THE EFFECTS OF CARD PLAYING ON COGNITION

by

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A Thesis

Submitted to the Faculty of Purdue University

In Partial Fulfillment of the Requirements for the degree of

Master of Science

Department of Speech, Language, & Hearing Sciences

West Lafayette, Indiana

August 2018

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For my family, friends, and professors

ACKNOWLEDGMENTS

First and foremost, I'd like to thank my mentor, Dr. Jessica Huber. Without her support and guidance, many more mistakes would have been made along my journey to complete this project. Her complete faith in me made me feel like I could indeed complete this project, however unfounded I thought her confidence was at the time.

Next, I'd like to thank the rest of my committee, Dr. Jiyeon Lee and Courtney Johnson. The knowledge and suggestions they provided throughout the process tremendously helped guide the direction and completion of this project.

Thank you to all the members of the Motor Speech Lab. Without their assistance this project could never have been completed. They made this experience the best it could have been with their advice, guidance, and ability to make even the most mundane task fun.

I'd like to thank my friends for providing a reprieve from the stress of the project as well as graduate school. Without the breaks they provided, my life would have been much less entertaining and lively during the completion of my project.

A huge thank you to my family, especially my parents, for continually supporting and encouraging me along the way. Their never-ending confidence and support not only helped me reach for my dreams, but helped me accomplish them. I am eternally grateful for the support they have provided me throughout my life, and I hope to one day be as incredible of a parent as they both were to me.

Last, but not least, I'd like to thank Joshua Selbo, my wonderful fiancé. I most certainly would have been at my wits end throughout this process without you in my life. Your words of encouragement helped me push through the most trying of times. You inspire me every day to become the best version of myself there is and without your support, I would not have been able to complete this project.

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ABSTRACT

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Institution: Purdue University
Degree Received: August 2018
Title: The Effects of Card Playing on Cognition
Major Professor: Jessica Huber

The present study aimed to examine the potential effects of card playing and socialization on cognition. Participants completed a battery of cognitive tests in order to obtain a baseline of cognitive function. Each participant was randomized to one of three training paradigms: group socialization, group card playing, and individual card playing. The socialization group met once a week for an hour for eight weeks and discussed topics of their choice. The card playing groups played Hearts either in a group or on the computer for one hour a week for eight weeks. After eight weeks of their training, participants completed post-testing which consisted of the same battery of cognitive tests in order to measure changes in cognition from pre- to post-testing. The results revealed that participants who were exposed to socialization during training demonstrated the most significant improvements on the cognitive tests. Groups that only received the card playing intervention demonstrated little change. Greatest improvement was seen for those tests that indexed verbal information processing, such as the Cognitive Linguistic Quick Test language domain, the California Verbal Learning Test, and the Excluded Letter Fluency test.

INTRODUCTION

As individuals age cognitive function declines, including processing speed, executive function, working memory, and attention (Leung et al., 2015). Even though cognitive function declines with age, neuroplasticity, the brain's ability to adapt to different stimuli and environments, is still intact (Strobach & Karbach, 2016). One way to improve cognitive function in older adults is through creating an environment in which the brain is challenged such as during cognitive training. Many researchers have found that cognitive training improves or maintains aspects of cognitive function in both typically aging individuals as well as those with cognitive impairment (La Rue et al., 2013, Small, 2008, Svenningsson, Westman, Ballard, & Aarsland, 2012, Mowszowski et al., 2010, and Rizkalla, 2015).

There are different approaches to determine the focus of cognitive training, two of which are compensating for memory problems and restoring memory (Mowszowski et al., 2010). Compensatory training aims to teach a new approach that bypasses the individual's impairment in order for the individual to complete a task more effectively. Compensatory training typically uses the learning technique of strategy training to lower the demands of the task (Brom & Kliegel, 2014). An example of strategy training is learning memory tricks, such as mnemonic devices, to remember grocery lists or forgotten words and then practicing the use of that strategy (Pike, 2014 and Paquin, Wilson, Cellard, Lecomte, & Potvin, 2014). Conversely, restorative cognitive training involves teaching techniques to recover impaired skills in order to improve functioning on tasks. The technique used to restore cognition is typically drill-and-practice, which consists of learning a specific task and practicing it to improve the cognitive function targeted in the task (Brom & Kliegel, 2014). During drill-and-practice training, the difficulty of the task increases over time and

requires individuals to intrinsically develop a strategy to complete the task efficiently (Paquin et al., 2014). Both compensatory and restorative training can be utilized to target multiple cognitive skills such as processing speed, attention, working memory, and executive functioning (Mowszowski et al., 2010). In addition, both techniques can be administered by a computer program or by a trained individual. In order to be considered cognitive training, it must be administered for a minimum duration of four hours for both techniques (Mowszowski et al., 2010 and Leung et al., 2015). Whether the training strategy is compensatory or restorative, the overarching goal is the same. The goal is to learn techniques with guided practice that target strategies and skills individuals can utilize in daily living (Mowszowski et al., 2010).

Compensatory and restorative aims can be seen within the three groups of prevention: primary prevention, secondary prevention, and tertiary prevention (Thal, 2006 as cited by Mowszowski et al., 2010). Primary prevention is used for healthy older adults, defined as mid-sixties and older, to reduce the likelihood of cognitive decline (Pike, 2014). Secondary prevention is targeted at individuals who are considered "at risk" for dementia and have a diagnosis of mild cognitive impairment, a common precursor to dementia. Lastly, tertiary prevention is utilized for individuals who have been diagnosed with dementia and aims to slow the progression of the disease.

Primary Prevention Studies/Cognitive training in older adults

Healthy older adults who utilize cognitive training fall into the primary prevention group for cognitive training (Thal, 2006, as cited by Mowszowski et al., 2010). Several studies have investigated the cognitive benefits healthy older adults can experience as a result of the use of cognitive training (Small, 2008 and Reijnders, Van Heugten, & Van Boxtel, 2013). In one study,

Reijnders and colleagues performed a meta-analysis involving cognitive training's impact on healthy older adults. The meta-analysis included twenty-one distinct studies, with the most common outcome measure of memory performance. Of the twenty-one studies investigated, seventeen of them found significant improvements in memory after intervention. The studies used a variety of tests to determine memory function including: working memory tasks, recognition task, face-name learning tasks, learning potential, recall tasks, Rivermead Behavioral Memory Test, Repeatable Battery for the Assessment of Neuropsychological Status, Rey Auditory Verbal Learning Test, and memory strategy use. Due to the vast number of tests used to determine memory performance, comparing strategies across studies proved difficult for researchers, although general memory improvement within studies was observed. Eight studies investigated changes in executive functioning through cognitive training, five of which found significant effects. Several studies found significant improvement on fluid intelligence, attentional tasks, and speed of processing. One study utilized a measure of general cognitive functioning and found an increase after training (Reijnders et al., 2013).

Reijnders and colleagues (2013) also investigated the design of the studies using the Consort item checklist for each of the studies. The Consort item checklist was developed to increase the quality of randomized control studies by providing a checklist of items that should be included in research articles. The checklist helps ensure that enough information is given on the studies to increase the reliability of the evidence given in the articles (Moher, Hopewell, Schulz, & Altman, 2011). In the Reijnders and colleagues (2013) study, the average Consort rating of the studies was forty-four percent, with a range of scores from sixteen to seventy-three percent. In addition to the Consort item checklist, researchers discussed transfer, subjective measures, and practice-related improvements seen in several of the eight non-randomized control studies. One

study showed near transfer effects but no far transfer effects, meaning the intervention only improved performance on similar tasks. Two studies used subjective outcome measures of perceptual speed, episodic memory, and working memory. Lastly, one study showed practice-related improvement with no significant transfer effects. Overall, Rijnders and colleagues concluded that improved cognition can be seen in healthy older adults through cognitive training although some of the studies demonstrated weaknesses in research design.

