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Computer-Based Cognitive Retraining for Individuals with Chronic Acquired Brain Injury: A Pilot Study

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Computer-Based Cognitive Retraining for Individuals with Chronic Acquired Brain Injury: A Pilot Study

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This thesis, written under the direction of Dr. Kitsum Li, OTR/L and approved by the chair of the program, Dr. Ruth Ramsey, OTR/L, has been presented to and accepted by the Faculty of the Occupational Therapy Department in partial fulfillment of the requirements for the degree of Master of Science in Occupational Therapy. The content, project, and research methodologies presented in this work represent the work of the candidates alone.

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Abstract

Objective: The purpose of this study was to evaluate the effectiveness of a computer-based cognitive retraining program, the Parrot Software, on improving cognitive deficits in memory and attention in individuals with a chronic acquired brain injury (ABI).

Research Design: This study utilized a quantitative quasi-experimental one-group pretest-posttest design.

Participants: Eleven adults over 18 years of age who sustained a chronic ABI two or more years prior to participation in the study and demonstrated deficits in memory and attention were included. Only individuals with ABI due to traumatic brain injury, hemorrhagic cerebrovascular accident, or ischemic cerebrovascular accident were included.

Method and Procedures: The study was conducted over a period of five months, during which participants completed a total of eight 60-minute sessions using the Parrot Software. The participants completed eight sub-programs in memory and attention. Pretest and posttest data were collected using the paper version of the Cognistat Assessment (2009). In order to control for bias and create inter-rater reliability, each researcher was trained in administering the standardized Cognistat Assessment (2009) and the Parrot software, and participated in the process of data collection and analysis.

Results: A significant improvement was found in both memory and attention scores post-intervention. No significant correlations were found between memory or attention changes and age, years since injury, and education level.

Conclusion: Computer-based cognitive retraining programs, such as the Parrot Software, may be effective in improving cognitive deficits in memory and attention in individuals

with chronic acquired brain injury; however, further research is recommended to strengthen these findings and to investigate transfer to functional performance.

Introduction/Statement of Problem

An acquired brain injury (ABI) is an insult to the brain that has occurred after birth, which is not hereditary or degenerative, and is often referred to as a "silent" and "invisible" disability (Brain Injury Association of America, 2011). ABIs are primarily caused by ischemic or hemorrhagic cerebrovascular accident, or trauma induced to the head (Holmqvist, Kamwendo, & Ivarsson, 2009). An ABI is considered to be chronic when the resulting cognitive deficits persist after the individual is medically stable. The impairments commonly seen in individuals with chronic ABI can vary from deficits in memory and executive function, to inflexible thought processes, decreased attention, and impaired perception. The occupations, roles, and the overall quality of life of individuals with chronic ABI are affected by the deficits they sustained as a result of the injury.

Occupational therapy is well-suited for addressing the cognitive deficits experienced by individuals with chronic ABI. The remedial approach focuses on "reinforcing, strengthening, or restoring functions that remain partially intact after injury" (ECRI, 2011, p. 2). One remedial intervention utilizes computerized cognitive retraining exercises designed to target specific cognitive deficits such as memory, attention, and visual spatial ability. Many computer programs claim to improve cognitive function; however, there is a paucity of available research that shows that computer-based cognitive retraining (CBCR) is an effective approach for improving cognitive deficits in attention and memory. Therefore, the purpose of our research was to evaluate the effectiveness of a commercially available CBCR program, the Parrot Software, in improving the attention and memory deficits of individuals with chronic ABI.

Literature Review

Introduction

An ABI is an injury to the brain that has occurred after birth (Brain Injury Association of America, 2011). Approximately 2.5 million individuals sustain an ABI in the United States each year, making it a considerable public health concern (Faul, Xu, Wald, & Coronado, 2010; Lloyd-Jones et al, 2009; Turkstra & Kennedy, 2008). ABI is primarily caused by traumatic brain injury (TBI) from an external force or through non-traumatic injury, such as ischemic or hemorrhagic cerebral vascular accidents (Holmqvist, Kamwendo, & Ivarsson, 2009). It disrupts functioning in all areas of daily living, and is often remediated through cognitive rehabilitation and retraining.

As a holistic profession, occupational therapy is well-suited to address the needs of individuals with ABI and their families. Occupational therapists have a profound understanding of the impact that ABI has on human performance in all areas of occupation. Occupational therapists play an important role in modifying the environment, adapting activity demands, instructing clients in compensatory strategies for their deficits, and teaching clients and their families how to cope with the changes that occur after ABI (Blundon & Smits, 2000). Occupational therapists are also instrumental in creating therapeutic programs that are tailored to the individual needs of the client, restoring any cognitive deficits to the highest possible functional level.

This literature review begins with a description of the effects of ABI on cognition and overall functioning in daily life and a discussion of the latest evidence for brain neuroplasticity. We then provide an overview and synthesis of the existing literature on

common cognitive rehabilitation approaches and techniques, and conclude with an evaluation of the efficacy of CBCR programs.

Cognitive Deficits Due to Brain Injury

Depending on the location and severity of the brain injury, individuals can exhibit various deficits that affect cognitive functioning after an ABI (Holmqvist et al., 2009; Tsaousides & Gordon, 2009). The most common cognitive deficits found in individuals with ABI include, but are not limited to: decreased attention, decreased information processing speed, memory deficits, executive function problems, visuospatial deficits, and language difficulties (Ellingsen & Aas, 2009; Handratta, Hsu, Vento, Yang, & Taney, 2010; McCrory, Zazryn, & Cameron, 2007; Mcewen, Huijbregts, Ryan, & Polatjko, 2009; Poggi et al., 2005; Tsaousides & Gordon, 2009).

Himanen et al. (2005) examined the cognitive deficits of individuals with TBIs of various severities using magnetic resonance imaging (MRI) scans. Sixty-one participants, 30 years post-injury, were recruited and screened for overall cognitive impairments. The participants' memory, learning, attention, and executive functions were evaluated in-depth using several assessments. The MRI scans were used to evaluate the relationships between the cognitive deficits and the MRI volumetric findings and locations of local contusions. The researchers found that impairments in memory functions and executive dysfunctions were largely associated with reductions in hippocampus volumes and lateral ventricular enlargement. They also found that the severity of the injury showed only a modest relationship to the severity of cognitive impairments found in the participants. The MRI scan results suggested that the long-term effects of TBI were associated with MRI volumetric changes. The researchers suggested

that the degree of the injury diffusion that led to the brain matter changes was more important than the severity of the TBI. The study showed that TBIs could be dynamic and unpredictable. Therefore, an individual who sustains a TBI or any other ABI should be assessed using various assessments such as self-reports, standardized tests, and medical technology to determine overall deficits, and to predict what effect the brain injury may have on the individual's ability to function (Himanen et al., 2005). Each cognitive deficit can affect individuals in different ways, and no two individuals with ABI will present with the same cognitive deficits (Japp, 2005; Tsaousides & Gordon, 2009).

Cognitive deficits in individuals with ABI vary depending on the severity and the complexity of the brain injury. An individual with a mild ABI may show subtle deficits in cognition that may potentially go unnoticed (Japp, 2005). On the other hand, cognitive deficits are more apparent in individuals with moderate to severe ABIs, resulting in significant cognitive deficits that could limit the individual's functional performance (Japp, 2005; Sloan, Winkler, & Anson, 2007). Deficits are typically seen with activities that require working with multiple tasks simultaneously or tasks that require executive decision making (Japp, 2005). Mild ABI may last for a few months, whereas moderate to severe ABIs tend to be more chronic.

Chronic effects of ABI. Impairments seen with chronic ABI can vary from deficits in memory and executive function to inflexible thought processes, decreased attention, and impaired perception. These impairments, however, are difficult to predict (McCrory et al., 2007; Toneman, Brayshaw, Lange, & Trimboli, 2009). According to Koskinen, O'Connor et al., and Hoofien et al.'s longitudinal studies (as cited in Draper

and Ponsford, 2009), cognitive, behavioral, and emotional changes resulting in slow processing speed, poor attention, lack of motivation, depression, and anxiety continue to occur 10-30 years following an ABI.

Although the exact effects of chronic ABI can be difficult to predict in the long term, the inability to understand and adjust to a new way of functioning can adversely affect an individual's mental and physical state post- injury

Effect of cognitive deficits on individuals with ABI. The occupations, roles and overall quality of life of individuals with chronic ABI are affected by the resulting cognitive deficits. Activities of daily living such as bathing, dressing, and grooming, and instrumental activities of daily living such as meal preparation, balancing a check book, and shopping may be affected post-injury (Blundon & Smits, 2000; Toneman et al, 2009). Sloan et al. (2007) completed a study to explore the long-term functional outcomes, role participation, individual care needs, and community integration in 13 individuals who sustained a severe TBI eight to nine years prior to the study. The participants were asked to participate in a structured interview and completed The Care and Needs Scale, Functional Independence Measure (FIM), Community Integration Questionnaire, and Role Checklist. The researchers found that most of the participants reported having higher support needs. Five participants stated they required 24-hour support; four reported being able to be left alone for only a few hours a day; and only three reported that they were completely independent. The participants' FIM scores were widely spread, showing that independence levels among this population can vary. The majority of the participants reported their housing had changed and 85% of the participants reported that they received outside help with their banking. In terms of

community participation, 62% stated that they could not access the community independently. The researchers concluded that individuals with TBI must be able to take care of themselves before engaging in more complex roles and that social support, financial resources and community integration need to be considered in order to enhance the individuals' functional roles and role participation (Sloan, Winkler & Anson, 2007).

Coming to terms with acquired cognitive deficits and learning to adapt while doing essential tasks can make occupations such as returning to work a difficult process for this population (Bottari, Dassa, Rainville, & Dutil, 2009; Ellingsen & Aas, 2009). Damage in brain regions necessary for functions such as independent navigation, new learning, and awareness of cognitive deficits make previous roles and occupations difficult after the injury has occurred (Ellignsen & Aas, 2009; Sohlberg, Todis, Pickas, Hung, & Lemoncello, 2005). These individuals may require special arrangements for transportation, aids to enter or leave their homes, prompting to initiate tasks, and may need family members to help with completing other everyday tasks (Bottari et al., 2009; Sohlberg et al., 2005).

Neuroplasticity and Brain Injury

Research supports that neurons in the brain are able to alter their structure and function in response to an individual's behavioral, sensory, and cognitive experiences (Hallett, 2005; Kleim & Jones, 2008). This response defines neuroplasticity, the brain's ability to create, strengthen, and modify neurological connections to allow individuals to learn new knowledge and establish new skills (Defina et al., 2009). An ABI often results in damaged brain matter, which alters an individual's physical and cognitive functioning. An individual undergoes rehabilitation following this neurological damage in order to

modify the neural connections for functional relearning (Kimberley, Samargia, Moore, Shakya & Lang, 2010). Understanding the brain's ability to rewire is important when working to facilitate compensatory learning for lost or compromised function (Kleim & Jones, 2008).

