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Skill Generalization Following Computer-Based Cognitive Retraining Among Individuals with Acquired Brain Injury

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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

Individuals with acquired brain injury (ABI) often experience cognitive deficits. This creates many challenges in learning or relearning skills and generalizing skills among different contexts and task demands. Computer-Based Cognitive Retraining (CBCR) is a common intervention utilized by occupational therapists to help remediate cognitive deficits in individuals with ABI. Although research has shown that CBCR programs are effective at improving cognitive domains, there is limited evidence to support generalization of these skills to functional daily living tasks. Therefore, the primary purpose of this study was to assess the occurrence of generalizing gained skills in overall cognition, attention, and memory from a CBCR program to a medication-box task in individuals with ABI. This study utilized the Parrot Software for the CBCR intervention and evaluated changes in overall cognition, attention, and memory skills with the Montreal Cognitive Assessment (MoCA©), and generalization of those skills utilizing a performance-based medication-box task. The results indicated that the Parrot Software CBCR was effective at improving overall cognition, but not significantly in any particular cognitive domain. In addition, the gains in overall cognition failed to generalize to improved performance in the medication-box task. Extraneous variables did not affect the changes in cognition. However, participants without previous CBCR experience improved significantly when compared to participants with previous CBCR experience. Future areas of research should include interventions that can bridge the gap between CBCR and performance in daily living tasks.

Introduction

An acquired brain injury (ABI) is damage to the brain that occurs after birth (Rees, Marshall, Hartridge, Mackie, & Weiser, 2007). It is a term used to describe a wide variety of brain injuries and neurological conditions that include traumatic brain injuries (TBI), strokes, hypoxias, infections, tumors, encephalopathies, and neurosurgical conditions (Slomine & Locascio, 2009). Congenital disorders, developmental disabilities, and progressive neurological disorders and diseases are in separate diagnosis groups. Every year 1.7 million Americans sustain a TBI and 795,000 survive a stroke (Centers for Disease Control and Prevention, 2013). Many of these individuals often suffer from chronic impairments that interfere with daily life and community participation. In particular, cognitive deficits in attention, memory, and executive functioning commonly exhibit following an ABI. These deficits substantially hinder an individual's ability to learn and relearn basic skills (Slomine & Locascio, 2009). This can affect the ability to perform activities of daily living (ADLs) (essential self-care tasks, such as, grooming, dressing, self-feeding, bathing, and toileting), solve problems, and participate in desired occupations.

Occupational therapy facilitates participation in daily activities that are meaningful and purposeful to the individual (American Occupational Therapy Association [AOTA], 2008). The primary focus of the profession is to improve functional performance. Occupational therapists commonly utilize a cognitive remediation approach to facilitate rehabilitation in individuals with ABI. This approach focuses on improving and restoring specific deficits in cognition with the overall purpose of restoring useful skills (Guiffrida, Demery, Reyes, Lebowitz, & Hanlon, 2009).

Computer-based cognitive retraining (CBCR) has become a popular method in cognitive intervention (Yip & Man, 2009, 2013). The foundational premise behind the design of CBCR programs is to retrain cognitive skills and restore cognitive deficits through computer activities. This approach stems from the rapid progression of technology while providing individuals with the least restrictive environment. Due to the high availability and widespread access to computers, individuals with ABI have the opportunity to access and utilize CBCR programs in non-clinical settings.

Research has shown that CBCR is an effective approach to improve cognitive function, specifically in attention and memory (Gunning & Clegg, 2005; Li, Robertson, Ramos, and Gella, 2013; Lindquist & Borell, 2010; Westerberg et al., 2007). However, research demonstrating the occurrence of generalizing cognitive skills attained from CBCR to improved performance in functional daily living tasks is limited. The available research has shown that individuals with ABI have difficulties automatically generalizing a skill to different tasks and demonstrate a decreased ability to transfer a skill from one context to another (Toglia, Johnston, Goverover, & Dain, 2010). These challenges can potentially impede the skills restored using CBCR, making the transfer of skills to improvement in task-performance unattainable. Therefore, the purpose of this study was to evaluate the generalization of skills attained in a CBCR program, to a performance-based task in individuals with ABI.

Literature Review

This literature review discusses cognitive remediation for people with ABI. The first section addresses cognition and its effects on occupation. The second section examines the cognitive deficits that often accompany ABI and the ability of the brain to restructure after injury. The third section explores various studies that utilized CBCR as an intervention modality. The fourth section focuses on the generalization of skills. The final section examines the various types of assessments used in cognitive rehabilitation.

