.43	6.27	0.19	No Effect
Delayed Visual Recall (BVMT-R)	6.59	3.55	7.71	5.43	0.27	Small Effect
Visual Recognition (BVMT-R)	5.29	1.31	5.29	0.76	0.00	No Effect
Immediate Verbal Recall (HVLT)	23.18	4.68	23.14	4.34	-0.01	No Effect
Delayed Verbal Recall (HVLT)	8.12	2.29	7.71	2.93	-0.17	No Effect
Verbal Recognition (HVLT)	10.29	1.49	9.86	1.86	-0.27	Negative Small Effect
Processing Speed (Trails A)	43.94	16.07	41.71	17.89	-0.13	No Effect

Processing Speed/Executive Functioning (Trails B)	114.88	47.71	117.29	63.99	0.05	No Effect
Visuospatial (Visual Puzzles)	11.41	2.69	14.43	3.69	1.01	Large Effect
Perception of Memory (CFQ)	34.00	12.36	31.57	11.36	-0.20	Small Effect
Depression (PHQ-9)	4.59	4.47	2.14	1.77	-0.63	Moderate Effect

* *"Negative" effect size indicates a change in the direction of decline*

Table 6

Pre- and Follow-up Intervention Means and Standard Deviations, and Effect Sizes

Measure	Pre		Follow-up		Cohen's d	Interpretation
	M	SD	M	SD		
Global Cognitive Ability (3MS)	92.24	4.63	95.29	6.13	0.60	Moderate Effect
Divided Attention (BTA)	5.76	2.51	7.00	2.89	0.47	Small Effect
Simple Attention (Forward Digit Span)	8.71	1.69	10.71	1.98	1.13	Large Effect
Working Memory (Backward Digit Span)	8.18	2.19	8.71	0.95	0.27	Small Effect
Language (Boston Naming)	24.88	2.74	25.43	4.35	0.17	No Effect
Language/Executive Functioning (COWAT)	27.12	7.73	31.00	11.15	0.44	Small Effect
Immediate Visual Recall (BVMT-R)	14.47	7.72	17.43	6.27	0.40	Small Effect
Delayed Visual Recall (BVMT-R)	5.82	3.43	7.71	5.43	0.46	Small Effect
Visual Recognition (BVMT-R)	5.00	1.37	5.29	0.76	0.24	Small Effect
Immediate Verbal Recall (HVLT)	19.41	4.23	23.14	4.34	0.88	Large Effect
Delayed Verbal Recall (HVLT)	6.29	2.69	7.71	2.93	0.52	Moderate Effect
Verbal Recognition (HVLT)	9.47	1.38	9.86	1.86	0.26	Small Effect
Processing Speed (Trails A)	50.35	20.85	41.71	17.89	-0.43	Small Effect

Processing Speed/Executive Functioning (Trails B)	126.94	46.46	117.29	63.99	-0.19	No Effect
Visuospatial (Visual Puzzles)	10.71	2.52	14.43	3.69	1.29	Large Effect
Perception of Memory (CFQ)	34.94	13.10	31.57	11.36	-0.27	Small Effect
Depression (PHQ-9)	5.47	4.30	2.14	1.77	-0.88	Large Effect