In a quasi-experimental study investigating the relationship between the degree of recovery after stroke and the recruitment of brain regions during a task in 46 stroke patients, Ward, Brown, Thompson, and Frackowiak (2003) found that after a stroke, individuals recruited more regions of the brain while completing task-related activities than when performing standard gross motor activities. This study suggested that specific training was beneficial to neuroplasticity after stroke. With the use of a functional MRI, Ward et al. (2003) found that facilitating the use of the affected limb after stroke promoted reorganization in the cortex of the injured region in the brain, demonstrating the brain's ability to adapt and rewire after damage.

Smith et al. (2009) found that implementing a cognitive training program incorporating intensive practice, focus on perceptual speed and accuracy, use of adaptive algorithms, and an emphasis on attention can improve auditory memory and attention. In a randomized controlled trial, 487 community-dwelling older adults without cognitive impairment were either given a computerized cognitive training program or a general cognitive stimulation program. The group receiving the computerized cognitive training program was found to have significantly greater improvements in memory and attention than the group receiving the cognitive stimulation, showing the effectiveness of a computerized cognitive program on attention and memory (Smith et al., 2009).

Neural reorganization and functional improvements occur after a specific task is performed repetitively (Kimberley et al, 2010). Canning, Shepherd, Carr, Alison, Wade, and White (2003) found that increasing the number of repetitions during therapy sessions resulted in an improvement in motor performance in individuals with TBI. Carey et al (2002) found that individuals with chronic stroke and impaired finger movement demonstrated significant cortical reorganization and functional improvement after performing a finger-tracking exercise for over 100 repetitions per day. In a review conducted to provide an overview of accumulated evidence on the effectiveness of various rehabilitation methods for stroke patients, Arya, Pandian, Verma, and Garg (2011) found that repetitive practice caused permanent structural and functional changes in the motor cortex and cerebellum, while simple exercises did not elicit these changes.

Cognitive Rehabilitation for Individuals with ABI

Cognitive rehabilitation is a therapeutic intervention that is frequently used for individuals who have sustained an ABI. It is implemented by multiple disciplines, including occupational therapy, physical therapy, speech therapy, and psychotherapy (ECRI, 2011, p. 2). Cognitive rehabilitation is an individualized and specialized process that is tailored to address the specific cognitive impairments experienced by the client (Salazar et al., 2000). The aim of cognitive rehabilitation is to ameliorate an individual's ability to perform cognitive tasks by relearning previous skills and adopting compensatory strategies (Tsaousides & Gordon, 2009).

The primary goals of cognitive rehabilitation are to recover the individual's ability to process, interpret, and respond to environmental stimuli, and to facilitate appropriate functional outcomes (Friere et al., 2011). Although cognitive rehabilitation is

intended to address cognitive functioning directly, improving cognitive abilities can also lead to enhancement in psychosocial and physical functioning. According to a review of the evidence supporting cognitive rehabilitation compiled by Tsaousides and Gordon (2009), improvements in cognitive, psychosocial, and physical functioning can ultimately result in a higher quality of life for individuals with ABI.

The cognitive rehabilitation process. In order to create a cognitive rehabilitation program that is appropriate for the unique needs of the client, a neurological assessment must be completed (Tsaousides & Gordon, 2009). There are several reasons to include a neurological assessment in the treatment process. Firstly, it identifies the areas of cognitive function that need improvement and gives therapists a clear picture of the extent of the injury. Secondly, it allows therapists to pinpoint and take advantage of the individual's strengths and remaining cognitive skills to support treatment. Lastly, it provides baseline data that can be used to track progression and evaluate the effectiveness of treatment (Tsaousides & Gordon, 2009). Roy, Thornhill, and Teasdale (2002) completed a prospective cohort study to assess the effectiveness of a structured questionnaire and a clinical assessment in identifying the rehabilitation needs of 26 patients with head injuries. The patients first completed a structured questionnaire and were assessed using the Functional Impairment Measure, the Functional Assessment Measure, and the Glascow Outcome Scale in order to identify areas for intervention. The participants then underwent a clinical interview with an experienced Rehabilitation Medicine Physician, who was blinded to the results of the initial interview and assessment. Based on the clinical interview, the physician gave recommendations regarding the interventions needed for addressing the head injury symptoms experienced

by each patient. The results of the clinical interview were then compared to the initial questionnaire and assessment to determine if information derived from the questionnaire process resulted in the same recommendations for services as was generated by the physician. The researchers concluded that using either an approach based on a structured questionnaire and interview, or an approach using in-depth, personalized clinical assessment by a rehabilitation specialist yielded the information required for appropriate service planning to address deficits experienced by individuals with ABI (Roy et al., 2002).

Once the cognitive rehabilitation needs of the client have been identified, therapists must decide which approach will effectively address the deficits and facilitate functional improvement. Cognitive rehabilitation uses a remedial/restorative approach, an adaptive/compensatory approach, or a combination of the two. According to the Emergency Care Research Institute (ECRI), "the restorative (remedial) approach focuses on reinforcing, strengthening, or restoring functions that remain partially intact after the injury, whereas the compensatory (adaptive) approach focuses on teaching patients to use strategies to cope with the impairment" (ECRI, 2011, p. 2). Interventions that employ a remedial approach utilize pen and pencil tasks, computer exercises, or board games designed to target specific cognitive deficits such as memory, attention, and visuospatial ability. Adaptive approaches involve changing the environment and using external devices in order to compensate for cognitive deficits and improve the individual's ability to function independently (ECRI, 2011; Freire et al., 2011; Holmqvist et al., 2009).

Holmqvist et al. (2009) completed a qualitative study to explore occupational therapists' descriptions of their work with clients who experienced cognitive impairments

as a result of ABI. Twelve occupational therapists working in medical rehabilitation, geriatric rehabilitation, adult habilitation, community-based in-client rehabilitation, community-based day care, and community-based occupational therapy in ordinary housing participated in the study. The occupational therapists were interviewed using a structured interview guide. The interviews were then transcribed and analyzed to generate themes surrounding the occupational therapists' descriptions of their work with individuals with ABI. Results showed that the primary remedial interventions used by the therapists targeted impairments in memory, planning, organization, and self-awareness. It also discovered that the therapists preferred using adaptive approaches when working with clients with ABI, and that they regularly integrated assistive devices and compensatory strategies into their interventions (Holmqvist et al., 2009). The results of this qualitative study give insight into cognitive intervention methods frequently used by occupational therapists when treating individuals with ABI.

Blundon and Smits (2000) completed a pilot survey to identify therapeutic approaches and modalities used by Canadian occupational therapists when treating clients with TBI. A questionnaire was developed, tested, and sent to 27 sample sites across Canada where occupational therapists worked with adults who had sustained a TBI. Of these 27 sites, 20 returned the questionnaire and the data were used for analysis. The researchers found that paper and pencil exercises were frequently used to remediate orientation, attention, and memory impairments. Tabletop games were also used to address these impairments and were discovered to be advantageous because they were familiar, non-threatening, and relatively inexpensive. Compensatory modalities that were used most often by the occupational therapists were memory notebooks, wall charts, and

strategies such as the rehearsal of information (Blundon & Smits, 2000). The results of this study were limited, however, by the small sample size.

Remedial/Restorative Strategies. Two evidence-based reviews, one systematic review, and one meta-analysis support the use of remedial/restorative strategies for individuals with ABI (Cicerone et al., 2005; ECRI, 2011; Rees, Marshall, Hartridge, Mackie, & Weiser, 2007; Rohling, Faust, Beverly, & Demakis, 2009). Cicerone et al., (2005) concluded that there was evidence to support the efficacy of remedial rehabilitation approaches for attention, visuospatial, and memory deficits, as well as the effectiveness of rehabilitation programs for remediating executive functioning, problem solving, and awareness. Conversely, the ECRI Institute (2011) completed a systematic review of the literature on cognitive rehabilitation methods and concluded that there was not enough evidence to support the effectiveness of cognitive rehabilitation for treating attention, memory, visuospatial, and executive functioning deficits. Rohling et al. (2009) re-examined Cicerone et al.'s (2005) review using meta-analysis and concluded that therapists should focus their interventions on specific and direct cognitive skills training rather than implementing broad, generalized interventions. An evidence-based review completed by Rees et al. (2007) examined cognitive rehabilitation approaches for four domains of cognition: attention, learning and memory, executive functioning, and general cognitive rehabilitation approaches. The researchers concluded that there was moderate evidence that supports the efficacy of dual-task training for improving processing speed; there was limited evidence that group interventions were effective for treating executive functioning; and there was limited evidence that general cognitive rehabilitation was effective for improving cognition (Rees et al., 2007).

Remedial strategies have been effectively used with individuals who exhibit levels of cognitive impairment ranging from mild to severe. Cicerone (2002) completed a prospective, case-comparison study with eight participants who had experienced a mild TBI. The participants were assigned to either the experimental or the control group, comprised of four participants each. The experimental group was given various attention tasks that were administered in ascending order from least difficult to most difficult. The comparison group received no intervention. The researcher found that the experimental group experienced significant improvement in several measures of attention in comparison to the control group. The results of this study indicated that attention training was effective for individuals with mild TBI (Cicerone, 2002). Conversely, Couillet et al. (2010) completed a randomized AB versus BA crossover study design with twelve individuals who had experienced a severe TBI, in order to evaluate the effectiveness of divided attention training. The participants were divided into two groups: one that started with the divided attention training (experimental condition) and another that started with non-specific cognitive retraining (control condition). Similar to Cicerone's (2002) study, the researchers utilized a hierarchical order for presenting the divided attention tasks. The researchers found that there was a training-related improvement on divided attention for both groups (Couillet at al., 2010). They further discovered that the group who underwent the experimental condition first performed significantly better than the controlled condition group. The results of this study indicated that attention training is also effective for individuals with severe TBI. Thus, it can be concluded that cognitive retraining is appropriate for use with mild to severe TBI.

Computer-Based Cognitive Rehabilitation for Individuals with ABI

The United States Census Bureau (2009) has reported that of the 119,296 households, 68.7% use the Internet at home and 76.7% have someone in the household who is able to access the Internet at some location. Because many individuals use the computer at home, CBCR is appropriate to engage individuals in computer-based rehabilitation to address cognitive deficits. Individuals with cognitive deficits in memory, attention, problem solving, and executive function have difficulty managing activities of daily life and can benefit from computer assisted technology to regain cognitive abilities (de Joode, van Heugten, Verhey, & van Boxtel, 2010). One type of assisted technology that helps improve an individual’s cognitive impairments post-ABI is CBCR. CBCR uses computerized exercises and tasks to train cognitive skills in a game-like program (Chen, Thomas, Glueckauf, & Bracy, 1997). The use of CBCR allows a person to improve cognitive skills needed to “successfully and accurately receive sensory input, process information, and act in as independently and appropriately a manner as possible” (Tam & Man, 2004, p.461). Programs that utilize CBCR can also help identify an individual’s cognitive abilities, and help determine which cognitive skills to work on while using the program.

