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The Effects of a Cognitive Training Program for Healthy Older Adults: A Program Evaluation Study

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By

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A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE
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ABSTRACT

As one ages, some degree of cognitive decline is expected. Despite this, declines in cognitive abilities and the possibility of developing dementia are common concerns 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. Previous 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 19 participants who engaged in two, one-hour long cognitive training classes each week for 12 weeks. Each class required participants to complete activities that targeted the following cognitive domains: attention, visuospatial skills, memory, processing speed, executive functioning, and language. These cognitive domains, along with depression and memory self-efficacy, were assessed prior to and immediately following completion of the program, and at a three-month follow-up. A moderate improvement on global cognitive functioning was observed and small to large improvements were observed on other measures of cognitive functioning. The findings of the current study provide preliminary support for the use of a cognitive training program for healthy older adults.

Introduction

As adults age, many begin to notice declines in cognitive abilities such as memory and problem solving, and report complaints that they are not as mentally capable as they once were. These changes are a normal part of aging known as “age-related cognitive decline” (Deary et al., 2009). Although these changes are normal, many older adults are interested in activities or programs that help maximize cognitive functioning and minimize cognitive decline. Cognitive training programs have been developed with this goal in mind and are designed to improve cognitive abilities that decline with age or even prevent these abilities from declining.

Age-Related Cognitive Decline

Typically, older adults experience declines in domains of fluid intelligence that are necessary in reasoning, problem-solving, abstract thinking, and decision making (Deary et al., 2009). Skills that typically slow or decline with age include: processing speed and reaction time, divided and sustained attention, various memory abilities (e.g., working, prospective, episodic), verbal fluency, confrontation naming, visual construction, cognitive flexibility, and response inhibition (Harada, Natelson-Love, & Triebel, 2013; Salthouse, 2012). In contrast, crystalized intelligence, which involves knowledge from past experiences, facts, and vocabulary as a result of learning, usually does not decline with age (Horn & Cattell, 1966).

Age-related cognitive decline is not pathological and typically does not cause significant impairment in everyday functioning (Salthouse, 2012). Age-related cognitive decline can, however, result in minor disturbances in daily functioning such as slight inconveniences (e.g., having difficulties finding car keys) or embarrassment (e.g., forgetting the name of an acquaintance). It is common for older adults to worry about their cognitive health and report subjective memory complaints related to these disturbances. Data from the United States of

Aging Survey conducted in 2015 revealed that 38 percent of adults over the age of 60 reported subjective memory complaints and rated losing their memory as their top concern about aging (National Council on Aging, 2015). Subjective memory complaints associated with age-related cognitive decline are associated with increases in depression (Minett et al., 2008) and may cause undue stress and anxiety. Older adults commonly worry about the implications of cognitive decline, particularly the possibility of developing diseases that cause progressive and irreversible cognitive impairment such as Alzheimer's disease (Ostergren, 2017). Concerns about dementia are certainly understandable given that approximately 5.8 million Americans have Alzheimer's disease (AD) and AD is projected to rise to nearly 14 million people by 2050 if no cure is found (Alzheimer's Association, 2019).

Cognitive Training

In response to older adults' concerns about cognitive decline, academic researchers as well as private businesses have developed cognitive training programs that have been created with the goal of improving cognitive abilities or preventing declines in these abilities. Cognitive training, sometimes marketed to the public as "brain training", is a term used to describe programs that provide guided practice on tasks requiring different cognitive abilities such as memory or language (Bahar-Fuchs, Clare, & Woods, 2013). Cognitive training typically takes place in small groups and is comprised of a standardized, structured program of activities (Belleville, 2008). It is typically delivered via computer or other electronic devices, although some programs are delivered to groups of participants by a live trainer. The assumption underlying cognitive training is that the brain remains plastic as people age, so practicing cognitive activities will improve or maintain functioning (Hertzog et al., 2008). Practice is assumed to lead to what is known as transfer of training, which is essentially improvement on tasks that are practiced as well as improvement on related tasks. Transfer depends on a similarity between the content (e.g., knowledge, skill) learned initially and its later application (Simons et al., 2016). It is assumed that regular practice of a cognitive domain (e.g., memory) will improve or maintain functioning in that given domain and that these results will generalize beyond the context of training.

Many “brain game” or “brain training” products on the market claim to improve cognitive abilities, but many exaggerate the positive effects of their programs and can mislead consumers (Simons et al., 2016). Simons and colleagues (2016) reviewed the “brain training” literature and found evidence for improvements on trained tasks, but little evidence of benefits on related cognitive tasks or everyday cognitive functioning. Conversely, recent reviews of the empirical literature on cognitive training suggest that cognitive training programs can improve cognitive functioning in older adults without dementia (Ball et al., 2002; Gross et al., 2012; Rebok et al., 2014).