Secondary Prevention Studies/Cognitive Training in individuals with cognitive impairment

Individuals in the secondary prevention group, such as individuals with mild cognitive impairment (MCI), have a significantly higher chance of dementia (Mowszowski et al., 2010). In fact, the annual conversion rate of MCI to dementia is approximately 10-15% compared to a conversion of 1-2% for healthy older adults (Li et al., 2011). Researchers have investigated two separate approaches to combatting MCI progressing toward dementia: pharmaceutical techniques and cognitive training. However, many pharmaceutical techniques prove to be insufficient after an extended period of time. In a double-blind study by Petersen et al. (2005), researchers found that the tested pharmaceutical treatments were initially effective in slowing cognitive decline but became equivalent to the placebo treatment in terms of disease progression after a period of three years. Thus, attention in the scientific community has turned to cognitive training as a means to combat MCI. Several studies have investigated the effects of cognitive training on individuals with MCI and have found that cognitive training does improve memory and aspects of cognitive performance (La Rue et al., 2013, Svenningsson et al., 2012, and Li et al., 2011).

In one study, Li and colleagues (2011) conducted a meta-analysis on research utilizing cognitive training with individuals with MCI. Researchers included seventeen articles that

investigated six domains: memory, executive function/working memory, attention/processing speed, visuo-spatial ability, performance on the Mini Mental State Examination (MMSE), and emotional state. Through the meta-analysis researchers found that individuals with MCI in intervention groups benefitted significantly more in overall cognition, self-ratings, episodic memory, executive functioning, and working memory when compared to individuals with MCI in control groups. Effect sizes for the MMSE, semantic memory, attention, visuo-spatial ability, language, self-rated memory, depression, anxiety, and activities of daily living did not reach statistical significance. Even though the effect size did not reach significance, the intervention groups' effect sizes were larger than the control groups'. In addition, researchers found that an individual's self-rated quality of life and activities of daily living improved from cognitive training intervention. Seven of the seventeen studies investigated the long-term effects of cognitive training and the largest long-term effect on individuals with MCI was self-rated quality of life. Moderate effects were seen for attention and processing speed and small effects were observed in overall cognition, MMSE, episodic memory and executive function. Three of the seven studies also provided follow-up data including episodic memory and self-rated memory for the MCI controls who did not receive cognitive training. No long-term effects were observed in the two areas investigated in the MCI controls. Based on these results, cognitive training impacts cognition in individuals with MCI (Li et al., 2011).

Tertiary Prevention Studies/Cognitive Training in individuals with dementia

Individuals diagnosed with dementia fall into the group of tertiary prevention. There are many different forms of dementia, the most common being Alzheimer's disease. While the specific cognitive skills impacted differ across the types of dementia, in general, cognitive impairment

reduces an individual's quality of life, increases the risk of nursing home admission, and increases the caregiver's burden (Svenningsson et al., 2012). Many cases of dementia go undiagnosed and untreated in primary care. Thus, the burden of care falls on the primary caregivers of the individual, usually family members. In 2012, this resulted in an estimated 17.5 billion dollars of unpaid help by family members and primary caregivers (La Rue et al., 2013). Several studies have found that cognitive training has positively impacted cognition for individuals with dementia (La Rue et al., 2013, Svenningsson et al., 2012, and Sitzer, Twamley, & Jeste, 2006). Sitzer et al. (2006) conducted a meta-analysis investigating the effects of cognitive training on individuals with Alzheimer's disease. Researchers analyzed nineteen different studies involving both compensatory and restorative cognitive training techniques. Studies that used compensatory strategies had the greatest effect size in domains of performance-based activities of daily living, informant-rated cognitive problems, and verbal and visual learning. Studies that utilized restorative training techniques had the greatest effect size in domains of verbal and visual learning, memory and self-rated general functioning. Four of the five studies that had the largest effect sizes in this analysis used restorative intervention rather than compensatory techniques. Researchers hypothesized that cognitively-stimulating individuals is more beneficial because the compensatory techniques taught by researchers are harder for individuals with Alzheimer's disease to employ in their everyday lives. In order to improve the effects of compensatory training, strategies should be easily transferrable to individuals' everyday lives (Sitzer et al., 2006).

Cognitive Training and Socialization

Studies have investigated the effects of multimodal training, or cognitive training, in conjunction with other stimulating activities such as socialization. Researchers have found that

increased level in engagement in different domains of daily activity leads to a lower risk of developing dementia (La Rue et al., 2013). Healthy individuals, individuals at risk for dementia, and individuals with dementia all show increased benefits after multimodal training. Two studies conducted by Davidson (2003) and Glie et al. (2005) revealed that multimodal training promotes optimal brain state in older adults (as cited in Pike, 2014). The additional component of socialization also improves individuals' subjective perceptions of therapy, increasing therapy participants' satisfaction with therapy (Alders, 2012 as cited in Pike, 2014). Based on the evidence cited above, providing multiple domains of stimulation during cognition training is beneficial for a variety of populations of individuals for whom cognitive training is recommended.

Shortcomings of Cognitive Training

Across all levels of cognitive ability, benefits of cognitive training can be seen. However, even with the promising outcomes of cognitive training, some shortcomings are present. For example, a trained individual needs to be hired or a computer program needs to be purchased in order for cognitive training to be administered (Mowszowski et al., 2010). The tasks provided by the therapist or computer program are described as repetitive exercises (Rizkalla, 2015). The repetitive nature of cognitive therapy may lead to individuals becoming disinterested with the tasks or causing them to lose motivation. Along with the repetitive nature of the tasks, many cognitive training tasks involve written language. A formal education may not have been accessible to older adults, which means their reading abilities may not be adequate for traditional cognitive training techniques (Elias & Wagster, 2007 and Sitzer et al., 2006). Even if reading abilities are adequate for the tasks required by cognitive training, many feel mentally fatigued after multiple weeks of

training. This fatigue can lead to frustration with the task at hand and even a decrease in cognitive functioning (Pike, 2014).

Aside from the difficulties in the training tasks themselves, the transfer of these tasks prove problematic. The ideal type of transfer in cognitive training is far transfer, which means that the training will develop skills to help individuals on tasks completely unrelated to the task for which they were trained in their everyday life. Little transfer effects have been found for strategy-based trainings and small to moderate near transfer effects have been found in process-based cognitive training (Strobach & Karbach, 2016). Near transfer effects have been seen in working memory and executive functioning intervention with very small far transfer effects (Strobach & Karbach, 2016). Due to the shortcomings of cognitive therapy in terms of transfer and the tasks themselves, alternative methods should be investigated in order to find a more accessible and enjoyable technique to combat cognitive decline and one in which transfer effects are more apparent (Mowszowski et al., 2010).

Cognitive Training Through Card Games

One solution to some of the downfalls in traditional cognitive training is to use games as cognitive training tasks. Games are easily accessible and can exercise many complex cognitive skills that are targeted in cognitive training (Briggs, 2000). Specifically, card game players have been investigated in previous studies and participating in card games have shown a positive impact on cognition (Smith & Hartley, 1990). Most card games do not rely on written language skills, which decreases the importance of educational status on training. In addition, card games do not require a trained professional and can be administered by family members or friends, making the activity more accessible than conventional methods. As a result of making cognitive training more

accessible, the frequency of training sessions can be more easily increased. In addition, participants may be more motivated to succeed at games, and participants are practicing techniques they use in everyday life (Briggs, 2000).

Working memory and reasoning are just a few of the cognitive areas that card playing can exercise. Players use working memory in order to remember cards that have been played and also use reasoning to infer what cards other players could have in their hand. Smith and Hartley (1990) investigated bridge players' abilities on working memory tasks as well as reasoning tasks and found improved ability as compared to non-players (Smith & Hartley, 1990). Due to these reasons, card playing may be an adequate alternative to traditional cognitive training techniques.