CBCR is not intended to replace other forms of rehabilitation for individuals with ABI, but is used to supplement intervention in order to remediate the individual’s cognitive skills. CBCR is better suited for individuals post-recovery once the cognitive deficits from the ABI have stabilized. By delaying computer-based interventions until the deficits have stabilized, the effects of spontaneous recovery can be eliminated (Gunning & Clegg, 2005).

Advantages of CBCR. There are many advantages of using CBCR with individuals who have sustained an ABI. Tam and Man (2004) asserted that one of the advantages computers had over other methods for cognitive rehabilitation was that "computers are capable of highly controlled presentation of stimuli in a standardized format and can record data more accurately, consistently, and objectively than can a therapist or observer" (p. 462). The visual and colorful stimuli allow the individual with ABI to become engaged and interested long enough to maintain his or her attention for completing the computerized task. Another advantage is that computerized intervention tasks can be tailored to the individual's abilities, deficits, and needs rather than having the individual adapt to the program (Gunning & Clegg, 2005). Computers are able to give quick, clear, and non-judgmental feedback on the individual's progress. An additional benefit of CBCR is that the program and tasks can be modified according to the individual's progress (Kirch et al., 2004).

CBCR programs. A commonly used CBCR program that has demonstrated mixed results in advancing cognition is the Posit Science of the Posit Science Corporation (San Francisco, CA). The Posit Science is a program developed for individuals with various cognitive levels. However, it is primarily focused on cognitive issues related to healthy aging, rather than cognitive deficits from an ABI (Posit Science, 2011). Barnes, et al. (2009) stated that the program focuses on brain plasticity with seven tasks intended to "improve processing speed and accuracy in the auditory cortex" (p.3). A pilot randomized control trial using 47 individuals with mild cognitive impairments, ages ranging from 54 years old to 91 years old, compared the effects of Posit Science with other computer-based activities. The results showed that the participants in the

study completed the program and did not show significance in the improvement of their cognition (Barnes, et. al, 2009).

Another study by Smith, et al. (2009), used a multi-site randomized controlled double blind trial with two treatment groups. The study was designed to compare the effectiveness of two treatment approaches using 487 community-dwelling adults who were not clinically diagnosed with any significant cognitive impairment. One treatment approach used the Posit Science and the other approach was a general cognitive stimulation program. The researchers concluded that the Posit Science could help improve memory and attention. The researchers also concluded that there was a significantly larger improvement in memory and attention when using the Posit Science compared to other general cognitive programs.

In a controlled experimental study using CBCR to improve memory, Lundqvist, Grundstrom, Samuelsson, and Ronnberg (2010) found that individuals with ABI showed improvements in cognitive functioning after undergoing treatment. The computer training program used for this study was titled QM, formerly named ReMemo, and targeted visuospatial and verbal working memory (WM). Lundqvist et al. (2010) selected a sample of 21 subjects from 76 individuals with ABI and cognitive impairments for a controlled experimental study. The study used a cross over design to examine the short and long-term effects of WM training. The study concluded that QM was successful for improving an individual’s WM. Structured and intense training in the program revealed stronger improvement in the individual’s WM compared to no training. Similarly, another study completed by Westerberg et. al. (2007) found that computerized systematic WM training for individuals recovering from a cerebral vascular accident resulted in

significant improvement in WM and attention. The study also concluded that the increase in WM and attention positively affected the cognitive functioning needed to perform daily activities.

Kerner and Acker (1985) utilized a randomized controlled trial to evaluate the effectiveness of computer memory retraining for 24 participants with mild to severe memory impairments. The participants were divided into three groups: an experimental computer group that used the memory retraining software, a computer control group that used only a graphics program and a control group that was not exposed to any computer work or memory retraining. The researchers found that the treatment group showed an improvement in memory skills as a result of using the memory retraining software. The results of the study indicated that individuals with ABI may experience improvement in memory skills after using a CBCR program, regardless of the level of impairment.

Batchelor, Shores, Marosszeky, Sandanam, and Lovarini (1988) conducted a study to determine if individuals with severe closed-head injuries would benefit more from CBCR than non computer-based cognitive retraining. The study, using a pre-test post-test analysis of covariance test, included 34 participants with severe to extremely severe closed head injuries. Among the 34 participants, the experimental group of 17 received CBCR and the control group of 17 did not received computer-based intervention strategies. The results did not demonstrate significant findings in favor of CBCR for cognitive retraining compared to non computer-based intervention strategies (Batchelor, 1988).

Despite the popularity of CBCR programs, many programs are geared solely for the general population and those with cognitive deficits due to aging. Few CBCR

programs designed specifically for individuals with ABI are readily available. Cognitive rehabilitation approaches using the Posit Science, QM, and standard office software all showed some or little significance in improving cognition in individuals with cognitive impairments. However, minimal evidence or research exists to show that CBCR provides a significant improvement in the cognitive abilities necessary for the completion of activities of daily living by individuals with ABI.

Conclusion

An ABI can affect an individual's life in various ways. Following an ABI, the individual may experience cognitive deficits in numerous cognitive domains, including attention and memory. The brain's ability to rewire and reconnect, also known as neuroplasticity, plays an important role in an individual's recovery following ABI. Neuroplasticity and functional improvements occur in individuals with ABI following task- specific high repetition-based activities.

Cognitive rehabilitation is frequently used with individuals with ABI to improve deficits in cognitive domains and adopt compensatory strategies for cognitive task performance. Cognitive deficits following ABI have been shown to decrease with the use of assisted technology, such as CBCR. CBCR uses computerized exercises and tasks to train cognitive skills in game-like programs. Lundqvist et al (2010) found that subjects who were trained with a computer-based program addressing working memory showed improvement in cognitive function.

Statement of Purpose

Brain Injury Network of the Bay Area (BINBA) is a non-profit organization dedicated to providing a variety of support services to individuals with ABI. These services include support groups, stress management classes, and a day program that offers art therapy, yoga, and other programs to its members. BINBA planned to expand the services available to their participants by including a CBCR program, such as the Parrot Software. In order to receive funding to implement a CBCR program, BINBA needed evidence that supported the effectiveness of the Parrot Software in improving cognitive function in clients with chronic ABI.

Individuals with chronic ABI often exhibit cognitive deficits in memory and attention (Draper & Ponsford, 2009; Toneman et al., 2010). Therefore, the purpose of our study was to determine the effectiveness of the Parrot Software for improving memory and attention for individuals with chronic ABI. Our null hypothesis stated that the Parrot Software would have no effect on memory or attention for individuals with chronic ABI. Our two alternative hypotheses stated that a) the Parrot Software would improve memory and b) the Parrot Software would improve attention for individuals with chronic ABI.

Theoretical Framework: Cognitive Information Processing

Cognitive Information-Processing (CIP), originally introduced in Atkinson and Shiffrin's (1968) model of memory, is a model influenced by cognitive neuroscience and cognitive psychology (Levy, 2011). CIP offers an overview of the process of learning through the structures of the memory systems. According to CIP, information is processed through three stages of memory: (a) sensory-perceptual memory, (b) short-term memory, and (c) long term memory (see Figure 1) (Levy, 2011). Short-term memory can be broken down into *primary memory* and *working memory,* while long-term memory can be categorized into either *explicit memory* or *implicit memory*. CIP provides a perspective on how individuals with ABI process, store and retrieve information within the various stages of memory when using a CBCR program, such as the Parrot Software. Thus, CIP served as the primary theoretical framework for this study.

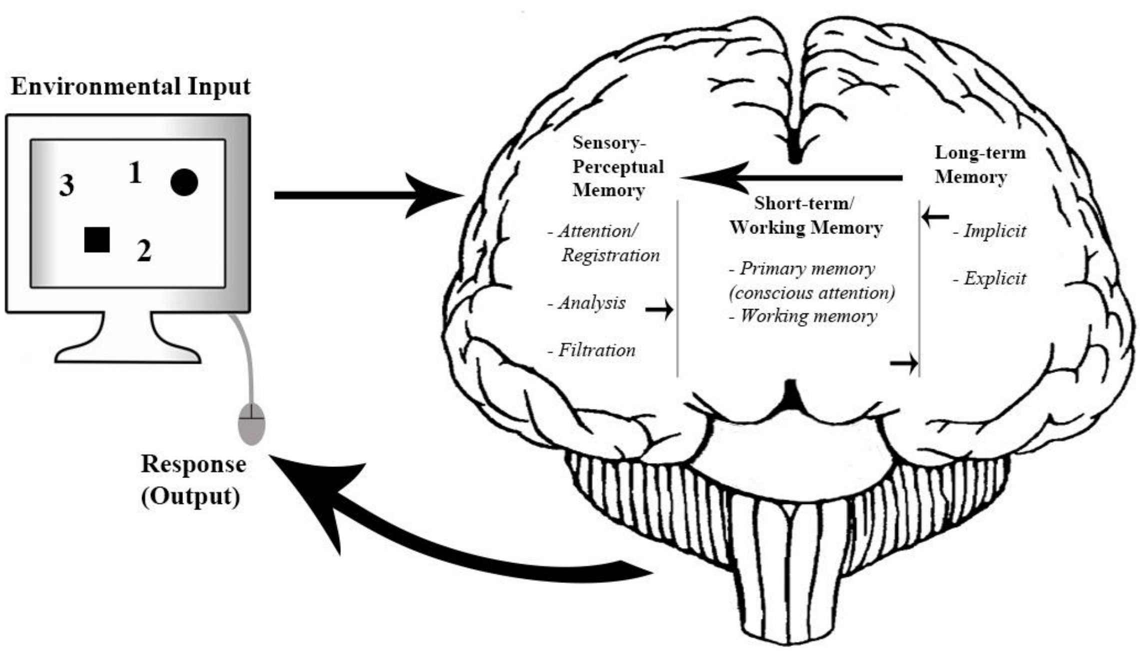

Figure 1: Adapted from Cognitive Information Processing Flow Chart (Levy, 2011)

Sensory-Perceptual Memory

Sensory-perceptual memory is the first stage of CIP. Sensory-perceptual memory is the initial acquisition and processing of sensory information from an environmental stimulus. Attention, which is the ability to maintain a general state of readiness to respond to the external stimulus, is required for information processing (Adamovich, Henderson, & Auerbach, 1985). In the context of the study, attention occurs when the participant is ready and able to receive visual input from the computer screen provided by the Parrot Software.