The largest and most notable study evaluating the effectiveness of cognitive training for independent older adults began in 1998 and is known as the ACTIVE study (Advanced Cognitive Training for Independent and Vital Elderly; Ball et al., 2002). The study was randomized, single-blind, and had a control group. A volunteer sample of 2,832 older adults with ages ranging from 65 to 94 years old were involved in the evaluation of three cognitive training interventions. The three interventions targeted different cognitive abilities, which were: verbal episodic memory, reasoning abilities, and speed of processing. Each intervention group improved at the target cognitive ability compared to their baseline performance, and this improvement sustained through a two-year observation period. However, the study did not find that training effects generalized to everyday functioning.

A 10-year follow-up of the ACTIVE study was also completed (Rebok et al., 2014). The reasoning and speed of processing group maintained their effects from the interventions at the 10-year follow-up. However, the memory training group no longer maintained the effects in memory performance. This long-term study provides support for the efficacy of cognitive training in cognitively intact older adults.

A meta-analysis conducted in 2012 examined the results of memory training interventions for community-dwelling, cognitively intact older adults (Gross et al., 2012). The review identified 402 publications, but only 35 met inclusion criteria for the review. To be included in the review, the publications had to report original data on memory training, involve randomization, all participants had to be at least 60 years of age, and the intervention had to be non-pharmacological and target memory. The review found that memory gains in treatment groups were larger than retest effects in the control groups. Additionally, training multiple strategies resulted in larger treatment gains.

Overall, the literature has shown that improvements in cognitive functioning for healthy older adults are typically observed only on measures of the specific domain for which someone was trained. For example, individuals completing cognitive training that is focused on improving memory skills often show improvements on measures of memory, but not on measures of other important cognitive domains such as language or problem solving (Simons et al., 2016). Additionally, there is little evidence that cognitive training enhances performance on distantly related tasks or that training improves everyday cognitive functioning (Simons et al., 2016).

Purpose of Current Study

This study represents a program evaluation study in that the researchers were approached by a community organization about evaluating the effects of a cognitive training program that was being implemented with grant funding. Therefore, this research was conducted in the context of program implementation in a real-world setting as opposed to being a traditional experimental study conducted in a controlled setting.

This study aims to contribute to the current literature in two ways. First, the cognitive training program utilized in this study was a comprehensive training program targeting all six primary cognitive domains (i.e., processing speed, memory, language, attention/concentration, visuospatial skills, and problem solving/executive functioning). Few existing studies have examined the effects of comprehensive cognitive training programs, particularly those delivered in community-based organizations as opposed to research settings. Second, many studies have investigated computer-based cognitive training programs (Simons et al., 2016), whereas the current study investigated a socially based cognitive training program delivered to a group of individuals with a live facilitator/trainer.

The purpose of the current study was to determine the effects of a cognitive training program on cognitive and emotional functioning for healthy, community-dwelling older adults who reported subjective cognitive impairment. Based on previous literature, it was hypothesized that there would not be robust changes in memory, however, there would be meaningful improvements in executive functioning, processing speed, and self-reports of memory self-efficacy. Additionally, it was hypothesized that there would be a decline in depressive symptoms.

Method

Participants and Setting

Participants were recruited from a non-profit organization serving community-dwelling older adults in a small Midwestern metropolitan area in the United States. Staff at the facility were asked to recruit individuals who were interested in participating in a cognitive training program and who reported subjective changes in cognitive functioning. To be included in 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. 3MS scores ranged from 90-99 (*M* = 95.26, *SD* = 3.25) for participants, indicating intact cognitive abilities. Exclusion criteria included a 3MS score below 78, a diagnosis or condition that causes progressive dementia, or the presence of a significant visual, hearing, or motor impairment that could prevent successful participation in the program. No individuals were excluded from the study based on these criteria.

A sample of 31 individuals initially consented to participate in the study. To be included in data analysis, participants were required to complete at least 75% of all cognitive training classes. Twenty-six participants met this criterion of completing at least 75% of the classes, while five participants dropped out of the study prior to completing the program due to various reasons. One participant obtained a job and could no longer attend classes, one participant became ill, and the other three stopped coming to class due to unknown reasons. To be included in the final analysis, participants needed to complete testing at the three-month follow-up in addition to having already completed the pre-test and post-test. Seven participants were unable to complete follow-up testing due to various reasons. Three participants were out of the state, two participants could not be reached, one participant had a medical emergency, and one participant was ill. Nineteen participants completed all testing that was required to be included in the final analysis. Participants in the final analysis included 13 Caucasian females and 6 Caucasian males whose ages ranged from 61-92 years old (*M* = 75.26, *SD* = 8.43). The amount of education completed ranged from high school degree to doctoral degree. A full summary of participant demographics can be found in Table 1 of the Appendix.

Materials

Cognitive training program.