Hypothesis

The present study aimed to investigate the effects of cognitive card game training, with and without socialization, on cognition in older adults. Researchers have found increased cognitive improvements in individuals who experienced multiple modes of stimulation such as cognitive training in addition to socialization (Leung et al., 2015, La Rue et al., 2013, and Davidson 2003; Glei et al. 2005 as cited in Pike, 2014, p. 14). Therefore, it was hypothesized that individuals exposed to both cognitive and social stimulation during training would show the most improvement in cognition due to the multimodal nature of engagement.

METHODS

Participants

12 participants were recruited through the Speech, Language, and Hearing Sciences department registry as well as through flyers. In order to be eligible to participate in this study, individuals were required to be at least 65 years of age and not have a diagnosis of dementia or mild cognitive impairment, as indicated by a normal score for their age on the Cognitive-Linguistic Quick Test (CLQT). The CLQT will also be utilized as a measure of cognitive change in pre- and post-testing. Participants also needed normal or corrected hearing and vision per participant report and results from a hearing screening administered at 500, 1000, and 2000 Hz at 40dB. FOA12 initially failed the hearing screening at 500Hz at 55dB, but received a hearing aid prior to the start of training. A summary of participant information and medication is presented in Table 1 and Table 2. Table one provides the gender, age, years of education, time playing cards prior to the study, and time spent playing cards during the study, excluding time in training. Table 2 demonstrates no medications were prescribed to participants to enhance or maintain cognition.

Measures

Participants completed a battery of cognitive tests in order to provide a baseline for cognition. The cognitive test battery included assessments to evaluate premorbid intellectual function, attention, memory, language, processing speed, executive functioning, visuospatial abilities, and fine motor abilities. The cognitive tests as well as their measures are listed in Table 3.

Procedures

Prior to training, the participants attended four hours of pre-testing spread across two days. After consent was obtained, participants were given a questionnaire, the CLQT, and a hearing screening to ensure they met inclusionary criteria. Pre-testing consisted of the assessment battery of cognition as listed in Table 3.

An overall sample size of 12 was recruited and participants were randomly assigned to three groups for 8-week training, one-hour per week; cognition, cognition-socialization, and socialization. Each group consisted of 4 participants. The cognition group independently played hearts online for one hour every week of the training period and will be referred to as the individual card playing group. The cognition-socialization group played hearts in a group for one hour with other participants randomized to this group and will be referred to as the group card playing group. The socialization group conversed with other participants randomized to this group and will be referred to as the socialization group. After the training period, participants completed four hours of post-testing spread across two days. The same cognitive tests were administered in the pre-testing as well as post-testing, but alternate versions were given when available.

All Participants were given written instructions (see appendix, taken from https://cardgames.io/hearts/) on playing hearts to read prior to the first session. At the first session, the researcher summarized the instructions and moderated the rules of the game for both card playing groups (in person and on the computer). After the first session, the researcher moderated play and conversation in the in-person group. When participants continuously conversed for more than five minutes, the researcher redirected participants back to the game. The computer moderated play in the individual computer group, with the researcher present to ensure completion of training.

The online card playing group received identical instructions to the in-person group and instructions were listed on the card playing website (https://cardgames.io/hearts/) underneath the online card playing table. The socialization group was moderated by a researcher who prepared topics related to personal interest to spur conversation when it lagged.

RESULTS

A reliable change index ((posttest score - pretest score)/standard error) was utilized to determine the significance of change in the participant's performance on a specific test, although standard deviation was used rather than standard error due to its availability (Jacobson, Follette, & Revenstorf, 1984 and Beeson & Robey, 2006). The normal standard deviation was taken from published test manuals when available and from articles utilizing normative samples. Sources from normative samples are listed in Table 4. Tables 5 through 17 demonstrate the raw data for each test as well as the reliable change index calculated. The level of significance was set at +/- 1, since the denominator was standard deviation rather than standard error (Maas & Farinella, 2012).

Improvements in Socialization Group

In the socialization group, half of the participants (2/4) demonstrated significant improvement on the clock drawing subtest of the CLQT. Other tests where significant improvements were seen by one of the four participants included: the memory and language cognitive domains of the CLQT, the ELF, the FAB, the CVLT, dominant finger tapping, Trails B, and the JLO. Significant worsening of scores was present for the BVMT, FAB, and Rivermead in one of the four participants. Additionally, three of the four participants self-reported a significant decrease in executive function as reported by the BRIEF. Subject specific data are presented below.

FOA05 demonstrated improvement that reached significance on the clock drawing portion of the CLQT (1.89), the CVLT (1.25), dominant finger tapping (1.42), and Trails B (-1.87, for this test a reduction is an improvement). Conversely, FOA05 demonstrated significantly reduced performance that reached significance on the FAB (-1.63). This significant decrease in

performance resulted from difficulty following a finger tapping sequence in post-testing. FOA05 self-reported a significant decrease in the behavioral regulation index (-1.35) and the metacognition index (-1.55) components of the BRIEF.

FOA06 demonstrated significant improvement on the memory (1.12) and language (1.28) domains on the CLQT. The increased score in both domains resulted from an improvement on the story retell and generative naming tasks of the CLQT. FOA06's scores worsened significantly on the BVMT (-1.55) and Rivermead (-2.14) from pre- to post- testing. The decrease in performance on the Rivermead resulted from lower scores on first and second name recall, picture recognition, delayed story retell, and face recognition. FOA06 self-reported a significant decrease in the behavioral regulation index (-1.20) of the BRIEF.

FOA11's scores increased significantly on the CLQT's clock drawing (1.89) and the Judgment of Line Orientation (1.43) tests.

FOA12 demonstrated significantly increased performance on the ELF (1.32) and FAB (2.90) from pre- to post-testing. The increase in performance on the FAB resulted from low scores across subtests of the FAB during pre-testing and marked improvement across subtests during post-testing. This improvement may be due to difficulty hearing instructions during pre-testing which was alleviated in post-testing by use of a hearing aid. FOA12 self-reported a significant decrease in the behavioral regulation index (-1.26) of the BRIEF.

Improvements in Group Card Playing

Within the group card playing setting, half of the individuals (2/4) demonstrated significant improvements on the CVLT. Other tests where one of the four individuals' scores significantly improved include: the memory and language cognitive domains of the CLQT, the clock drawing

subtest of the CLQT, the BVMT, the ELF, the COWA, the digit span backward, dominant finger tapping, and the behavioral regulation index and metacognition index components of the self-reported BRIEF. Tests that one of the four participants demonstrated significantly worsened performance include the clock drawing subtest of the CLQT. Subject specific data are presented below.

FOA02's scores significantly increased from pre- to post-testing in both the CVLT (1.75) and backward Digit Span (1.30). Her scores significantly decreased on the CLQT clock drawing subtest (-1.26).

FOA03 maintained her performance on the cognitive test battery, with no score changes reaching significance.

FOA08 demonstrated a significant increase in the memory (1.35) and language (1.28) domains of the CLQT, the ELF (1.97), the COWA (1.09), and dominant finger tapping (1.42). The increase on both domains of the CLQT resulted from increased scores on the story retell and generative naming subtests. FOA08 demonstrated significant improvement on the self-reported components of the BRIEF including the behavioral regulation index (2.02) and metacognition index (1.53).

FOA10's scores significantly increased on the clock drawing subtest of the CLQT (1.26), the BVMT (1.55), and the CVLT (1.37).

Improvements in Individual Card Playing

In the individual card playing group, one participant (FOA04) discontinued training due to lack of motivation. Three participants completed pre-testing, training, and post-testing. Significant improvement was seen in one of the three participants on the memory and language domains of

the CLQT, the BVMT, the CVLT, and the behavioral regulation index and metacognition index components of the self-reported BRIEF. Significantly worsened performance was seen in one of three participants in the clock drawing subtest of the CLQT, the memory and language cognitive domain of the CLQT, the Rivermead and the behavioral regulation index component of the self-reported BRIEF.