Once the information was attended to or registered, it was then analyzed and then filtered through the participant's perception. Perception is the ability to process relevant sensory information while filtering out irrelevant sensory information based on factors such as the individual's prior experiences, beliefs, motivation and mood at the moment (Levy, 2011). After the participant filtered the visual input from the CBCR program, the information became sorted and organized in the participant's short-term memory

Short-Term Memory

After sensory-perceptual memory occurs, the information is stored in the next stage, short-term memory. Short-term memory, also known as *active memory,* occurs when the participant consciously attends to the environmental input provided from the computer tasks in the CBCR program. In our study, participants required conscious attention in order to process information from the CBCR program, analyze the information, store the information, and produce a response within short-term memory (Levy, 2011). Short-term memory includes further processing of information from

sensory-perceptual memory and long-term memory, both of which are possible through two components of short-term memory, *primary memory* and *working memory*

Primary memory, which is the initial component of short-term memory, includes the participant's ability to take information from the environmental stimuli, for instance what is viewed on the computer screen, and disregard distractions around the room which could interfere with the participant's ability to maintain their attention on the task (Levy, 2011). The participant's ability to maintain attention requires different forms of conscious attention, including alternating attention, sustained attention, and selective attention. Alternating attention is the ability to attend to external stimuli, while switching between one stimulus and another. Sustained attention is the ability to attend to external stimuli continuously without disruption (McAvinue, O'Keeffe, McMackin, & Robertson, 2005). Selective attention is the ability to filter out or ignore certain stimuli and attend to other specific external stimuli (Willmott, Ponsford, Hocking, & Schönberger, 2009).

Working memory is the second component of short-term memory. During working memory, the participant must maintain attention to analyze both information from primary memory and previously learned information within long-term memory to determine the meaning of the computer task (Simon, 1978; Levy, 2011). Once the meaning of the information from the computer task is determined, the information is used to produce a response output and, if appropriate, store the information into long-term memory for future learning (Levy, 2011). For example, based on the information derived from the CBCR program, if environmental stimuli from the computer screen displayed colored geometric figures, the participant filters and categorizes the figures by shapes and

colors in order to determine a proper response and proceed through the CBCR program, such as clicking on the correct button.

Long-term Memory

Long-term memory is limitless, whereas sensory-perceptual memory and short-term memory both have limited capacity. Long-term memory occurs only when the information is processed multiple times, building the information into chunks to form knowledge (Simon, 1978). Knowledge is built when previously learned information from long-term memory is relayed back to either sensory-perceptual memory or short-term memory for further processing. Long-term memory is often associated with information that no longer requires conscious attention, which is also known as *implicit* long-term memory; conversely, *explicit* long-term memory is the conscious recollection of information (Levy, 2011). The participants within our study increased their ability to process information by gradually building on their previous experience with the CBCR program. The buildup of knowledge enables information to be retained within long-term memory.

Definitions and Variables

Definitions

- Cognitive Retraining: Training in specific cognitive strategies to improve an impaired cognitive function using specially designed tools and methods that are suited to individual abilities (Averbuch & Katz, 2011).

- Memory: The “retention, storage and retrieval of information” (Pendleton & Schultz-Krohn, 2006, p.1216; Levy, 2011, p.95).
- Attention: “Concentration, ignoring distractions and/or shifting attention fluidly” (Japp, 2005, p. 115). A process that allows for the input of external stimuli and is a general state of readiness to filter information and respond to external stimuli (Levi, 2011, p.97).

Variables

The independent variable in our study was participation in the CBCR program. The dependent variables were the participants’ memory and attention, as measured by the Cognistat Assessment (2009). We also took into consideration extraneous variables such as age (which supports the participant’s ability to learn), history of previous cognitive training, years since the injury occurred, and level of education prior to injury. This extraneous information was collected at intake and was examined during the analysis phase to determine the correlation between the extraneous variables and the outcomes after completing the CBCR program.

Methodology

Design

This study employed a quantitative quasi-experimental one-group pretest-posttest design. The purpose of this design was to determine the effect of participating in the Parrot CBCR program on participants’ cognitive domains of attention and memory. The CBCR program was conducted in eight sessions lasting 60 minutes each during a period

of five months. Participants were given a pretest assessing their memory and attention before undergoing the Parrot CBCR program. After completing the program, participants were given a posttest assessment to reassess their memory and attention. Pretest and posttest data were collected using the paper version of the Cognistat Assessment (2009). The effectiveness of the CBCR program in improving memory and attention was measured by the differences between the Cognistat pretest and posttest results. The use of the pretest-posttest design helped the researchers determine any correlational relationships between the CBCR program and participants' improvement in attention and memory.

In order to control for bias and create inter-rater reliability, each researcher was trained in administering the standardized paper version of the Cognistat Assessment (2009) and the Parrot Software, and participated in the process of data collection and analysis.

Subjects

The study utilized a convenience sample of English-speaking, community-dwelling adults over 18 years of age who sustained an ABI two or more years prior to the study. Individuals with chronic ABI were recruited via referrals from neurologists and neuropsychologists (See Appendix A), and via self-referrals. Self-referrals were made in response to the Craigslist advertisements, Dominican University community e-mail blasts, and BINBA e-mail blasts (See Appendices B, C, and D). Individuals with chronic ABI were also recruited via self-referrals in response to Marin County community advertisements, and via announcements at meetings and flier distribution at BINBA (See

Appendix D). There were no gender, racial, or ethnic-based enrollment restrictions. Only individuals who were fluent in English were included in the study

According to the power analysis conducted using normative data from the Cognistat Assessment, 10 participants would give the researchers significant results and 12 were recruited for the study. Eleven of the 12 participants completed the study in its entirety. To be included in the study individuals were required to have a chronic ABI due to TBI, hemorrhagic cerebrovascular accident, or ischemic cerebrovascular accident, as indicated by the individual’s medical history prior to the study’s implementation. Individuals were included in the study if they had cognitive deficits in both attention and memory. For participation in the study, the individual was required to have either legal guardianship or the ability to make his or her own legal and medical decision and give consent. For those that were under legal guardianship, the guardians of the participants signed a proxy consent form (Appendix E). The participants without guardianship gave their own consent by independently signing the consent form (Appendix F).

Exclusion criteria for participation in the study included severe ABI and injuries that occurred less than two years before the implementation of this study. Severe ABI was determined by a score of 4 or below in orientation, a score of 1 or below in attention, or a score of 0 for memory on the Cognistat Assessment. Individuals with visual impairments, visual perceptual impairments, or motor impairments were excluded, as well as individuals who had previous experience with the Parrot Software. Individuals with ABI due to encephalopathy, degenerative neurological diseases, brain tumors, or brain injury acquired at birth were also excluded from the study.

Ethical and Legal Considerations. A research application was sent to Dominican University of California's Institutional Review Board for the Protection of Human Subjects (IRBPHS). The university's IRBHS helped ensure that the researchers were protecting the rights and welfare of all the participants within the study. The research used for this study followed the guidelines of the IRBPHS and the American Occupational Therapy Association's (AOTA) Code of Ethics. The researchers received permission for application #9030 from Sherry Volk, Ph.D at the Dominican University of California Institutional Review Board on December 9, 2011 to recruit and collect data from the Marin County community. On February 29, 2012, the researchers received permission for amendments made to the original proposal from Martha Nelson, Ph.D. to extend our recruitment effort in the greater Marin County community.

The researchers upheld the AOTA Code of Ethics through three principles: (a) beneficence, (b) nonmaleficence, and (c) autonomy and confidentiality. The principle of beneficence ensures that the research will contribute to the participants' health and welfare. To ensure the participants' well being, the researchers attempted to maximize the possible benefits of the study, while minimizing all possible harm. If working on the computer during the allotted time caused the participants any harm or discomfort, the researchers allowed the participant to end the session and make it up at another time. All research was conducted in an ethical manner to protect the safety of the participants. In the case of any inappropriate conduct, the researchers would have reported the incident to the IRBHS. No such incident occurred. Nonmaleficence is the principle that prevents the researchers from allowing any harm, injury, or wrong doing to be inflicted on the participants (AOTA, 2010). No incident of harm, injury, or wrong doing inflicted on the

participants occurred. The participants were not forced to continue with the study if they felt they were being harmed or if they felt uncomfortable to continue. If the participants felt any physical or psychological fatigue during any session, they were allowed to stop and continue the computer session at another time.

The principle of autonomy and confidentiality requires the researchers to respect the rights of the participants' self-determination (AOTA, 2010). The participants were provided with informed consent forms to verify that they were aware of the purpose and procedure of the study, the potential risks and benefits, and their right to withdraw or discontinue their participation at any time during the study without any adverse effects. Under the principle of autonomy and confidentiality, the researchers respected the participants by keeping all verbal, nonverbal, written, or electronic information confidential. All identifying information about the participants was removed when the data were collected. Individuals' records were only identified through a code that was kept in a separate locked file. All information about the participants was kept in a locked drawer at the research site and in a computer that was password protected at the researcher's private residence. All data collected was destroyed one year after the completion of the study.

To obtain necessary consent for specific participants, recruitment letters describing the purpose of the study, where it was implemented, the criteria for inclusion, the software program that was used, and contact information were sent to neurologists and neurospychologists for referrals (See Appendix A). Any other forms of recruitment, including fliers and Craigslist advertisements (See Appendices B, C, and D), were all approved by the IRBPHS before being released. Once a participant was recruited, he or

she was given an informed consent form to sign. If a participant was under guardianship, the participant's guardian was given a proxy consent form. The consent form described the purpose, background, procedure of the study, potential risks, benefits, contact information for any questions, and notification that participation was voluntary (see Appendices E and F).

A site consent form was sent to BINBA to obtain permission to use the facility for the implementation of the study. To prevent copyright infringement, permission letters were sent to Cognistat and Parrot Software, asking for permission to use the materials for the study. Cognistat donated booklets and assessment forms for this study and permission to use the donated items was obtained. Lastly, a written request was sent to Parrot Software regarding a free, five month subscription, which was granted by the CEO of Parrot Software, Dr. Frederick F. Weiner.

Data Collection

Participants met with the researchers to complete a brief questionnaire (See Appendix G). The questionnaire gathered information from the participants regarding their age, education level, prior experience with the Parrot Software or other CBCR programs, the type of ABI they sustained, and the amount of time since their brain injury occurred. If potential participants met the initial inclusion criteria, they were then given informed consent forms and the "Participants Bill of Rights" (See Appendix H). After potential participants gave consent to participate, the participants were then assessed using the Cognistat assessment. If participants showed memory and attention deficits, as evidenced by the results from the Cognistat assessment, they were included in the study. The Cognistat assessment was also used to measure the outcomes after completion of the

CBCR program. Therefore, data obtained with the Cognistat assessment was used to establish a pretest baseline and posttest outcome for each participant.

The CBCR program used for this study was called the Parrot Software. Participants completed eight 60-minute sessions using the attention and memory sub-programs within this software. Their participation in the program was monitored by the researchers and progress was documented in a chart provided for each participant. All work was completed on individual computers within the computer room at BINBA. After the participants completed the required amount of sessions, the researchers reassessed their progress using the Cognistat assessment.