The program evaluated in this study was created by a non-profit organization devoted to the development of cognitive training programs. The program, *Mind Sharpener*, developed by the New England Cognitive Center (NECC), is designed for older adults who report subjective cognitive decline that does not interfere with completing daily activities and have little to no objective cognitive decline.

Prior to the start of the study, a master trainer from NECC trained three staff members at the adult community center to deliver the program. A manual that included detailed instructions about how to deliver the program was also provided. Throughout the study, NECC staff were available for consultation or further training if necessary. The cognitive training program was delivered to four separate groups of participants at different times. The program included 24, one-hour classes delivered twice a week over a twelve-week period. Each class included a sequence of paper-and-pencil activities related to six cognitive domains: processing speed, visuospatial skills, attention and concentration, memory, language, and problem solving/executive functioning. Each class was structured such that there was a 5-minute warm-up, then 5-7 minutes on activities involving processing speed, 10-12 minutes on visuospatial activities, 5-7 minutes on attention and concentration, 12-14 minutes on memory, 8-10 minutes on language, 8-10 minutes on problem solving, and then a 3-5 minute wrap-up at the end. Processing speed activities targeted speed, accuracy and automaticity of response and involved almost no processing. Visuospatial activities targeted location, position, composition, relationship, direction and perspective of objects in the environment. Attending to tasks and maintaining focus are the primary targets for activities of attention and concentration. Memory activities targeted short-term recall and working memory, as well as provided strategies to facilitate information storage. The memory exercises attempted to stimulate multiple types of memory, including short-term and long-term, verbal, visual, and auditory memories. Language activities targeted language fluency, focusing on word recognition and word retrieval. Problem solving activities may have involved identification, sorting, classifying, comparing/contrasting, connecting, computing, sequencing, manipulating, decoding, and/or evaluating. All activities involved repetition and positive reinforcement (i.e., praise) to promote learning. Activities within each domain gradually increased in difficulty as the program progressed. The activities required minimal instruction, therefore allowing the class time to be primarily dedicated to having the participants engage in the activities. Feedback about performance was provided; however, participants were never graded on activities and never directly compared their answers to others given that the goal of the program was to engage participants in cognitively stimulating activities.

Measures of cognition.

Modified Mini-Mental Status Examination (3MS)**.** The 3MS (Teng & Chui, 1987) is a measure of global cognitive functioning that was used to screen for dementia and determine appropriateness for the *Mind Sharpener* program. It is a standardized assessment that is widely used to evaluate individuals with cognitive impairment. The 3MS measures multiple cognitive domains such as attention, orientation, short-term memory, and verbal reasoning. The measure is highly reliable for assessing individuals with dementia ($\alpha = .88$) and has high sensitivity (.93) in differentiating between individuals with and without dementia (Tombaugh et al., 1996). Scores can range from 0 to 100 with lower scores indicative of greater cognitive impairment.

Repeatable Battery for the Assessment of Neuropsychological Status (RBANS). The RBANS is a multi-component assessment that measures the cognitive domains of immediate memory, visuospatial and constructional abilities, attention and concentration, language, and delayed memory (Randolph, 1998). The cognitive domains assessed on the RBANS are represented as index scores. The measurement of each cognitive domain, or index, includes two subtests except for the delayed memory domain that includes four subtests, resulting in 12 subtests and five indexes that comprise the RBANS. A composite, total scaled index score of all cognitive domains is calculated as well and is a measure of global cognitive functioning. In the present analysis, index scores from the RBANS were reported rather than subtest scores as these provide a more accurate assessment of performance. The primary focus of RBANS interpretation is at the index level as index scores have the highest level of internal consistency and stability (Randolph, 1998). An index score of 100 on any given cognitive domain is considered average and is at the 50th percentile, while the standard deviation for all scales is 15.

The RBANS takes approximately 30 minutes to administer. Four alternate forms can be used to evaluate cognitive functioning over time and minimize practice effects. Participants were randomly assigned to complete either Form A or Form B first. Participants then completed the other form at post-testing and finally completed the first form at follow-up testing. When comparing performance over time on the same form, it is necessary to control for practice effects; however, using alternate forms limits the impact of these effects and no adjustments need to be made to account for increased performance due to previous exposure to the items (Randolph, 1998).

The immediate memory domain of the RBANS includes the list-learning subtest and the story memory subtest. During the list-learning subtest, participants were read a list of ten words and then asked to recall the words. This was done four times, with each trial involving the examiner reading the same list of words and asking the participant to recall the words. The story memory subtest involved the examiner reading a short story and then asking the participant to recall as much of the story as they could. This procedure was done two times.