FOA01 demonstrated significantly increased performance on the memory (1.09) and language (1.17) domains of the CLQT and significantly decreased performance on the clock drawing subtest of the CLQT (-1.11). Increased performance on both the memory and language cognitive domains of the CLQT resulted from improved scores on the story retell and generative naming portions of the CLQT. FOA01 self-reported a significant decrease in executive function in the behavioral regulation index (-1.30) of the BRIEF.

FOA07's scores decreased significantly on the memory (-1.35) and language (-1.28) domains of the CLQT and the Rivermead (-1.23). The decrease in performance in both domains of the CLQT resulted from a decrease in story retell subtest. Increased difficulty on the immediate and delayed story retell, face recognition, and novel puzzle task subtests of the Rivermead resulted in the significant decrease in performance observed at post-testing.

FOA13 demonstrated increased performance on the BVMT (2.23), the CVLT (1.12), and the behavioral regulation index and metacognition index components of the self-reported BRIEF.

DISCUSSION

The present pilot study served the purpose of examining card playing and socialization's impact on cognition. It was hypothesized that individuals in the group card playing training would show the most improvements due to the social and cognitive stimulation they would be exposed to. Findings revealed that the individuals who were exposed to any type of socialization demonstrated the most significant improvements. This means that both the socialization group and group card playing group demonstrated more improvements compared to the individual card playing group. Tests that demonstrated the most significant changes include the CLQT, CVLT, BVMT, ELF, and finger tapping. Three of these five tests (CLQT, CVLT, and ELF) heavily rely on verbal information processing and changes to the CLQT were driven by improved subscores in areas strongly supported by verbal information processing, providing support that tests related to verbal information processing were most sensitive to change.

The CLQT detected significant improvements in the clock drawing subtest, the memory domain, and the language domain across participants. In the groups with social interactions, 37.5% (3/8) of participants showed significant improvements in the clock drawing subtest of the CLQT. Conversely, 12.5% (1/8) participants in groups with social interactions showed significant decreased performance. In the group without social interaction, 33% (1/3) demonstrated significant decreased performance on the clock drawing subtest. Along with the clock drawing subtest of the CLQT, the language and memory domains elicited significant changes in participants. In the groups with socialization, 25% (2/8) demonstrated significantly increased improvement on both the memory and language components of the CLQT. No significant decrease in performance was observed on the language and memory components of the CLQT in the groups with socialization.

In the group without socialization, 33% (1/3) demonstrated significant improvements on the memory and language domain and 33% (1/3) demonstrated significant decrease of performance on the memory and language domain of the CLQT. The language and memory domains significantly improved or worsened in tandem across participants, and there were no instances of a significant improvement or worsening in one of the two domains without the other. The language domain of the CLQT is comprised of personal facts, confrontation naming, story retelling, and generative naming. The memory domain of the CLQT is composed of personal facts, story retelling, design memory, and generative naming. There is an overlap of story retelling and generative naming subtests within both the language and memory domain and these two subtests drove the change observed in the individual's performance. Both the story retelling and generative naming subtests rely on verbal information processing and may be more indicative of a change in language and verbal information processing rather than memory. This idea is supported by the lack of significant change in the Rivermead, a memory test. The Rivermead consists of participants recalling immediate and delayed information about personal items, face recognition, object recognition, stories, routes, orientation, and a novel task. If the change was caused by an improvement in memory, increases in performance on the Rivermead would have been observed in conjunction with the improvement on the memory domain of the CLQT. Due to no change being observed on participants' Rivermead performance, it is likely that the improvement in performance on the memory domain of the CLQT was driven by increased verbal information processing.

The CVLT captured significant increases in score for four participants with no significant decreases. The CVLT requires participants to recall a lists of words five times immediately after presentation and after a 20-minute delay with and without cues. In groups that incorporated socialization, 37.5% (3/8) of participants demonstrated significant improvement. In groups

without socialization, 33% (1/3) of individuals demonstrated significant improvement. These significant score increases may be attributable to a learning effect of the test. The test categorizes sixteen nouns into four groups and initially asks participants to recall items in any order. Later in the test the participants use a cued recall in which the category the objects fall into is given (e.g. "name all items that are methods of transportation"). The cued recall provides the participants the strategy of chunking, which helps them break down larger information into smaller meaningful segments. If participants remembered the strategy of chunking in post-testing, this may account for the significant improvement observed on performance of the CVLT that may be the result of a compensatory strategy and not improved memory function.

The BVMT identified two improvements between groups. The BVMT consists of participants being shown a stimulus page for 10 seconds and then asked to draw as many of the figures they can recall immediately after presentation and again after 25 minutes. Participants are then asked to identify figures that were presented on the stimulus page after a 25-minute delay. In the groups with socialization, 12.5% (1/8) of individuals demonstrated significantly increased performance, and 12.5% (1/8) of individuals demonstrated significantly decreased performance. Conversely, in the group without aspects of socialization, 33.3% (1/3) of participants demonstrated a significant increase in performance. The BVMT utilizes memory by asking individuals to recall and draw figures. This test relies on visuospatial abilities and does not rely on verbal information processing. Thus, socialization did not play a role in improvements on visuospatial skills based on these results.

The ELF captured two significant improvements across groups. The ELF requires participants to list words that do not contain "A", "E", and "I" for 90 seconds each. In groups with socialization, 25% (2/8) of participants demonstrated significantly increased performance. In the

individual card playing group, no individuals demonstrated a significant change in performance. The ELF consists of naming words that do not include a certain letter, such as the letter “e”. This test relies on vocabulary size, lexical access speed, updating, and inhibition ability of an individual (Shao, Janse, Visser, & Meyer, 2014). Again, this demonstrates the importance socialization has on tests relying on verbal information processing components.

Finger tapping detected two significant changes across groups as well. The finger tapping test consists of participants tapping their fingers five times with each hand for ten second intervals. Of individuals in groups with aspects of socialization, 25% (2/8) of them demonstrated significant improvement. No individuals in a group without socialization demonstrated significant change. This test was added as a measure unrelated to aspects of cognition that we anticipated to not change through training. There are several explanations as to why these significant changes occurred. One of which is the time of day varied between post- and pre-testing, which may have positively impacted participants. Another cause of this change could be the amount of arthritis pain an individual felt that day which may have been due to weather changes. Several participants complained of arthritis pain and this may have impacted their performance.

The BRIEF, a self-reported test of daily executive function, demonstrated that card playing groups displayed an increase in self-perceived executive functioning. In the card playing group and individual card playing group 28.6% (2/7) of individuals self-reported a significant improvement in executive function in both the behavioral regulation index and metacognition index. However, 14.3% (1/7) of individuals in a card playing group self-reported a significant decrease in improvement in the behavioral regulation index of the BRIEF. Conversely, in the socialization group, 75% (3/4) individuals self-reported a significant decrease of executive function in the behavioral regulation index of the BRIEF. Additionally, 25% (1/4) individuals in

the socialization group reported a significant decrease in self-perceived executive function in the metacognition index of the BRIEF. This suggests that even though individuals in a group with some form of socialization demonstrated the most significant improvements on cognitive tests, participants did not perceive their cognition as changing. Individuals who were a part of a card playing group were more likely to self-rate a significant increase in cognition than individuals in the socialization group. This decrease in perception of executive function within the socialization group may be due to outside factors influencing the individual. For example, at post-testing FOA05's husband underwent a surgery during training and she was beginning the process of moving, which may have impacted her perception of her executive function. Additionally, FOA12 dealt with several health difficulties throughout training, which again may have impacted her self-perception of her executive function. Factors within the training could have influenced the changes in BRIEF scores as well. These factors could be comparing their cognitive abilities to others within the group, which could decrease their perceived executive function abilities. These two factors within the training and outside of the training may have influenced participants' perception of their executive function.