Description of the assessment tool. The purpose of the Cognistat assessment is to assess the participants' cognitive functioning (Kiernan, Mueller, & Langston, 2009). Cognistat is a standardized assessment tool, developed by Ralph J. Kiernan, PhD, Jonathan Mueller, MD, and J. William Langston, MD. It is administered using either a traditional paper approach or a computer web-based approach. Cognistat assesses three cognitive domains of function: attention, orientation, and level of consciousness. The assessment is also used to test abilities such as language, memory, calculation skills, reasoning, and constructional ability. For the purpose of this study, the traditional paper Cognistat assessment (2009) was administered and was used to assess the degree of impairment in attention and memory for participants with chronic ABI.

Orientation was assessed by asking the participants questions about who they were, where they were, and the date and time. Each participant's level of orientation was assessed because they had to be fully alert and oriented in order to complete the computer programs. Attention was measured by asking the participants to repeat a series of digital

sequences, followed by a subtest that required the participant to repeat a four-word list. Memory was measured by asking the participants to repeat the four-word list given previously in the attention subtest.

Description of the CBCR software. The Parrot Software (2009) is an interactive Internet rehabilitation program with over 100 different programs to improve cognitive reasoning, memory and attention, reading, speech and language, vocabulary and grammar, and word recall. It was developed by Dr. Frederick F. Weiner and is commercially available through Internet access or by CD software. To date, there is no research that shows the efficacy of the Parrot Software in improving cognition for the targeted populations. The program was developed for individuals with aphasia and brain injury, closed head injury, dysphasia, and individuals who have experienced a stroke.

For our study, participants completed eight sub-programs in memory and attention. The attention sub-programs used in the study within the Parrot Software included *Attention Perception and Discrimination, Visual Instructions, Concentration, and Visual Attention Training.* In the *Attention Perception and Discrimination* sub-program, participants were presented with a target picture alongside four similar pictures, and were given instructions to click a picture related to the target picture. In the *Visual Instructions* sub-program, the participants were presented four geometric forms varying in size, color and shape, and were given instructions to click on a geometric form based on its size, color, or shape. In the *Concentration* sub-program, participants were shown a number of pictures depending on the lesson difficulty for a set amount of time before the pictures were hidden. The participants were then instructed to remember the location of the pictures, and click on each matching pair. In the *Visual Attention Training* sub-

program, the participants were asked to watch for a colored box, and were instructed to click on the box when it appeared. The box appeared randomly on the screen, and only appeared for a brief period. As the lessons progressed, the participants were given visual distractions, such as additional colors and boxes, and were required to alternate their attention between multiple colors that were shown.

The memory sub- programs used in the study included *Remembering Visual Patterns, Remembering Written Numbers, Remembering Written Letters, and Remembering Written Directions.* In the *Remembering Visual Patterns* sub-program, participants were presented with a picture grid of 16 pictures. Some pictures were temporarily removed, revealing a pattern with pictures still being shown. The participants were asked to remember the pattern, identify and click on the pictures that made up the pattern once all 16 pictures were displayed. The participants were required to use attention as well as memory to recall the pictures included in the patterns provided, in addition to the specific location of each picture. In the *Remembering Written Numbers* and *Remembering Written Letters* sub-programs, the participants were presented a list of numbers or letters. The participants were asked to remember the entire list in the correct order, and identify which numbers or letters were used, and in what order. The amount of numbers and letters shown varied depending on each lesson. In the *Remembering Written Directions* sub-program, participants were given written directions to move a picture to a certain location relative to other pictures shown on the screen. As the lessons progressed, the participants were given multiple directions. The participants' progress with the program was monitored and tracked individually.

Data Analysis

A power analysis was completed to determine the sample size necessary to achieve results that were statistically significant. Using standardization data from the Cognistat assessment, setting the margin of error to 0.75, and assuming a potential attrition rate of 5, we concluded that a total of 15 participants needed to be included in the study. We used descriptive statistics to report the characteristics of our participants and to report the means and standard deviations of the pretest and posttest results. Using inferential statistics, we attempted to disprove the null hypothesis, thus allowing us to accept the alternative hypotheses.

In order to test our hypotheses, we compared the pretest mean for attention with the posttest mean for attention using a two-tailed t-test. The same procedure was used to compare pretest and posttest means for memory. Using a 95% confidence interval, a two-tailed t-test allowed us to determine whether or not the Parrot software had any significant effect on the participants' memory and attention.

We then used correlation coefficients to determine the strength of the relationship between changes in posttest scores and age. Correlation coefficients were used to determine the strength of the relationship between changes in posttest scores and level of education and between changes in posttest scores and the amount of time that has elapsed since the brain injury occurred. Microsoft Excel and SPSS for Windows were used to calculate and interpret the statistical data. The researchers also regularly consulted with a statistician to ensure that all calculations were correct.

Results

Participant Demographics

Table 1: Participant Demographics

(n = 11)

Code Name	Age	Years s/p Injury	Education Level	Previous CBCR
A	58	38	Some college	No
B	38	29	Some college	Yes
C	31	13	Some college	Yes
D	69	4	Bachelors	No
E	34	23	High school	Yes
F	50	9	Associates	No
G	73	4	PhD	No
H	30	26	Associates	No
I	60	18	Middle school	Yes
J	77	50	Masters	Yes
K	24	20	High school	No

Note. s/p = status post, or years since injury occurred. CBCR = computer-based cognitive retraining

Attention

A significant improvement in attention scores was found. A matched pair t-test revealed significant improvement in the 11 subjects. The mean attention improvement score was 2.1 with a standard deviation of 1.7 ($t(10) = 4.079$, $p < 0.005$). The 95% confidence interval shows that the true mean improvement lies between 0.95 and 3.23.

Table 2: Pre-and Post test Scores for Attention

(n = 11)

Participant	Attention Pre	Attention Post	Improvement
A	5	6	1
B	4	6	2
C	5	7	2
D	5	5	0
E	4	8	4
F	3	3	0
G	5	6	1
H	5	8	3
I	3	8	5
J	4	8	4
K	5	6	1
mean	4.3	6.5	2.1
std dev	0.8	1.6	1.7

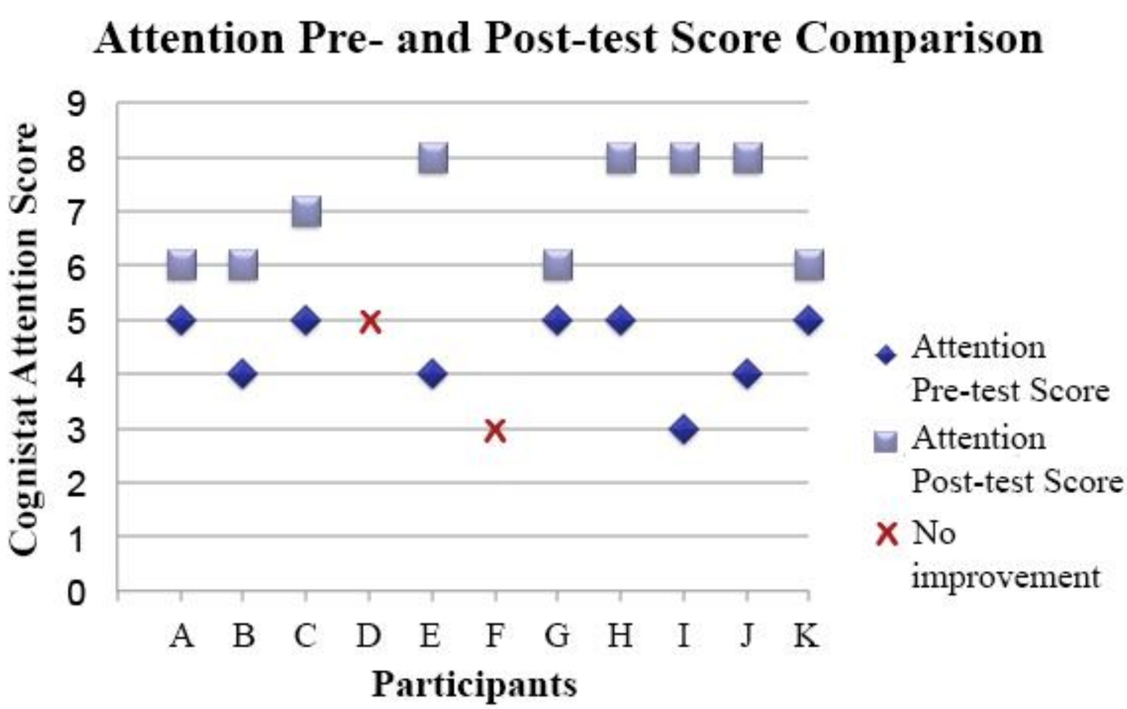

Figure 2: Attention Pre- and Post-test Score Comparison

Scatter plot displaying the changes in attention scores pre- and post-intervention for each participant. No improvement indicates no change between pre- and post-test scores

Memory

A significant improvement in memory scores was found. A matched pair t-test revealed significant improvement in the 11 subjects. The mean memory improvement score was 1.7 with a standard deviation of 2.2 ($t(10) = 2.610$, $p < 0.05$). The 95% confidence interval shows that the true mean improvement lies between 0.25 and 3.2.

Table 3: Pre- and Post-test Scores for Memory

(n = 11)

Participant	Memory Pre	Memory Post	Improvement
A	2	2	0
B	5	7	2
C	5	10	5
D	7	10	3
E	5	5	0
F	7	12	5
G	8	6	-2
H	9	12	3
I	8	9	1
J	7	9	2
K	8	8	0
mean	6.5	8.2	1.7
std dev	2.0	3.0	2.2

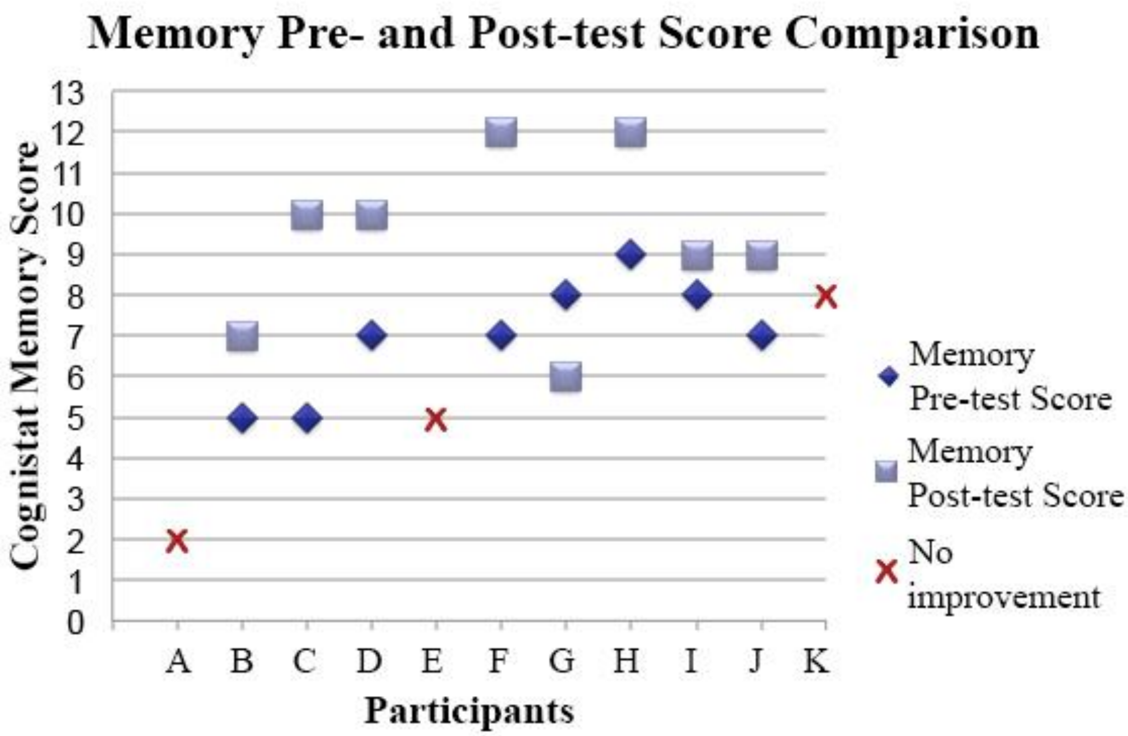

Figure 3: Memory Pre- and Post-test Score Comparison

Scatter plot displaying the changes in attention scores pre- and post-intervention for each participant. No improvement indicates no change between pre- and post-test scores.