The visuospatial and constructional domain of the RBANS includes the figure copy subtest and the line orientation subtest. During the figure copy subtest, participants were asked to copy a complex geometric figure from a model. Each different shape was scored separately to comprise a score on the overall figure. During the line orientation subtest, participants were shown a series of ten line-orientation cards and were asked to determine which two numbers corresponded with the angles of the lines shown on each card.

The attention and concentration domain of the RBANS is comprised of the digit span subtest and the coding subtest. The digit span subtest involved the examiner reading a series of digits to the participant and then asking the participant to repeat the digits back in the exact order they heard them. The number of digits increases by one each trial, for eight trials, or is discontinued once the participant can no longer recall digits correctly for two consecutive attempts. During the coding subtest, participants were asked to write down numbers in boxes that were associated with specific simple shapes as quickly as they could. Participants had 90 seconds to fill in as many boxes as they could.

The language domain of the RBANS includes the picture-naming subtest and the semantic fluency subtest. During the picture-naming subtest, participants were shown ten drawings of common objects and asked to name each one. The picture-naming subtest measures confrontation naming skills. During the semantic fluency subtest, participants were asked to say as many words associated with a specific category of objects as they could in 60 seconds.

The final domain assessed in the RBANS is the delayed memory domain. It is administered after a delay of 20 minutes and it assesses rate of forgetting over time. The delayed memory domain of the RBANS includes the list recall subtest, the list recognition subtest, the story recall subtest, and the figure recall subtest. During the list recall subtest, participants were asked to recall any words that they remembered from the list of ten words presented during the list learning subtest. Immediately following free recall, participants were read a list of 20 words during the list recognition subtest and were asked to say “yes” to a word if they thought it was on the original list and “no” if they thought it was not. Ten were on the list and ten were not. During the story recall subtest, participants were asked to recall any details from the story that was read to them during the story memory subtest. Finally, during the figure recall subtest, participants were presented with a blank sheet of paper and asked to draw the complex geometric figure that was shown during the figure copy subtest as they remembered it.

The RBANS demonstrates respectable psychometric properties. The reliability coefficients of the five domains and total scaled score range from .83-.94 for ages 60-89, and test-retest correlations range from .62-.81 for ages 20-89. Additionally, the internal consistency demonstrates correlations of .81-.94 for ages 60-89. When examining the alternate-form comparison between Form A and Form B, the calculated differences for all ages from Form A to B range from .46-.82 (Randolph, 1998).

***Visual Puzzles*.** Although the RBANS assesses visuospatial skills, Visual Puzzles, which is part of the Perceptual Reasoning Index on the WAIS-IV (Wechsler, 2008), was also administered as it provided a more challenging assessment of visuospatial skills for the cognitively intact participants in this study. This test assesses visuospatial reasoning and requires mental transformation, manipulation, and the ability to analyze dimensional objects. Participants were shown a completed puzzle with a display of six figures. Participants were then asked to select three of the six possible figures that could create the completed puzzle. Participants continued the test until they answered three consecutive items incorrectly.

Trail Making Test Part A. Trail Making Test Part A assesses cognitive processing speed (Trail Making Test; Armitage; 1946, Reitan & Davison, 1974). Participants were given a piece of paper with the numbers 1 through 25 contained in circles scattered across the paper. Participants were asked to connect the numbers as fast as they could in numerical order. Participants were instructed to "draw a line from 1 to 2, 2 to 3, 3 to 4, and so on until you reach the end."

Trail Making Test Part B. Trail Making Test Part B is used to examine executive functioning (Trail Making Test; Armitage, 1946; Reitan & Davison, 1974). Part B is similar to Trail Making Test Part A, but Part B requires participants to alternate between numbers and letters in order as fast as they can. They were told to "draw a line from 1 to A, A to 2, 2 to B, B to 3, and so on until you reach the end." Trail Making Test Part A and Part B are sensitive to detecting brain damage and cognitive impairment (Reitan & Davison, 1974; Aschendorf et al., 2008). However, Part B of the Trail Making Test has been found to have better specificity and sensitivity to cognitive dysfunction at any level compared to Part A (Rasmusson et al., 1998).

Non-cognitive measures.

The Patient Health Questionnaire-9 (PHQ-9). The PHQ-9 is a 9-item self-report instrument, which assesses the frequency and severity of depressive symptoms (PHQ-9; Kroenke, Spitzer, & Williams, 2001). It has high internal reliability ($\alpha = .89$), sensitivity of 88%, and specificity of 88% for major depression (Kroenke, Spitzer, & Williams, 2001). The PHQ-9 has been validated for use with older adults (Ell et al., 2005), including those with cognitive impairment (Boyle et al., 2011).

Cognitive Failures Questionnaire (CFQ). The CFQ is a 25-item measure that assesses participants' perception of their memory (Broadbent et al., 1982). Participants were asked to estimate how frequently they experience common memory problems (e.g., forgetting appointments, forgetting names of people, forgetting if a light was turned off or if a door was locked, etc.). The measure is positively correlated with other self-report measures of memory, absentmindedness, and slips of action (Broadbent et al., 1982).