There are a number of potential reasons for our finding of more improvements in groups that included social interactions. One reason for greater significant improvements may be because personal interactions were more motivating. Individuals in the socialization group may have been motivated to remember personal information about their peers in order to not repeat previously discussed information and to appear competent and caring to their peers. Individuals in the group card playing may have had more motivation to obtain better scores and improve faster to perform at the level of their peers. For example, in the group card playing several women would try to team up against each other to try to prevent someone from shooting the moon or ensure someone would

get more points. Another example is that one woman went home and looked up tricks of hearts in order to perform as well as her peers. Both of these examples demonstrate increased motivation in the group card playing compared to the individual card playing group. In addition to motivation, the game was much slower in the group card playing. While the slower game resulted in fewer rounds completed in training, it may have aided in processing information and more careful decisions by participants. Conversely, on the computer, all the opponents' cards were played within the span of a few seconds, which made it more likely for participants to focus less attention on the cards their opponents played. This may have led to less time to process information and decreased ability to make the most informed choice by participants. Lastly, many of the tests where improvements were observed dealt with aspects of verbal information processing. For example, improvements were seen on the language domain of the CLQT, ELF, and CVLT. In both the group card playing and socialization group, verbal information processing was stimulated through their social interaction, which may be why tests relying on verbal information processing showed improvements.

The participant (FOA08) that demonstrated the most significant improvements across tests was 92 years old at the time of the study and the oldest participant. She significantly improved on 5 of the tests and her performance did not significantly decrease on any tests. Additionally, her self-rating of her executive function significantly improved in the behavioral regulation index and metacognition index of the BRIEF. Her age may have been a factor in the reason behind the large number of significant improvements observed. The next most significant improvements by a participant (FOA05) were on four tests with a significant decrease on one test. FOA05 self-rated a significant decrease in executive function in the behavioral regulation index and metacognition index of the BRIEF. FOA05 was 72 at the time of the study and the average age of participants

was 79. FOA05's age falls below the average age and FOA08's age is above the average age of participants. Age may be one of the contributing factors in the amount of significant improvements observed on the cognitive tests, but does not explain all of the results. Future studies should try to explain the mechanisms that drive variability in cognitive change across participants.

One limitation of the current study is the low number of participants. In addition, all participants were Caucasian females, which may skew the results. Another limitation of this study was the brevity of training. If training were longer, there may have been more robust significant increases in scores. Future research should investigate if the results can be replicated with a larger sample size, more diverse participants, and a longer training period.

Overall, tests that relied on verbal information processing demonstrated the most significant improvements within groups that experienced social interactions during training. Groups that only received the card playing intervention demonstrated little change. Tests including the CLQT language domain, the CVLT, and the ELF demonstrated more significant increases in groups with aspects of socialization. In sum, social interactions resulted in the most significant improvements on a variety of cognitive tests.

TABLES

Table 1: Participant Information

Participant	Gender	Age	Years of Education	Time reported playing cards pre-training	Avg. Time per week spent playing cards during study (hours/week)	Group
FOA01	Female	68	12	doesn't play regularly	0	Indv. Card
FOA02	Female	72	18	doesn't play regularly	0	Group Card
FOA03	Female	82	16	none	0.875	Group Card
FOA04	Female	68	14	not playing now, used to play once a month for three hours (Euchre)	0	Indv. Card
FOA05	Female	72	18	none	0	Social
FOA06	Female	78	17	infrequently	11 (FreeCell)	Social
FOA07	Female	74	18	1-2 hours per week	0.604	Indv. Card
FOA08	Female	92	17	9 hours/week	4.375	Grp. Card
FOA10	Female	77	18	3-6 hours/week	5.125	Grp. Card
FOA11	Female	90	12	8 hours/week (online, kings on the corner or solitaire)	5.063	Social
FOA12	Female	91	12	several hours/week	2.188	Social
FOA13	Female	79	12	6-12 hours/week (bridge)	9.5	Indv. Card

*It should be noted that the hour playing cards in training was not counted in the average time per week spent playing cards.

**One person (FOA09) was assigned a number, but was never consented

Table 2: List of Participant Medications

Participant	Medications
FOA01	None
FOA02	81mg baby aspirin; multivitamins; 18mg Lisinopril 1/day; 10mg Atorvastatin 1/day; 300mg Labetalol 1/day
FOA03	81mg low dose aspirin 1/day; Sr. multivitamins 1/day; 1000mg Vitamin D3 2/day; 500mg Vitamin C 1/day; 250mg Magnesium 1/day; 7.5mg Meloxicam 1/day; 320mg Valsartan 1/day; 25mg Hydrochlorothiazide 1/day; 200mg Hydroxychloroquine 2/day
FOA04	175 micrograms 1/day; 50mg Metoprold 1/2 tap 2/day; 10-20mg Mamlod/Benzopril 1/day; 25mg Hydrochlorothiazide 1/day; 1mg Alprazolam 1/2 a day; 50 mg Tramadol 2x/day; 300mg Gabapentin 3x/day
FOA05	20mg Simvastatin 1/night; 70mg Fosamax 1/week; 25mg Losartan-HCTZ 1/day; 1mg Anastrozole 1/day; 25mg Metoprolol 1/night
FOA06	20mg Atorvastatin 1/day
FOA07	None
FOA08	Timolol Mal; 25mg Chlorthalidone; 50mg Atenolol; 50mg Losartan
FOA10	25mg Hydrochlorothiazide 1/2 tab; 40mg Simvastatin 1/day; multiple vitamin mineral; 600mg calcium/vit D; acid reducer; 81mg aspirin; ibuprofen as needed
FOA11	325mg aspirin 1/day; calcium 3x/day; 12.5mg Hydrochlorothiazide 1/day; 1 caps caps 2x/day; 100mg Losartan potassium 1/day; 40mg Simvastatin 1/day; Tylenol; 400mg vitaminD3 2/day
FOA12	20mg Lisinopril 1/day; 2000mg Vitamin D3 1/day; Latanoprost 1drop/day; Dorzolamide 1drop/day; 81mg aspirin 1/day
FOA13	10mg Lisinopril; 80mg Lovastatin; Spiriva

Table 3: List of Tests

Neuropsychological Test Battery		
Test name	**Sections of Test**	**Brief Description**
Word Reading		
Wechsler Test of Adult Reading (or WTAR-4 Reading)	Entire Test	The participant will read 50 words with irregular spelling.
Attention		
Wechsler Adult Intelligence Scale (WAIS)-IV	Digit Span	The participant will repeat back numbers in the order the examiner stated them and recall the numbers in reverse order.
Cognitive Linguistic Quick Test (CLQT)	Attention Domain	The participant will find a specific symbol among distractors, retell a story, alternate connecting lines between circles and triangles in ascending size, remember designs, complete mazes, and create unique designs out of four lines.
Memory		
Rivermead Behavioural Memory Test (RBMT)-3	Entire Test	The participant will recall immediate and delayed information about personal items, face recognition, object recognition, stories, routes, orientation, and a novel task.
California Verbal Learning Test (CVLT)-2	Entire Test	The participant will recall several lists of words.
Brief Visuospatial Memory Test (BVMT)-R	Entire Test	The participant will be shown the stimulus page for 10 seconds and then draw as many of the figures they can recall immediately and after 25 minutes. The participant will be asked to identify figures that were presented on the stimulus page (after 25 minutes).
Cognitive Linguistic Quick Test (CLQT)	Memory domain	The participant will recall personal facts, retell a story, name items within a certain category or beginning with a certain letter, and remember designs.
Executive Function		
Trails	Part B	The participant will connect numbers and letters as quickly as possible, alternating between the two in ascending order.
Frontal Assessment Battery (FAB)	All sections	The participant will describe similarities between objects, say as many words beginning with the letter “S”, repeat a motor series, follow conflicting instructions by tapping once when the examiner taps twice (and vice versa), and inhibit a reflexive response.
Excluded Letter Fluency (ELF)	Entire Test	The participant will list words that do not contain “A”, “E”, and “I” for 90 seconds each.
Behavior Rating Inventory of Executive Function(BRIEF)-A	Entire Test	The participant will self-report executive functioning in daily life.