Correlation Between Attention and Memory Scores and Demographic Information

There are no significant correlations between attention or memory change and age, years since injury, and education level.

Table 4: Correlation Between Attention and Memory Scores and Demographic Information

(n = 11)

		Attention Diff	Memory Diff
Age at Injury	Pearson Correlation	-.329	-.113
	Sig. (2-tailed)	.323	.741
	N	11	11
Years Since Injury	Pearson Correlation	.478	-.117
	Sig. (2-tailed)	.137	.733
	N	11	11
EdLevel	Pearson Correlation	-.347	-.053
	Sig. (2-tailed)	.296	.877
	N	11	11

Note. Diff = difference. EdLevel = level of education.

Five subjects had previous cognitive retraining, six subjects did not. There was a statistically significant difference in average attention change between those who had previous cognitive retraining (M = 3.4, SD = 1.34) and those who did not (M = 1.0, SD = 1.10), $t(7.76) = 3.207$, $p < .05$. There was not a statistically significant difference in average memory change between those who had previous retraining (M = 2.0, SD = 1.9) and those who did not (M = 1.5, SD = 2.6), $t(8.87) = 0.371$, $p > .05$.

Correlation Between Time Spent with the CBCR Program and Changes in Scores

There are no significant correlations between time spent with the CBCR intervention and attention or memory improvement. The correlation between memory improvement and elapsed weeks with intervention was 0.578, p = 0.05. The correlation between memory improvement and total weeks with intervention was 0.577, p = 0.05.

The following correlations are weak and very insignificant: The correlation between memory improvement and days in therapy was 0.300, $p >> 0.05$. The correlation between attention improvement and elapsed weeks in therapy was 0.071, $p = 0.05$. The correlation between attention improvement and total weeks in therapy was 0.061, $p = 0.05$. The correlation between attention improvement and days in therapy was 0.068, $p = 0.05$.

Table 5: Time Spent with CBCR Compared with Scores for Memory and Attention (n= 11)

Participant	Days	Elapsed Weeks	Total Weeks	Attention Improvement	Memory Improvement
A	7	6	7	1	0
B	6	3	3	2	2
C	8	6	6	2	5
D	6	5	6	0	3
E	7	7	7	4	0
F	6	3	3	0	5
G	8	8	8	1	-2
H	8	5	5	3	3
I	5	3	3	5	1
J	4	2	2	4	2
K	4	3	3	1	0
Mean	6.3	4.6	4.8		
std dev	1.5	2.0	2.1		

Correlation Between Memory and Attention

Attention improvement and memory improvement were not significantly correlated ($r = -0.153$, $p >> 0.05$). Improvement in attention is not significantly different than improvement in memory. The 95% confidence interval of the true mean difference in scores, from a matched pair t-test, shows that the true mean lies between -1.64 and 2.36 centered at 0.36.

Table 6: Differences in Scores between Attention Improvement and Memory Improvement (n = 11)

Participant	Attention Improvement	Memory Improvement	Difference
A	1	0	1
B	2	2	0
C	2	5	-3
D	0	3	-3
E	4	0	4
F	0	5	-5
G	1	-2	3
H	3	3	0
I	5	1	4
J	4	2	2
K	1	0	1
mean	2.1	1.7	0.4
std dev	1.7	2.2	3.0

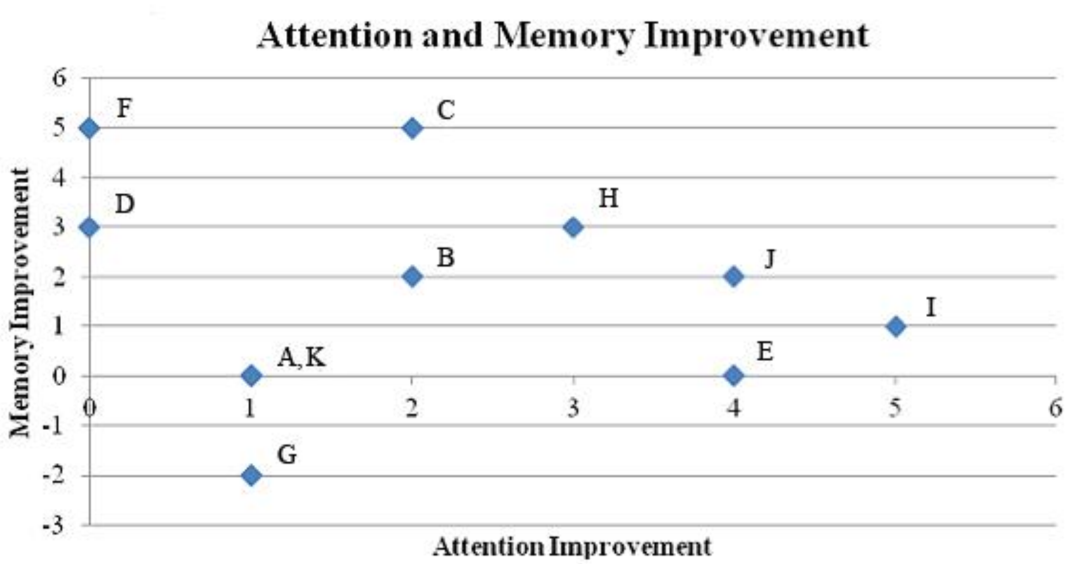

Figure 4: Attention and Memory Improvement

Scatter plot displaying the relationship between attention improvement and memory improvement. Each letter represents one participant.

Discussion and Limitations

Discussion

The purpose of this study was to determine the effectiveness of a commercially available CBCR program on improving memory and attention deficits for individuals with chronic ABI. A total of twelve recruits were included, eleven of which completed the study in its entirety. One participant was unable to complete the study due to personal reasons. The participants completed eight 60-minute sessions using the Parrot Software, completing tasks within eight attention and memory sub-programs. Changes in memory and attention were measured using the paper version of the Cognistat assessment (2009).

There was a significant improvement in attention scores post intervention, thus confirming the hypothesis that the Parrot Software could improve attention for individuals with chronic ABI. Additionally, there was a significant improvement in memory scores post intervention, confirming the hypothesis that the Parrot Software could also improve memory. The eight sub-programs used in the study were selected out of a total of 18 attention and memory sub-programs, and were separated into the two categories of memory and attention. The sub-programs chosen to be included in the study incorporated intensive practice and a focus on perceptual speed and accuracy; the participants were required to maneuver the mouse based on visual stimuli and were often timed. The improvements in post-test Cognistat scores shown by the participants is consistent with the findings of Smith et al (2009), which showed that cognitive training programs incorporating these factors improves memory and attention. Each participant focused solely on one sub-program each session, thus incorporating repetition. The

participants' improvement in both attention and memory confirms the findings by Kimberly et al (2010), suggesting neural improvements can occur after a specific task is performed repetitively.

A statistical analysis found a significant correlation between previous cognitive retraining and attention. This finding suggests that previous gains in attention can carry over to current cognitive ability once training has ended. A correlation between previous cognitive retraining and attention indicates that it is possible to retrain attention skills in an individual with chronic ABI. Additionally, carryover of attention skills from previous cognitive retraining may suggest that this type of intervention has a long-standing effect on attention for adults with chronic ABI. However, further research is needed to assess the length of carryover post-cognitive retraining.

Analysis revealed that there were no significant correlations between time spent with the CBCR program and attention or memory improvement. Each participant completed the eight designated sub-programs within varying time frames due to scheduling conflicts and availability. The researchers had initially planned for each participant to complete one sub-program per week, but several of the participants required a different time frame due to outside obligations or dependence on caregiver schedules for transportation. The participants spent two to eight weeks in the study. However, it was discovered that the varying weeks spent using the CBCR program did not have an effect on the post intervention scores in memory and attention. This finding suggests that CBCR can improve memory and attention scores regardless of whether the participant spends as little as two weeks with the program or as many as eight weeks.

Another important finding was that there were no significant correlations between attention or memory change and age, years since injury, or education level. The ages of the participants ranged from 24 to 77 years old and because age did not affect the participants' changes in scores, it can be concluded that CBCR is an effective intervention for adults with ABI. The time since injury for the 11 participants spanned from four to 50 years post ABI. Since there was no correlation between years since injury and scores in memory and attention, it can be concluded that adults with chronic ABI can show improvements in memory and attention with the use of a CBCR program regardless of the time that has passed since their injury. This finding may imply that the brain has the ability to restore neurological pathways many years after an injury has occurred. The participants had a wide range of education levels, with one participant who completed middle school, two participants who completed high school, three who took some college courses, two who earned their associates degree, one who received a bachelor's degree, one who completed their master's degree, and one who received his PhD. The wide span of education levels among the participants, coupled with a lack of correlation between changes in memory and attention scores and amount of schooling, indicates that CBCR has a positive effect on these two cognitive domains regardless of how much education the individual has received. Although using a CBCR program requires basic knowledge of computer use, it does not necessitate extensive education for it to be effective with adults who have sustained an ABI. Overall, these findings imply that the changes in scores for memory and attention were genuinely due to the time spent with the CBCR program and were not due to any extraneous variables such as age, years since injury, and education level.

One surprising finding from this study was the lack of correlation between improved memory scores and improved attention scores post intervention. According to the theory of Cognitive Information-Processing (CIP), information is processed through sensory-perceptual memory, short-term memory, and long-term memory (Levy, 2011). CIP postulates that for information to be processed and stored within the various stages of memory, we must first attend to environmental stimuli, such as visual input received from a computer screen. In our study, the memory skills being employed fall in the domains of short-term and working memories. It was our assumption that improvements in attention scores may lead to improvements in memory scores because of the direct relationship between these two cognitive functions. However, this assumption was not supported by the data. It was discovered that changes in memory and attention scores occurred independently of each other, which may indicate that the relationship between attention and memory may not be as direct as previously assumed. Further research is needed to determine the nature of the relationship between attention and memory within the CIP framework.