Frequency of Forgetting-10 Scale. The Frequency of Forgetting-10 Scale is a 10-item measure that assesses participants' judgement about their cognitive capabilities (Zelinski & Gilewski, 2004). Participants were asked to rate how confident they were in their memory abilities (e.g., how distressing memory problems were, overall confidence in memory, etc.).

Experimental Design and Procedure

A pre-post plus quasi-experimental design with a three-month follow-up was employed to evaluate the potential benefits of the cognitive training program. After signing a consent form (approved by the Institutional Review Board), the researchers administered a battery of neuropsychological tests to assess the six cognitive domains targeted by the program. Tests were administered one week prior to starting the program, within one week following the completion of the program, and then again at the three-month follow-up. At each testing period, participants also completed measures of memory self-efficacy and mood. The measures took approximately 60 minutes to administer.

Results

A within-subjects repeated measures analysis of variance (ANOVA) was conducted on each individual measure. This was done to determine if there were meaningful differences between pre-, post-, or follow-up testing for each given measure. If a main effect was discovered in the overall model of the repeated measures ANOVA, then pairwise comparisons were examined to determine where significant differences were. If a significant difference was found from one testing period to another on a given measure, then an effect size statistic (Cohen's *d*) was computed to determine the magnitude of the difference. According to Cohen, $d \geq 0.20$ is a small effect size, $d \geq 0.50$ is a moderate effect size, and $d \geq 0.80$ is a large effect size (Cohen, 1988). Effect sizes provide a measure of clinical significance as opposed to evaluating solely the statistical significance (i.e., rareness of a result). Results are explained for each of the six cognitive domains that were targeted in the cognitive training program. A full summary of results can be found in Table 2 of the Appendix.

Attention.

RBANS Attention and Concentration Index Score. Results from the repeated measures ANOVA revealed no main effect, $F(1.49, 26.74) = 0.63$, $p = 0.50$, indicating no significant differences between any of the three testing periods for the domain of attention. A Greenhouse-Geisser adjustment of the degrees of freedom was performed due to a violation of the assumption of sphericity.

Visuospatial skills.

RBANS Visuospatial and Constructional Index Score**.** A main effect was discovered for the domain of visuospatial skills, $F(2, 36) = 5.03$, $p = 0.01$. There was a significant difference (*p*

= 0.03) between pre-test (*M* = 101.95, *SD* = 17.55) and post-test (*M* = 111.21, *SD* = 13.55). In addition, a moderate effect (*d* = 0.60) from pre-test to post-test was found.

***WAIS-IV Visual Puzzles*.** A main effect was not found for this additional measure of visuospatial skills, *F*(2, 36) = 1.82, *p* = 0.18, indicating no significant differences between pre-, post-, or follow-up testing periods on this measure.

Memory.

***RBANS Immediate Memory Index Score*.** Results revealed a main effect for the domain of immediate memory, *F*(2,36) = 4.15, *p* = 0.02. There was a significant difference (*p* = 0.03) between post-test (*M* = 103.53, *SD* = 15.77) and follow-up test (*M* = 110.53, *SD* = 15.78). In addition, a moderate effect (*d* = 0.67) from post-test to follow-up test was found.

***RBANS Delayed Memory Index Score*.** A main effect was discovered for the domain of delayed memory, *F*(2, 36) = 15.46, *p* = 0.00. There was a significant difference (*p* = 0.02) from post-test (*M* = 102.95, *SD* = 17.15) to follow-up test (*M* = 108.79, *SD* = 14.87). In addition, a moderate effect (*d* = 0.67) from post-test to follow-up test found. There was also a significant difference (*p* = 0.00) from pre-test (*M* = 98.16, *SD* = 16.31) to follow-up test (*M* = 108.79, *SD* = 14.87). In addition, a large effect (*d* = 1.39) from pre-test to follow-up test was found.

Language.

***RBANS Language Index Score*.** No main effect was discovered for the domain of language, *F*(2, 36) = 0.58, *p* = 0.56, indicating no meaningful differences between any of the three testing periods for the domain of language.

Processing speed.

***Trail Making Test Part A*.** Scores were very similar between all three testing periods on Trail Making Test Part A and no main effect was discovered, $F(2, 36) = 0.44$, $p = 0.65$, indicating no significant improvement on this measure of processing speed.

Problem solving.

***Trail Making Test Part B*.** There were slight differences between pre-, post-, and follow-up test scores on Trail Making Test Part B, however, no main effect was discovered, $F(2, 36) = 1.02$, $p = 0.37$, indicating no significant improvement on this measure of executive functioning/problem solving.

Global cognitive functioning.