Table 3 Continued

Cognitive Linguistic Quick Test (CLQT)	Executive Functions Domain	The participant will alternate connecting lines between circles and triangles in ascending size, name items within a certain category or beginning with a certain letter, complete mazes, and create unique designs out of four lines.
Visuospatial		
Rivermead Behavioral Memory Test (RBMT)-3	Picture recognition, Facial Recognition, Route, Novel Task	The participant will recall immediate and delayed information about face recognition, object recognition, routes, and a novel task.
Judgment of Line Orientation (JLO)	Entire Test	The participant will choose two lines from an array that are replicas of two lines individually presented.
Cognitive Linguistic Quick Test (CLQT)	Visuospatial Skills Domain	The participant will find a specific symbol among distractors, alternate connecting lines between circles and triangles in ascending size, remember designs, complete mazes, and create unique designs out of four lines.
Verbal		
Rivermead Behavioral Memory Test (RBMT)-3	Stories, Orientation	The participant will recall orientation information and immediate and delayed information about a story.
Controlled Oral Association Test	Entire Test	The participant will name as many words beginning with C in one minute, and then using the same procedure the participant will name words beginning with F and L.
Cognitive Linguistic Quick Test (CLQT)	Language Domain	The participant will recall personal facts, name picture items, retell a story, and name items within a certain category or beginning with a certain letter.
Motor and Coordination		
Trails	Part A	The participant will connect numbers in ascending order as quickly as possible.
WAIS-IV	Digit Symbol Coding	The participant will be given a key and asked to record associations between the symbols and numbers. Then, the key will be covered, and the participant will fill in the symbols associated with the numbers from memory.
Finger tapping	Entire Test	The participant will tap their fingers five times with each hand for ten second intervals.
Depression		
Patient Health Questionnaire-9 (PHQ-9)	Entire Test	The participant will rate how often they have experienced certain problems over the past two weeks.

Table 4: Sources for Normative Samples

Test	Where normative SD came from
BRIEF	Published test manual
BVMT-R	Published test manual
CLQT	Published test manual
COWA	(Tombaugha, Kozakb, & Reesc, 1999)
CVLT	(Woods, Delis, Scott, Kramer, & Holdnack, 2006)
Digit Span	(Choi et al., 2014)
Digit Symbol	unavailable
ELF	(Barry, Bates, & Labouvie, 2008)
FAB	(Coen et al., 2016)
Finger Tapping	(Arnold et al., 2005)
JLO	(Calamia, Markon, Denburg, & Tranel, 2011)
PHQ-9	unavailable
Rivermead	Published test manual
Trails	(Tombaugh, 2004)
WTAR	(Bright, Hale, Gooch, Myhill & Van Der Linde, 2016)

Table 5: CLQT RCI and Raw Scores

Subject	Age	Group	Pre Score	Post Score	RCI
FOA05	72	Social	clock: 9 attention: 190 memory: 182 executive functions: 24 language: 34 visuospatial skills: 84	clock: 12 attention: 12 memory: 180 executive functions: 25 language: 35 visuospatial skills: 79	clock: 1.89* attention: -0.28 memory: 0.07 executive functions: 0.23 language: 0.43 visuospatial skills: -0.39
FOA06	78	Social	clock: 12 attention: 196 memory: 169 executive functions: 29 language: 33 visuospatial skills: 92	clock: 13 attention: 202 memory: 184 executive functions: 32 language: 36 visuospatial skills: 94	clock: 0.63 attention: 0.17 memory: 1.12* executive functions: 0.70 language: 1.28* visuospatial skills: 0.16
FOA11	90	Social	clock: 10 attention: 189 memory: 148 executive functions: 27 language: 30 visuospatial skills: 87	clock: 13 attention: 192 memory: 146 executive functions: 23 language: 29 visuospatial skills: 75	clock: 1.89* attention: 0.08 memory: -0.15 executive functions: -0.93 language: -0.43 visuospatial skills: -0.94
FOA12	91	Social	clock: 10 attention: 179 memory: 173 executive functions: 23 language: 30 visuospatial skills: 83	clock: 10 attention: 171 memory: 162 executive functions: 21 language: 29 visuospatial skills: 79	clock: 0.00 attention: -0.22 memory: -0.82 executive functions: -0.46 language: -0.43 visuospatial skills: -0.31
FOA02	72	Group Card	clock: 13 attention: 208 memory: 178 executive functions: 34 language: 35 visuospatial skills: 100	clock: 11 attention: 204 memory: 172 executive functions: 32 language: 34 visuospatial skills: 98	clock: -1.26* attention: -0.11 memory: -0.45 executive functions: -0.46 language: -0.43 visuospatial skills: -0.16
FOA03	82	Group Card	clock: 13 attention: 206 memory: 176 executive functions: 30 language: 33 visuospatial skills: 98	clock: 13 attention: 207 memory: 182 executive functions: 29 language: 34 visuospatial skills: 97	clock: 0.00 attention: 0.03 memory: 0.45 executive functions: -0.23 language: 0.43 visuospatial skills: -0.08

Table 5 continued

FOA08	92	Group Card	clock: 13 attention: 198 memory: 153 executive functions: 30 language: 30 visuospatial skills: 93	clock: 12 attention: 201 memory: 171 executive functions: 31 language: 33 visuospatial skills: 96	clock: -0.63 attention: 0.08 memory: 1.35* executive functions: 0.23 language: 1.28* visuospatial skills: 0.23
FOA10	77	Group Card	clock: 11 attention: 202 memory: 182 executive functions: 30 language: 34 visuospatial skills: 94	clock: 13 attention: 204 memory: 179 executive functions: 34 language: 36 visuospatial skills: 97	clock: 1.26* attention: 0.06 memory: -0.22 executive functions: 0.93 language: 0.85 visuospatial skills: 0.23
FOA01	68	Individual Card	clock: 13 attention: 201 memory: 156 executive functions: 29 language: 28 visuospatial skills: 99	clock: 12 attention: 209 memory: 169 executive functions: 32 language: 31 visuospatial skills:	clock: -1.11* attention: memory: 1.09* executive functions: language: 1.17* visuospatial skills:
FOA07	74	Individual Card	clock: 12 attention: 207 memory: 184 executive functions: 31 language: 36 visuospatial skills: 97	clock: 12 attention: 204 memory: 166 executive functions: 34 language: 33 visuospatial skills: 100	clock: 0.00 attention: -0.08 memory: -1.35* executive functions: 0.70 language: -1.28* visuospatial skills: 0.23
FOA13	79	Individual Card	clock: 11 attention: 203 memory: 169 executive functions: 28 language: 31 visuospatial skills: 97	clock: 11 attention: 200 memory: 160 executive functions: 28 language: 32 visuospatial skills: 92	clock: 0.00 attention: -0.08 memory: -0.67 executive functions: 0.00 language: 0.43 visuospatial skills: -0.39

* Only significant scores are listed

** Subtests utilized for RCI: Clock score, attention domain, executive functions domain, language domain, visuospatial skills domain

*** Pre and Post: raw scores from test

Table 6: CVLT RCI and Raw Scores

Subject	Age	Group	Pre Score	Post Score	CVLT
FOA05	72	Social	48	58	1.25*
FOA06	78	Social	54	56	0.25
FOA11	90	Social	41	41	0.00
FOA12	91	Social	40	47	0.87
FOA02	72	Group Card	58	72	1.75*
FOA03	82	Group Card	68	69	0.12
FOA08	92	Group Card	79	77	-0.25
FOA10	77	Group Card	61	72	1.37*
FOA01	68	Individual Card	35	34	-0.12
FOA07	74	Individual Card	70	74	0.50
FOA13	79	Individual Card	66	75	1.12*