The results of this study demonstrate the effectiveness of a commercially available CBCR program in improving memory and attention for individuals with chronic ABI. Based on the findings presented above, we conclude that the Parrot Software can be an effective intervention for remediating deficits in memory and attention for adults with chronic ABI. Many occupational therapists may hesitate to use CBCR programs for individuals with chronic ABI due to limited available research with this population. This study aims to increase awareness of the effectiveness of a commercially available CBCR program, such as the Parrot Software, for improving

attention and memory for individuals with chronic ABI. CBCR programs, such as the Parrot Software, focus solely on improving cognitive deficits and do not address occupational performance; therefore, in occupational therapy, CBCR programs should be used as a supplement to additional occupation-based interventions.

Limitations

Several limitations were noted throughout the study. One limitation is the lack of a control group. Although the researchers were able to recruit eleven qualifying participants to meet the minimum requirement of ten participants in order to obtain statistically significant results, a larger sample would further strengthen the study's findings. Additionally, because the results target a specific population of individuals with chronic ABI due to TBI or CVA, the results may not be able to generalize to the overall ABI population, including individuals with acute ABI or ABI due to brain tumor, degenerative conditions, infection, or anoxia. Another limitation is the exclusion of a functional component within the intervention. In an article discussing the generalization of treatment of cognitive perceptual impairments in adults with brain injury, Toglia (1990) found that the exclusive use of abstract tasks, such as CBCR tasks targeting memory and attention, resulted in little to no transfer of skills learned in therapy to other situations. Since current research supports a weak transfer of cognitive skill to functional performance, further studies in the area of skill transfer is recommended.

For future studies, a control group should be included to assess the effectiveness of the CBCR program compared to a group receiving an alternative intervention. Implementing randomization would further strengthen the research. Additionally, further studies can separate groups by type of ABI to compare the effects of the CBCR program

on individuals with CVA and individuals with TBI. Expanding the inclusion criteria to include individuals with ABI due to encephalopathy, tumor, infection, and anoxia can improve the generalization to the general population of ABI. Future researchers can also incorporate a functional component into the study to assess carryover of cognitive improvements into daily activity.

Summary, Conclusion and Recommendations

Individuals with chronic ABI often acquire deficits in cognitive functioning within the domains of memory and attention. These deficits may affect the individual's occupations, roles, and overall quality of life. Occupational therapists often use a remedial approach when addressing cognitive deficits acquired by clients with chronic ABI. Interventions utilizing CBCR software are designed to target specific deficits such as memory and attention; however, there is little available research displaying the effectiveness of such CBCR programs on improving an individual's attention and memory after sustaining an ABI. This study evaluated the effectiveness of the Parrot Software, a commercially available computer-retraining program, in improving attention and memory deficits in individuals with chronic ABI. Overall, the researchers discovered that the completion of eight sub-programs within the Parrot Software improved the participants' scores in memory and attention, as measured by the Cognistat Assessment (2009). These findings indicated that CBCR programs such as the Parrot Software can be effective in improving these deficits; however further research is required to strengthen these findings.

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Appendix A-Neurologists and Neuropsychologist Recruitment Letter

November 2, 2011

Dr. Patricia Gill, M.S., MFT (SAMPLE HEADING)
1132 Magnolia Avenue
Larkspur, CA 94939

Dear Dr. ________________:

Our names are Stephanie Gella, Joshua Ramos, Julie Robertson, and Lucia Ulloa. We are graduate Occupational Therapy students at Dominican University of California. We are conducting a research project: Computer-based Cognitive Retraining for Individuals with Chronic Acquired Brain Injury: A Pilot Study. This is a fulfillment of our Master's thesis requirements, and Dr. Kitsum Li, Assistant Professor, is advising this study. We are requesting your help in recruiting participants for our study, which concerns the effects of a computer-based cognitive retraining program on remediating attention and memory for individuals with chronic acquired brain injury. The study is going to be implemented at the non-profit brain injury organization, the Marin Brain Injury Network, in Larkspur, CA.

To be included in our study the individual must have a chronic acquired brain injury that is two or more years old due to traumatic brain injury, hemorrhagic cerebrovascular accident, or ischemic cerebrovascular accident, as indicated by the individual's medical history. The participant must also have cognitive deficits in both attention and memory, as evidenced by the pre-test results in these domains. We will be administering the Cognistat assessments with the participants to make sure they meet the inclusion criteria and to collect pretest data. The individual can be under legal guardianship or able to make his or her own legal and medical decisions and give consent. Exclusion criteria for participation include individuals with visual perceptual deficits, severe cognitive impairment, visual impairment, and motor impairment that may limit his/her ability to operate a mouse in computering. Severe cognitive impairment will be determined by a score of 4 or below for orientation, a score of 1 or below for attention, and a score of 0 for memory, as evidenced by results from the Cognistat assessment.

The computerized cognitive retraining program that we will be using for this study is called the Parrot Software. The Parrot Software is an interactive internet rehabilitation program with over 100 different programs to improve cognitive reasoning, memory and attention, reading, speech and language, vocabulary and grammar, and word recall. Each participant will complete eight 60-minute sessions using the attention and memory lessons within this software. Their participation in the program will be monitored by us and our research assistants, and progress will be documented in a chart provided for each participant. All work will be completed on individual computers within the computer

room at the Marin Brain Injury Network. After the participants have completed the required amount of sessions, the researchers will reassess their progress using the Cognistat Assessment.

If you have further questions you may contact our research advisor, Dr, Kitsum Li, Occupational Therapy Department, Dominican University of California, at 415-458-3753 or the Dominican University of California Institutional Review Board for the Protection of Human Subjects (IRBPHS), which is concerned with the protection of volunteers in the research projects. You may reach the IRBPHS Office by calling (415) 257-0168 and leaving a voicemail message, or FAX at (415) 458-3755, or by writing to IRBPHS, Office of Associate Vice President for Academic Affairs, Dominican University of California, 50 Acacia Avenue, San Rafael, CA 95901.

If you have clients who you think may qualify for this study, please give them a copy of the enclosed flier and have them contact us at the number provided on the flier. Participation in this research is voluntary. The individuals are free to decline to be in this study, or withdraw from it at any point. If you would like to know the results of this study once it has been completed, a summary of the results will be presented at the Dominican University of California Academic Exhibition in the Spring of 2013. We will keep your contact information and send you an invitation to visit the poster presentation at Dominican University of California. For information call the Office of Academic Affairs 415-257-0146. If you have any questions or concerns about making referrals to this study, please feel free to contact us.

Thank you in advance for your participation and assistance.

Sincerely,

Stephanie Gella, Joshua Ramos, Julie Robertson, and Lucia Ulloa
Occupational Therapy Student Researchers
Dominican University of California
50 Acacia Avenue, San Rafael, CA 94901

Appendix B-Craigslist Participant Recruitment Advertisement

Craigslist Advertisement

Research Study to Investigate New Methods in Memory and Attention Improvement

Occupational therapy students from Dominican University of California are looking for participants for their Master's thesis research study.

Occupational therapy students are doing a research study on how useful a computer-based cognitive training program is for individuals with chronic acquired brain injuries. Individuals with brain injuries may have difficulty with attention and memory. The researchers are interested in learning how effective the Parrot computer software program is for increasing attention and memory.

Benefits may include:
- Improved Memory
- Improved Attention
- Improved ability to use computer-based cognitive training program
- Increased ability to apply learned strategies in daily living

To participate in the study we are looking for both men and women who fit the following criteria:
- **Acquired brain injury more than 2 years old**
- **Acquired brain injury due to:**
    - **Traumatic brain injury or**
    - **Stroke**
- **Difficulty staying focused on a task**
- **Decreased memory**
- **At least 18 years old or older**

For more information or if interested please contact:

Occupational Therapy Students at
Email: ducogretraining@gmail.com
or call Kitsum Li at (415)458-3753

Appendix C-Dominican University Community E-mail Blast

From: "Li, Kitsum" <kitsum.li@dominican.edu>
Date: Wed, 29 Feb 2012 17:25:55 -0800
To: DU - Bulletin Board<du-bulletinboard@dominican.edu>; DU - Faculty<dominicanfaculty@dominican.edu>; DU - Staff<dominicanstaff@dominican.edu>
Subject: Occupational Therapy Students need your help with research recruitment

Dear Faculty and Staff,
One of my O.T. master's thesis groups could use some assistance in recruiting participants for their research project: Computer-based Cognitive Retraining for Individuals with Chronic Acquired Brain Injury: A Pilot Study. To be included in the study, the individual must be an adult and have a chronic acquired brain injury (two or more years old), resulting from traumatic brain injury, hemorrhagic cerebrovascular accident, or ischemic cerebrovascular accident. The participant must also have cognitive deficits in both attention and memory. If you know of any individuals who you think may qualify for this study, please have them contact us as soon as possible atducogretraining@gmail.com or (415) 458-3753.

Thank you for your assistant.

Kitsum Li, OTD, OTR/L
Assistant Professor
Department of Occupational Therapy
Dominican University of California
Kitsum.li@dominican.edu
415-458-3753

Appendix D-Participant Recruitment Flier

Research Study to Investigate New Method in Memory and Attention Improvement

Undergraduate and Graduate Occupational Therapy students from Dominican University of California are looking for participants for their Master's thesis research study.

Benefits may include:

- Improved Memory
- Improved Attention
- Improved ability to use computer-based cognitive training program
- Increased ability to apply learned strategies in daily living

Students in the Department of Occupational Therapy at Dominican University of California are doing a research study on how useful a computer-based cognitive training program is for individuals with chronic acquired brain injuries. Individuals with brain injuries may have difficulty with attention and/or memory. The researchers are interested in learning how effective computer software programs are for increasing attention and memory.

For more information or if interested please contact us ASAP:

Occupational Therapy Students at
Email:
ducogretraining@gmail.com
Phone:
(415) 458-3753

Criteria (For Both Men & Women):

- Acquired brain injury due to:
  - Traumatic brain injury or
  - Stroke
- At least 2 years since the injury occurred
- Difficulty with staying focused on tasks
- Decreased attention and /or memory
- At least 18 years old or older

Available hours for sessions:

- Tuesdays 9:00 am - 1:00 pm
- Thursdays 9:00 am - 1:00 pm
- Fridays as needed

DOMINICAN UNIVERSITY of CALIFORNIA 1890

Appendix E-Proxy Consent Form

DOMINICAN UNIVERSITY of CALIFORNIA
PROXY CONSENT FOR RESEARCH PARTICIPATION

Purpose and Background

Ms. Stephanie Gella, Mr. Joshua Ramos, Ms. Julie Robertson, and Ms. Lucia Ulloa, students in the Department of Occupational Therapy at Dominican University of California, are conducting a research study on the effectiveness of a computer-based cognitive retraining program for individuals with chronic acquired brain injury. Because individuals with chronic acquired brain injury may have deficits in attention and memory, the researchers are interested in learning the effectiveness of a computer-based cognitive retraining program on addressing the deficits within these domains.