***RBANS Total Scaled Score*.** Results from the repeated measures ANOVA revealed a main effect for the Total Scaled Score on the RBANS, $F(2, 36) = 9.23$, $p = 0.00$. This is a composite measure of all index scores on the RBANS and is a measure of global cognitive functioning. There was a significant improvement ($p = 0.01$) from pre-test ($M = 100.16$, $SD = 16.54$) to follow-up test ($M = 111.11$, $SD = 11.82$). In addition, a moderate effect ($d = 0.76$) from pre-test to follow-up test was found.

Non-cognitive measures.

***Patient Health Questionnaire-9 (PHQ-9)*.** All scores were in the healthy range (0-5) on the PHQ-9 at pre-, post- and follow-up assessment. There was no main effect for this measure of depressive symptoms, $F(2, 36) = 0.04$, $p = 0.96$, indicating no significant differences between testing periods.

***Cognitive Failures Questionnaire (CFQ)*.** All scores were in the average range on the CFQ at pre-, post- and follow-up test. A main effect was not discovered for this measure of minor cognitive errors occurring in everyday life, $F(2, 36) = 0.76$, $p = 0.47$, indicating no significant differences between testing periods.

Frequency of Forgetting-10 Scale. All scores were in the average range on the Frequency of Forgetting-10 Scale at pre-, post- and follow-up test. There was no main effect for this measure of memory self-efficacy, $F(2,36) = 1.82$, $p = 0.18$, indicating no significant differences between testing periods.

Discussion

The results of this study provide preliminary support for the use of the *Mind Sharpener* cognitive training program with healthy older adults. In general, there was improvement in the domains of global cognitive functioning, visuospatial skills, immediate memory and delayed memory. When examining the domain of global cognitive functioning, significant improvement from pre-test to follow-up test was discovered, suggesting improvement over time and maintenance of gains three months after the class was completed. This finding is consistent with the results of a recent meta-analysis that showed multi-component cognitive training programs that focused on improving global cognitive functioning for healthy older adults produced improvements over time (Basak, Qin, & O’Connell, 2020). This finding is particularly promising given that participants in the current study had global cognitive functioning scores in the average range at baseline, so there presumably was little room for improvement in the overall sample.

Additionally, this study found improvements in visuospatial skills, immediate memory, and delayed memory. This is consistent with previous research on cognitive training programs for healthy older adults (Ball et al., 2002; Gross et al., 2012). For the domain of visuospatial skills, significant improvement from pre-test to post-test was found, indicating short-term improvement. This result could be related to the content of the cognitive training program.

Classes included a variety of visuospatial tasks that required mental rotation or reversal of visual stimuli. For the domain of delayed memory, significant improvement was discovered from post-test to follow-up test and from pre-test to follow-up test, indicating sustained improvement in this domain following the cognitive training program. Sustained improvement was also discovered in the domain of immediate memory, as there was a significant improvement from post-test to follow-up test. These results could be related to the content of the cognitive training program as there is a heavy emphasis on memory tasks in the program. Approximately 25% of each class focuses on tasks involving immediate and delayed verbal memory skills similar to those assessed on the RBANS. These findings are particularly relevant to older adults experiencing age-related cognitive decline as many report subjective memory complaints and are most concerned about improving the cognitive domain of memory in improving their overall cognitive health.

Unlike previous research on cognitive training programs for cognitively healthy older adults (Ball et al., 2002), significant improvements in the domains of processing speed, as measured by Trail Making Test Part A, and executive functioning/problem solving, as measured by Trail Making Test Part B, were not discovered. It is possible that the classes did not adequately target these skills. There was relatively little time devoted to processing speed exercises (about five minutes per class). For the domain of executive functioning/problem solving, it is possible that the content of the exercises in the class did not translate to improvements on Trail Making Test Part B, and/or it is possible that this domain is too broad of a construct to influence through a comprehensive cognitive training class like *Mind Sharpener*.

Exploratory analyses were conducted on the cognitive domains of attention and language for which there is little existing empirical research. Results revealed no significant changes in these cognitive domains. It is possible that the tests used to measure these domains did not accurately assess the specific skills taught in the class. For example, “language” is a very broad construct that consists of a variety of abilities. The program includes several language exercises and there was relatively little practice devoted to the specific skills that were on the assessment (i.e., confrontation naming and semantic fluency). Therefore, the test used to measure language abilities may not have accurately assessed the language skills that were targeted in the class. The same reasoning can be applied to the domain of attention, since this is also a very broad domain consisting of a variety of abilities. Additionally, for the domain of language, since this domain is considered an ability of crystallized intelligence as opposed to an ability of fluid intelligence, improvement in this domain may be less likely.