* Only significant scores are listed

** Subtests utilized for RCI: Trial 1-5 combined raw score

*** Pre and Post: raw scores from test

Table 7: BVMT RCI and Raw Scores

Subject	Age	Group	Pre	Post	BVMT
FOA05	72	Social	16	16	0.00
FOA06	78	Social	19	10	-1.55*
FOA11	90	Social	4	8	0.69
FOA12	91	Social	9	10	0.17
FOA02	72	Group Card	20	19	-0.18
FOA03	82	Group Card	21	17	-0.69
FOA08	92	Group Card	18	20	0.34
FOA10	77	Group Card	17	26	1.55*
FOA01	68	Individual Card	17	12	-0.89
FOA07	74	Individual Card	29	27	-0.34
FOA13	79	Individual Card	16	29	2.23*

* Only significant scores are listed

** Subtests utilized for RCI: Total Recall from Trials 1-3

*** Pre and Post: raw scores from test

Table 8: ELF RCI and Raw Scores

Subject	Age	Group	Pre	Post	ELF
FOA05	72	Social	36	34	-0.33
FOA06	78	Social	45	50	0.82
FOA11	90	Social	32	34	0.33
FOA12	91	Social	21	29	1.32*
FOA02	72	Group Card	62	66	0.66
FOA03	82	Group Card	33	32	-0.16
FOA08	92	Group Card	41	53	1.97*
FOA10	77	Group Card	50	51	0.16
FOA01	68	Individual Card	32	30	-0.33
FOA07	74	Individual Card	49	54	0.82
FOA13	79	Individual Card	44	47	0.49

* Only significant scores are listed

** Subtests utilized for RCI: Raw Score

*** Pre and Post: raw scores from test

Table 9: Finger Tapping RCI and Raw Scores

Subject	Age	Group	Pre	Post	Finger Tapping
FOA05	72	Social	dominant: 20 non-dominant: 24.33	dominant: 26 non-dominant: 32	dominant: 1.42* non-dominant: 0.81
FOA06	78	Social	dominant: 33.67 non-dominant: 34.33	dominant: 29.67 non-dominant: 35	dominant: -0.66 non-dominant: 0.07
FOA11	90	Social	dominant: 37.33 non-dominant: 34	dominant: 43.33 non-dominant: 28.33	dominant: 0.98 non-dominant:-0.60
FOA12	91	Social	dominant:26.33 non-dominant: 23.67	dominant: 27 non-dominant: 19.67	dominant: 0.11 non-dominant: -0.42
FOA02	72	Group Card	dominant:30 non-dominant: 34	dominant: 35.33 non-dominant: 38.33	dominant:0.87 non-dominant: 0.46
FOA03	82	Group Card	dominant:31 non-dominant: 33.67	dominant: 34.67 non-dominant: 28.33	dominant:0.60 non-dominant:-0.56
FOA08	92	Group Card	dominant: 29.67 non-dominant: 33.67	dominant: 38.33 non-dominant: 36.33	dominant: 1.42* non-dominant: 0.28
FOA10	77	Group Card	dominant: 38.67 non-dominant: 39.67	dominant: 44 non-dominant: 35.67	dominant: 0.87 non-dominant:-0.42
FOA01	68	Individual Card	dominant: 40.67 non-dominant: 42.67	dominant: 41.33 non-dominant: 42.33	dominant: 0.11 non-dominant: -0.04
FOA07	74	Individual Card	dominant: 30.67 non-dominant: 28.67	dominant: 35 non-dominant: 28.6	dominant: 0.71 non-dominant: -0.01
FOA13	79	Individual Card	dominant: 45 non-dominant: 33.33	dominant: 40 non-dominant: 34	dominant: -0.82 non-dominant: 0.07

* Only significant scores are listed

** Subtests utilized for RCI: Dominant and Non-dominant hand means

*** Pre and Post: raw scores from test

Table 10: BRIEF RCI and Raw Scores

Subject	Age	Group	Pre	Post	BRIEF
FOA05	72	Social	BRI: 56 MI: 67 GEC: 63	BRI: 47 MI: 52 GEC: 50	BRI: -1.35* MI: -1.55* GEC: -0.84
FOA06	78	Social	BRI: 58 MI: 60 GEC: 60	BRI: 50 MI:54 GEC: 52	BRI: -1.20* MI: -0.62 GEC: -0.52
FOA11	90	Social	BRI: 42 MI: 44 GEC: 42	BRI: 39 MI: 43 GEC: 41	BRI: -0.38 MI: -0.11 GEC: -0.06
FOA12	91	Social	BRI: 57 MI: 53 GEC: 55	BRI: 47 MI: 44 GEC: 45	BRI: -1.26* MI: -0.98 GEC: -0.62
FOA02	72	Group Card	BRI: 63 MI: 47 GEC: 54	BRI: 60 MI: 47 GEC: 53	BRI: -0.45 MI: 0.00 GEC: -0.06
FOA03	82	Group Card	BRI: 42 MI: 58 GEC: 51	BRI: 46 MI: 59 GEC: 54	BRI: 0.51 MI: 0.11 GEC: 0.19
FOA08	92	Group Card	BRI: 46 MI: 59 GEC: 54	BRI: 62 MI: 73 GEC: 69	BRI: 2.02* MI: 1.53* GEC: 0.93
FOA10	77	Group Card	BRI: 46 MI: 48 GEC: 47	BRI: 41 MI: 52 GEC: 47	BRI: -0.75 MI: 0.41 GEC: 0.00
FOA01	68	Individual Card	BRI: 47 MI: 38 GEC: 41	BRI: 37 MI: 38 GEC: 37	BRI: -1.30* MI: 0.00 GEC: -0.22
FOA07	74	Individual Card	BRI: 48 MI: 63 GEC: 57	BRI: 48 MI: 68 GEC: 60	BRI: 0.00 MI: 0.52 GEC: 0.19
FOA13	79	Individual Card	BRI: 39 MI: 38 GEC: 38	BRI: 47 MI: 53 GEC: 53	BRI: 1.20* MI: 1.87* GEC: 0.97

* Only significant scores are listed

** Subtests utilized for RCI: Behavioral regulation index (BRI), metacognition index (MI), global executive composite (GEC)

*** Pre and Post: raw scores from test

Table 11: COWA RCI and Raw Scores

Subject	Age	Group	Pre	Post	COWA
FOA05	72	Social	36	34	-0.16
FOA06	78	Social	45	50	0.39
FOA11	90	Social	32	34	0.18
FOA12	91	Social	21	29	0.73
FOA02	72	Group Card	62	66	0.31
FOA03	82	Group Card	33	32	-0.09
FOA08	92	Group Card	41	53	1.09*
FOA10	77	Group Card	50	51	0.08
FOA01	68	Individual Card	32	30	-0.15
FOA07	74	Individual Card	49	54	0.39
FOA13	79	Individual Card	44	47	0.23

* Only significant scores are listed

** Subtests utilized for RCI: Raw Score

*** Pre and Post: raw scores from test

Table 12: FAB RCI and Raw Scores

Subject	Age	Group	Pre	Post	FAB
FOA05	72	Social	16	14	-1.63*
FOA06	78	Social	18	18	0.00
FOA11	90	Social	16	16	0.00
FOA12	91	Social	9	15	2.90*
FOA02	72	Group Card	17	18	0.81
FOA03	82	Group Card	18	18	0.00
FOA08	92	Group Card	17	18	0.64
FOA10	77	Group Card	16	17	0.74
FOA01	68	Individual Card	16	15	-0.63
FOA07	74	Individual Card	17	18	0.73
FOA13	79	Individual Card	17	16	-0.53