The individual under my guardianship is being asked to participate because s/he is an individual with chronic acquired brain injury due to traumatic brain injury or stroke with deficits in memory and attention.

Procedures:

If I agree to allow the individual under my guardianship to be a participant in this study, the following will happen:

1. I will allow the individual under my guardianship to complete a brief questionnaire, which will include questions regarding my ward's acquired brain injury.
2. If the individual under my guardianship meets the initial inclusion criteria, s/he will be given a Pre-test using the Cognistat Assessment System. A description of the Cognistat Assessment System is provided in the attached page. If the individual's results show a mild/moderate deficit in memory and attention, s/he will be included into the study.
3. The individual under my guardianship will complete eight 60-minute sessions using the attention and memory lessons of the Parrot Software. A description of the program is provided in the attached page. The individual's results will be recorded and kept confidential by the researchers on a password-protected computer. All paper records and individual charts will be kept in a locked drawer in the Marin Brain Injury Network.
4. If the individual under my guardianship experiences fatigue while using the computer program, s/he will be allowed to stop and make up the session at a later time.
5. The individual under my guardianship will be reassessed using the Cognistat Assessment, and data will be compared with the Pre-test data.
6. The individual under my guardianship will be provided with a written summary of the findings and conclusions of this project upon my request. Such results may not be available for three to six months.

Risks and/or Discomforts:

1. I understand that the individual under my guardianship's participation involves no physical risk.
2. Study records will be kept as confidential as is possible. No individual identities will be used in any reports or publications resulting from the study. All personal references and

identifying information will be eliminated when the data are transcribed, and all subjects will be identified by numerical code only, thereby assuring confidentiality regarding the subject's responses. The master list for these codes will be kept in a locked file, separate from the transcripts. Only the researchers and their advisors will see coded transcripts. One year after the completion of the research, all written and recorded materials will be destroyed.

3. I understand that the individual under my guardianship's participation in the study does not guarantee cognitive improvement in his/her attention and/or memory.
4. The individual under my guardianship may elect to stop participating in the study at any time and may refuse to participate before or after the study is started without any adverse effects.

<u>Benefits:</u>
The primary potential benefit is that the individual under my guardianship may have cognitive improvement in my attention and/or memory. S/he may gain insight into her/his attention and/or memory difficulties. S/he may also learn new strategies that they can apply in daily living.

<u>Costs/Financial Considerations</u>
There will be no costs to me or the individual under my guardianship as a result of taking part in this study.

<u>Payment/Reimbursement</u>
Neither the individual under my guardianship nor I will be reimbursed for participation in this study.

<u>Questions:</u>
I have talked to Ms. Gella, Mr. Ramos, Ms. Robertson or Ms. Ulloa about this study and have had all my questions answered. If the individual under my guardianship or I have further questions about the study, I may contact them at ducogretraining@gmail.com or their research advisor, Kitsum Li, Assistant Professor of Occupational Therapy, Dominican University at (415) 458-3753. If I have any questions or comments about participation in this study, I should first talk with the researchers. If for some reason I do not wish to do this, I may contact the Dominican University of California Institutional Review Board for the Protection of Human Subjects (IRBPHS), which is concerned with protection of volunteers in research projects. I may reach the IRBPHS Office by calling (415) 257-0168 and leaving a voicemail message, or FAX at (415) 458-3755, or by writing to IRBPHS, Office of Associate Vice President for Academic Affairs, Dominican University of California, 50 Acacia Avenue, San Rafael, CA 94901

<u>Consent:</u>
I have been given a copy of this consent form, signed and dated, to keep.

PARTICIPATION IN RESEARCH IS VOLUNTARY. I am free to decline to have the individual under my guardianship be in this study or withdraw his/her participation at any time without fear of adverse consequences.

My signature below indicates that I agree to allow the individual under my guardianship to participate in this study.

Signature of Subject's Guardian **DATE**

Signature of Person Obtaining Consent **DATE**

Description of the assessment tool:

The purpose of the Cognistat assessment is to assess an individual's cognitive functioning. Cognistat assesses three cognitive domains of function, which include attention, orientation, and level of consciousness. The assessment is also used to test different abilities such as language, memory, calculation skills, reasoning, and constructional ability. For the purpose of our study, the original paper Cognistat assessment will be administered and will take approximately 20-30 minutes.

Description of the computerized cognitive retraining software:

The Parrot Software is an interactive internet rehabilitation program with over 100 different programs to improve cognitive reasoning, memory and attention, reading, speech and language, vocabulary and grammar, and word recall. It is commercially available through internet subscription or by CD software.

The memory and the attention programs will be used in this study. Each program includes multiple lessons and the number of problems within each lesson ranges from 5-50.

Appendix F-Consent to be a Research Subject

DOMINICAN UNIVERSITY OF CALIFORNIA
CONSENT TO BE A RESEARCH SUBJECT

Purpose and Background:
Ms. Stephanie Gella, Mr. Joshua Ramos, Ms. Julie Robertson, and Ms. Lucia Ulloa, students in the Department of Occupational Therapy at Dominican University of California, are conducting a research study on the effectiveness of a computerized cognitive retraining program for individuals with chronic acquired brain injury. Because individuals with chronic acquired brain injury may have deficits in attention and memory, the researchers are interested in learning the effectiveness of a computerized cognitive retraining program on addressing the deficits within these domains.

I am being asked to participate because I am an individual with chronic acquired brain injury due to traumatic brain injury or stroke with deficits in memory and attention.

Procedures:
If I agree to be a participant in this study, the following will happen:

1. I will participate in the completion of a brief questionnaire, which will include questions regarding my acquired brain injury.
2. If I meet the initial inclusion criteria, I will be given a Pre-test using the Cognistat Assessment System. A description of the Cognistat Assessment System is provided in the attached page. If my results show a deficit in memory and attention, I will be included into the study.
3. I will complete eight 60-minute sessions using the attention and memory lessons of the Parrot Software. A description of the program is provided in the attached page. My results will be recorded and kept confidential by the researchers on a password-protected computer. All paper records and individual charts will be kept in a locked drawer in the Marin Brain Injury Network.
4. If I experience fatigue while using the computer program, I will be allowed to stop and make up the session at a later time.
5. I will be reassessed using the Cognistat Assessment, and data will be compared with the Pre-test data.
6. I will be provided with a written summary of the findings and conclusions of this project upon my request. Such results may not be available for three to six months.

Risks and/or Discomforts:

1. I understand that my participation involves no physical risk.
2. I understand that my participation in the study does not guarantee cognitive improvement in my attention and/or memory.

3. I may elect to stop participating in the study at any time and may refuse to participate before or after the study is started without any adverse effects.

Benefits:
The primary potential benefit is that I may have cognitive improvement in my attention and/or memory. I may gain insight into my attention and/or memory difficulties. I may also learn new strategies that I can apply in daily living.

Questions:
I have talked to Ms. Gella, Mr. Ramos, Ms. Robertson or Ms. Ulloa about this study and have had all my questions answered. If I have further questions about the study, I may contact them at ducogretraining@gmail.com or their research advisor, Kitsum Li, Assistant Professor of Occupational Therapy, Dominican University at (415) 458-3753.

Consent:
I have been given a copy of this consent form, signed and dated, to keep.

PARTICIPATION IN RESEARCH IS VOLUNTARY. I am free to decline to be in this study or withdraw my participation at any time without fear of adverse consequences.

My signature below indicates that I agree to participate in this study.

____________________________ _______________________

SUBJECT'S SIGNATURE **DATE**

Description of the assessment tool:

The purpose of the Cognistat assessment is to assess an individual's cognitive functioning. Cognistat assesses three cognitive domains of function, which include attention, orientation, and level of consciousness. The assessment is also used to test different abilities such as language, memory, calculation skills, reasoning, and constructional ability. For the purpose of our study, the original paper Cognistat assessment will be administered and will take approximately 20-30 minutes.

Description of the computerized cognitive retraining software:

The Parrot Software is an interactive internet rehabilitation program with over 100 different programs to improve cognitive reasoning, memory and attention, reading, speech and language, vocabulary and grammar, and word recall. It is commercially available through internet subscription or by CD software.

The memory and the attention programs will be used in this study. Each program includes multiple lessons and the number of problems within each lesson ranges from 5-50.

Appendix G-Initial Questionnaire

DOMINICAN UNIVERSITY
INITIAL QUESTIONNAIRE

Computer-based Cognitive Retraining Study Questionnaire

____
Full Name Date of Birth (MM/DD/YY)

____
Street Address

____
City State Zip

____
Education Level Type of Acquired Brain Injury (TBI, Stroke)

____
Date of Injury Email Address

____
Phone

Have you had any previous computer-based cognitive retraining?

☐ Yes. If yes, what program? ______________________________

☐ No

Have you had any prior experience with Parrot Software?

☐ Yes ☐ No

What other therapy are you currently receiving?

____

What experience do you have with computers?

____

Please check your availability:

☐ Tuesday	☐ Thursday
☐ 9:00-11:00AM ☐11:00AM – 1:00PM	☐ 9:00 – 11:00AM ☐ 11:00AM – 1:00PM

Appendix H- Participant's Bill of Rights

DOMINICAN UNIVERSITY of CALIFORNIA
RESEARCH PARTICIPANT'S BILL OF RIGHTS

Every person who is asked to be in a research study has the following rights:

1. To be told what the study is trying to find out;

2. To be told what will happen in the study and whether any of the procedures, drugs or devices are different from what would be used in standard practice;

3. To be told about important risks, side effects or discomforts of the things that will happen to her/him;

4. To be told if s/he can expect any benefit from participating and, if so, what the benefits might be;

5. To be told what other choices s/he has and how they may be better or worse than being in the study;

6. To be allowed to ask any questions concerning the study both before agreeing to be involved and during the course of the study;

7. To be told what sort of medical treatment is available if any complications arise;

8. To refuse to participate at all before or after the study is stated without any adverse effects. If such a decision is made, it will not affect h/her rights to receive the care or privileges expected if s/he were not in the study.

9. To receive a copy of the signed and dated consent form;

10. To be free of pressure when considering whether s/he wishes to agree to be in the study.

If you have other questions regarding the research study, you can contact the researchers at ducogretraining@gmail.com or their advisor, Kitsum Li, at (415) 458-3753. You may also contact The Dominican University of California Institutional Review Board for the Protection of Human Subjects by telephoning the Office of Academic Affairs at (415) 257-0168 or by writing to the Associate Vice President for Academic Affairs, Dominican University of California, 50 Acacia Avenue, San Rafael, CA. 94901.