No significant differences were discovered on non-cognitive domains. Previous research has suggested that cognitive training might have a beneficial effect on mood (Brum, Forlenza, & Yassuda, 2009), and so it was predicted that there would be an improvement on scores on the PHQ-9. Scores on the PHQ-9 did not significantly improve over time, although, baseline scores were very low (i.e., in the very healthy range) so there was little room for improvement. Based on previous literature (Rapp et al., 2002), we had also hypothesized that there would be a decrease in the subjective cognitive failures that participants reported. However, there was no change in the Cognitive Failures Questionnaire or the Memory Self-Efficacy Scale (Frequency of Forgetting Scale) following the program. It is possible that using a measure of self-efficacy related to broader cognitive functioning, as opposed to memory only, would produce different results. Additionally, the Cognitive Failures Questionnaire is an outdated instrument, and thus the content may no longer be relevant. Future researchers should consider using newer measures such as the Multifactorial Memory Questionnaire (MMQ; Troyer & Rich, 2002), which includes three subscales regarding memory ability, memory satisfaction and the use of memory strategies.

Limitations and Future Directions

The current study found tentative support for the effectiveness of cognitive training programs for healthy older adults. Although several positive results were found in important cognitive domains, these positive results need to be considered in the context of several limitations. One significant limitation is that there was no control group. The purpose of this study was to assess the effects of a cognitive training program that was already established at an adult community center. Therefore, the researchers were required to conduct the best possible evaluation of a grant-funded program being implemented in a community-based setting as opposed to the community center being required to adhere to the procedures necessary for an internally consistent experimental research study. In addition, a control group was not included due to the high community interest in the cognitive training program and to the needs of the adult community center to maximize utilization of the program because of grant requirements. Future studies will need to incorporate no-intervention control groups as well as active control groups (e.g., book clubs) to determine if the cognitive training program is responsible for changes in cognitive functioning observed in this study.

Another limitation is the relatively small sample size and lack of heterogeneity of the sample, which can be a threat to generalization. Future researchers should look to expand the sample size and include an equal number of males and females from diverse cultural backgrounds.

Some aspects of the assessment process also limit conclusions that can be drawn from this study. For example, pre-, post- and follow-up testing were not always conducted at the same time of day for each participant. Given that cognitive functioning in older adults tends to deteriorate as the day continues (Blatter & Cajochen, 2007), this variation in testing procedure could have resulted in unwanted variability in test scores unrelated to the effects of the program. Additionally, participants were tested with the same form of the RBANS at follow-up test as they were at pre-test. Although these tests were six months apart and were alternated with a different form at post-testing, it is possible, however unlikely, that practice effects occurred on the follow-up test. Significant improvements from pre-test to follow-up test should be interpreted with this possible limitation in mind.

One final limitation is attrition. There were originally 31 individuals who consented to participate in the study. Of these individuals, 26 completed pre- and post-testing, and 19 completed all testing necessary to be included in the final analysis. Participants were informed that they would receive a one-on-one feedback meeting about their individual results one week after their follow-up test as an incentive to their participation. Future researchers could look to provide additional incentives to increase motivation for participation and potentially limit attrition. Future research may also wish to examine the effects of a “concentrated” version of the program that can be delivered in a shorter period. This could involve conducting the 24, one-hour classes over a shorter period (e.g., six weeks) or reducing the total number of classes by increasing the length of classes (e.g., conducting 12, two-hour classes over a period of 6 weeks).

Conclusion

The findings of the current study provide preliminary support for the use of a cognitive training program for healthy older adults. A moderate improvement on global cognitive functioning was observed and small to large improvements were observed on other measures of cognitive functioning. These results are encouraging, particularly considering that the participants already had average levels of cognitive functioning before the program began. 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 and appropriate control groups is needed before making more definitive conclusions about the efficacy of this cognitive training program.

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Appendix

Table 1

Participant Demographics

	n	%	Range	*M*	*SD*
Age			61-92	75.26	8.43
Gender					
Male	13	68.42			
Female	6	31.58			
Ethnicity					
Caucasian	19	100.00			
Education					
High School Degree	5	26.32			
Some College	3	15.79			
Bachelor’s Degree	7	36.84			
Master’s Degree	2	10.53			
Doctoral Degree	2	10.53			

Table 2

Results for Cognitive and Non-Cognitive Measures: Means, Standard Deviations, Repeated Measures ANOVA Main Effects and Pairwise Comparisons, and Cohen's d Effect Sizes for Pairwise Comparisons