* Only significant scores are listed

** Subtests utilized for RCI: Total Raw Score

*** Pre and Post: raw scores from test

Table 13: RVMD RCI and Raw Scores

Subject	Age	Group	Pre	Post	RVMD General Memory Index
FOA05	72	Social	84	85	0.06
FOA06	78	Social	148	115	-2.14*
FOA11	90	Social	92	87	-0.32
FOA12	91	Social	81	77	-0.26
FOA02	72	Group Card	116	109	-0.45
FOA03	82	Group Card	99	101	0.13
FOA08	92	Group Card	121	111	-0.65
FOA10	77	Group Card	124	121	-0.19
FOA01	68	Individual Card	86	77	-0.58
FOA07	74	Individual Card	135	116	-1.23*
FOA13	79	Individual Card	117	130	0.84

* Only significant scores are listed

** Subtests utilized for RCI: General Memory Index

*** Pre and Post: raw scores from test

Table 14: WTAR RCI and Raw Scores

Subject	Age	Group	Pre	Post	WTAR
FOA05	72	Social	47	46	-0.14
FOA06	78	Social	45	47	0.29
FOA11	90	Social	30	32	0.29
FOA12	91	Social	30	24	-0.86
FOA02	72	Group Card	48	49	0.14
FOA03	82	Group Card	45	47	0.29
FOA08	92	Group Card	38	36	-0.29
FOA10	77	Group Card	46	46	0.00
FOA01	68	Individual Card	28	29	0.14
FOA07	74	Individual Card	47	47	0.00
FOA13	79	Individual Card	31	36	0.72

* Only significant scores are listed

** Subtests utilized for RCI: Total Raw Score

*** Pre and Post: raw scores from test

Table 15: Digit Span RCI and Raw Scores

Subject	Age	Group	Pre	Post	Digit Span
FOA05	72	Social	forward score: 13 backward score: 6	forward score: 12 backward score: 5	forward score: -0.50 backward score: -0.68
FOA06	78	Social	forward score: 12 backward score: 7	forward score: 14 backward score: 7	forward score: 0.70 backward score: 0.00
FOA11	90	Social	forward score: 6 backward score: 6	forward score: 6 backward score: 6	forward score: 0.00 backward score: 0.00
FOA12	91	Social	forward score: 11 backward score: 4	forward score: 10 backward score: 4	forward score: -0.35 backward score: 0.00
FOA02	72	Group Card	forward score: 15 backward score: 12	forward score: 15 backward score: 14	forward score: 0.00 backward score: 1.30*
FOA03	82	Group Card	forward score: 10 backward score: 7	forward score: 8 backward score: 6	forward score: -0.70 backward score: -0.68
FOA08	92	Group Card	forward score: 11 backward score: 9	forward score: 13 backward score: 9	forward score: 0.70 backward score: 0.00
FOA10	77	Group Card	forward score: 13 backward score: 7	forward score: 13 backward score: 8	forward score: 0.00 backward score: 0.68
FOA01	68	Individual Card	forward score: 10 backward score: 7	forward score: 11 backward score: 6	forward score: 0.35 backward score: -0.68
FOA07	74	Individual Card	forward score: 8 backward score: 7	forward score: 8 backward score: 7	forward score: 0.00 backward score: 0.00
FOA13	79	Individual Card	forward score: 11 backward score: 11	forward score: 10 backward score: 11	forward score: -0.35 backward score: 0.00

* Only significant scores are listed

** Subtests utilized for RCI: Forward and Backward Score

*** Pre and Post: raw scores from test

Table 16: Trails RCI and Raw Scores

Subject	Age	Group	Pre	Post	Trails A and B
FOA05	72	Social	trails A: 53 trails B:132	trails A: 41 trails B: 87	trails A: -0.83 trails B: -1.87*
FOA06	78	Social	trails A: 28 trails B: 68	trails A: 36 trails B: 51	trails A: 0.52 trails B: -0.38
FOA11	90	Social	trails A: 38 trails B: 100	trails A: 48 trails B: 131	trails A: 0.46 trails B: 0.39
FOA12	91	Social	trails A: 53 trails B: 169	trails A: 54 trails B: 111	trails A: 0.05 trails B: -0.74
FOA02	72	Group Card	trails A: 27 trails B: 49	trails A: 23 trails B: 37	trails A: -0.28 trails B: -0.50
FOA03	82	Group Card	trails A: 34 trails B: 62	trails A: 30 trails B: 74	trails A: -0.19 trails B: 0.28
FOA08	92	Group Card	trails A: 24 trails B: 57	trails A: 20 trails B: 59	trails A: -0.14 trails B: 0.03
FOA10	77	Group Card	trails A: 20 trails B: 44	trails A: 18 trails B: 43	trails A: -0.13 trails B: -0.02
FOA01	68	Individual Card	trails A: 30 trails B: 59	trails A: 35 trails B: 73	trails A: 0.42 trails B: 0.48
FOA07	74	Individual Card	trails A: 23 trails B: 47	trails A: 31 trails B: 44	trails A: 0.55 trails B: -0.12
FOA13	79	Individual Card	trails A: 21 trails B: 84	trails A: 23 trails B: 60	trails A: 0.11 trails B: -0.52

* Only significant scores are listed

** Subtests utilized for RCI: Trails A and B

*** Pre and Post: raw scores from test

Table 17: JLO RCI and Raw Scores

Subject	Age	Group	Pre	Post	JLO
FOA05	72	Social	23	26	0.71
FOA06	78	Social	29	26	-0.71
FOA11	90	Social	20	26	1.43*
FOA12	91	Social	20	24	0.95
FOA02	72	Group Card	24	24	0.00
FOA03	82	Group Card	21	24	0.71
FOA08	92	Group Card	27	29	0.48
FOA10	77	Group Card	24	25	0.24
FOA01	68	Individual Card	25	27	0.48
FOA07	74	Individual Card	25	27	0.48
FOA13	79	Individual Card	20	23	0.71

* Only significant scores are listed

** Subtests utilized for RCI: Total Raw Score

*** Pre and Post: raw scores from test

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APPENDIX

Rules of Hearts

1	The objective of Hearts is to get as few points as possible. Each heart gives one penalty point. There is also one special card, the Queen of spades, which gives 13 penalty points.
2	When the game starts, you select 3 cards to pass to one of your opponents. Typically, you want to pass your three worst cards to get rid of them. Which opponent you pass to varies, you start by passing to the opponent on your left, then in the next game you pass to the opponent on your right, third game you pass across the table and in the fourth game there is no card passing.
3	Each turn starts with one player playing a single card, also called leading. The suit of that card determines the suit of the trick. The other players then play one card each. If they have a card in the same suit as the first card, then they must play that. If they don't, then they can play one of their other cards. Once four cards have been played, the player who played the highest-ranking card in the original suit takes the trick, i.e. he takes the four cards on the table and he then starts the next turn. Any penalty cards in the trick (hearts or queen of spades) are added to the player's penalty score. So you want to avoid taking any tricks that have hearts or the queen of spades.
4	The player who has the two of clubs at the start of the game leads in the first hand, and he MUST lead with the two of clubs.
5	You cannot lead a trick with hearts, until hearts has been broken (played on another suit). So if it is your turn to lead and no heart has been played yet then you may not select a heart as the card to play first. In some variations of the game you can't play the queen of spades until hearts has been broken as well, but in this version, you can always play the queen of spades and she doesn't break hearts.
6	In the very first round, you may never play a heart or the queen of spades, not even if you don't have any card in the suit of the lead card.
7	Once all cards have been played, the penalty points are counted and the player with the fewest points wins that hand. When one or more players reach 100 points or more then the entire game is finished, and the player with the least points win. If points are over 100 and there are two or more equal with the least points, then play continues until there's only one winner.

Rules of Hearts Continued

8	Shooting the Moon! Generally, it's bad to get penalty cards, but there is one extra twist! If you get ALL the penalty cards (13 hearts + Queen of spades) then you get 0 points and the other 3 players get 26 points each! This is called Shooting the Moon. Trying this can be a really risky move though, since if another player gets just one of the hearts you'll end up with a lot of points...