	Pre-Test (1)		Post-Test (2)		Follow-Up (3)		ANOVA			
Measure	*M*	*SD*	*M*	*SD*	*M*	*SD*	*F*	*df*	*p* (2-tailed)	*d*
Attention										
	105.95	13.32	103.89	16.33	106.95	10.62	0.63		0.50	
1-2									1.00	-0.26
2-3									1.00	0.18
1-3									1.00	0.08
Visuospatial										
	101.95	17.55	111.21	13.55	110.84	11.63	5.03	2,36	0.01*	
1-2									0.03*	0.60
2-3									1.00	-0.03
1-3									0.09	0.48
Visuospatial (Visual Puzzles; WAIS-IV)										
	13.05	4.29	14.95	4.49	14.53	5.31	1.82	2,36	0.18	
1-2									0.29	0.41
2-3									1.00	-0.12
1-3									0.65	0.34
Immediate Memory										
	106.21	17.34	103.53	15.77	110.53	15.78	4.15	2,36	0.02*	
1-2									0.77	-0.28
2-3									0.03*	0.67
1-3									0.36	0.36
Delayed Memory										
	98.16	16.31	102.95	17.15	108.79	14.87	15.46	2,36	0.00**	
1-2									0.09	0.56
2-3									0.02*	0.67
1-3									0.00**	1.39
Language										
	102.37	10.61	100.21	8.92	102.00	7.79	0.59	2,36	0.56	
1-2									0.71	-0.26
2-3									1.00	0.16
1-3									1.00	-0.04
Processing Speed										
	38.21	12.95	38.68	12.66	36.47	12.71	0.44	2,36	0.65	

1-2									1.00	0.04
2-3									1.00	-0.22
1-3									1.00	-0.15
Executive Functioning/Problem Solving										
	87.63	36.27	93.16	33.87	100.37	47.39	1.02	2,36	0.37	
1-2									1.00	0.15
2-3									1.00	0.22
1-3									0.49	0.40
Global Cognitive Functioning										
	100.16	16.55	106.53	14.74	111.11	11.82	9.23	2,36	0.00**	
1-2									0.08	0.53
2-3									0.09	0.52
1-3									0.01*	0.76
Depressive Symptoms (PHQ-9)										
	1.53	1.50	1.47	1.98	1.42	1.47	0.04	2,36	0.96	
1-2									1.00	-0.05
2-3									1.00	-0.02
1-3									1.00	-0.08
Perception of Memory (CFQ)										
	37.47	10.45	36.42	10.97	35.16	8.69	0.76	2,36	0.47	
1-2									1.00	-0.13
2-3									1.00	-0.17
1-3									0.83	-0.24
Memory Self-Efficacy (Frequency of Forgetting-10 Scale)										
	46.95	8.31	45.89	9.85	46.89	5.64	0.20	2,36	0.82	
1-2									1.00	-0.14
2-3									1.00	0.10
1-3									1.00	-0.01

Note. *p < .05, **p < .001.

Informed Consent for Participation in the Research Study

Purpose
I understand that the purpose of the research study is to evaluate the effects of a cognitive training program.

Participants
I understand that I have been asked to participate because I am not experiencing cognitive decline but may have some minor complaints about declines in my memory or thinking.

Procedure
I understand the experimenter will administer a series of tests which will take about 60 minutes. These tests will assess my memory and other abilities and will be given before starting the classes as well as immediately after completion of the classes.

I understand that I will participate in a series of cognitive training classes (2-3 classes per week for 8-12 weeks and each class will last about 1 hour). These classes involve a number of activities that are meant to "exercise" various skills such as memory, language, and problem solving. The content of the activities is designed to be appropriate for adults, challenging, and enjoyable. The classes are conducted in groups, without about 10 people participating in each group. Classes will be led by activities staff working at my place of residence.

Risks
I understand that there are minimal risks associated with participation in this study. It is possible that I may become frustrated because I do not enjoy participating the classes. If this occurs, I may leave the class or stop attending classes altogether.

Benefits
I understand that I will not be compensated for my participation. The results of this study may yield useful information about how to improve or maintain cognitive functioning in older persons.

Confidentiality
The findings of this study will be completely confidential. Confidentiality will be protected in that no identifying information will be included on any records

Initial: ______

collected during this study. Participants will be assigned an identification number that will be linked to the data collected during this study. All information will be kept in a locked cabinet in Armstrong Hall room 23 and destroyed after three years.

Right to Refuse or Withdraw
I understand that my participation in this research is voluntary. I understand that I may refuse to participate or withdraw from the study at any time without penalty. I understand that I will not be penalized or jeopardize my relationship with Minnesota State University as a result of withdrawal from the study.

Questions
I have been informed that if I have questions, I am free to ask them. I understand that if I have any additional questions later, I may contact the office of the principal investigator Jeffrey Buchanan, Ph.D. at (507) 389-5824. If you have questions about participants' rights and for research-related injuries, please contact the Administrator of the Institutional Review Board at (507) 389-1242.

Closing Statement
My signature below indicates that I have decided to participate in a research study; that I have read this form; that I understand it; that I have had all my questions answered; and that I have received a copy of this consent form.

______________________________	____________________
Signature of Participant	Date
______________________________	____________________
Signature of Investigator	Date

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