Cognition Deficits Following ABI

Cognition has several components that include attention, memory, visual processing, organization, problem solving, and executive functioning (Toglia, 2005). These components are separate units that differ in complexity. The more fundamental elements are necessary for skills that are more complex. Attention and memory are the basic units of cognition (Toglia, 2005). Attention is the foundation of all cognitive components (Averbuch & Katz, 2005). The skill of attention requires one to have the ability to maintain focus on specific information for a particular amount of time while modulating environmental distractions. Without attention, the learning or remediation of skills is difficult. Memory refers to the storage and recovery of information and is composed of both short-term and long-term components. Memory is also crucial for learning and retaining new information. Working memory is the cognitive ability to retain and manipulate information for completing complex tasks (Lundqvist, Grundstrom, Samuelsson, & Ronnberg, 2010; Westerberg et al., 2007).

Individuals with ABI often experience cognitive deficits that affect daily tasks and activities. Attention and memory are the two most commonly impaired components following a brain injury (Lundqvist et al., 2010; Johansson & Tornmalm, 2012; Slovarp, Azuma, & LaPointe, 2012). Cognitive deficits in sustained attention and working memory can adversely affect an individual's quality of life because learning new information, remembering verbal directions, performing tasks, solving problems, and generalizing skills are difficult.

Slovarp et al. (2012) evaluated the relationship between sustained attention and working memory performance in nine individuals following severe TBI. The participants completed a sustained attention task and a working memory task on a computer using Psycope Software. The researchers found that the participants with TBI had lower hit rates and higher false alarm rates on the working memory task when compared to the control group. The relationship found between sustained attention and working memory performance implied that individuals must be able to inhibit disruptive stimuli to sustain attention on a task (Slovarp et al., 2012). The results also suggested that the positive correlation between sustained attention and gains in working memory performance might influence intervention foci to remediate attention skills in individuals with TBI.

Neuroplasticity

Neuroplasticity is the brain's ability to reorganize its structure following different types of treatment that involve altering sensory and motor input from the environment (Levine, 2009; Muir, Jones, & Signal, 2009; Nudo, 2003). The concept of neuroplasticity proposes that the injured brain has the potential to rewire, reconstruct, and rebuild succeeding the learning experience or participating in a novel task. The central nervous system has the capacity to learn after an injury and has the ability to remodel itself both structurally and functionally (Laatsch & Krisky, 2006; Penn, 2008). However, neuroplasticity is not an automatic occurrence and newly developed neural pathways do not necessarily equate to an increase in functional skill. Following a neurological injury, the individual with an ABI can benefit from participating in a rehabilitation process that facilitates the relearning of lost skill and function (Kimberley, Samargia, Moore, Shakya, & Lang, 2010).

Laatsch and Krisky (2006) studied the effects of cognitive rehabilitation therapy (CRT) on three individuals with a history of TBI using functional magnetic resonance imaging (fMRI). Researchers selected participants for this study from a large group of rehabilitation patients with similar deficits following their brain injury. Each participant completed an individualized CRT program that addressed different cognitive deficits based on the results of the neuropsychological testing pre-CRT. Individuals completed computerized and non-computerized tasks addressing visual processing and reading deficits. The researchers utilized fMRI pre and post-CRT to look at the areas of brain activity during a functional reading task. The fMRI revealed different parts of the brain activated with the functional reading task after completing CRT when compared to the control subjects (Laatsch & Krisky, 2006). This suggested that the use of CRT and repeated rehabilitation tasks could reorganize brain structure and improve cognitive abilities in individuals with brain injury.

Apart from improvements in the patients' cognitive functioning, neuroplasticity can also facilitate improvement in an individual's motor functioning. In line with this, Anderson, Eckburg, and Relucio (2002) revealed that the process of allowing the individual to undergo a series of physical exercises could lead to the thickening of the motor cortex. The thickening of the motor cortex is possible because of angiogenesis (Isaacs, Anderson, Alcantara, Black, & Greenough, 1992). Angiogenesis pertains to the physiological process where a new blood vessel can develop out of the old blood vessels (Penn, 2008). The researchers ascertained that since the brain synapses are constantly changing every second, it is possible to improve the patients' cognitive and motor functioning using proper exercise training intervention or rehabilitation therapy (Anderson et al., 2002).

Another longitudinal case study investigated the effects of a long-term comprehensive neurorehabilitation on neuroplasticity and motor function. The researchers observed an individual who had no functional use of their affected hand following a stroke using fMRI (Jang, You, & Ahn, 2007). The participant completed an eight-month course of neurorehabilitation to improve muscle strength, motor control, and performance by utilizing the affected hand in functional motor tasks and exercises. The researchers saw an increase in functional motor tasks with the participants' reaching and grasping a cup and picking a pencil after completing the intervention (Jang et al., 2007). Results suggested the use of long-term comprehensive neurorehabilitation could facilitate neuroplasticity in individuals with ABI by reorganizing motor pathways in the brain.

The study of Kleim et al. (2002) revealed that each time an individual undergoes a new learning experience, observable changes in the overall structure and function of the cortical region of the brain takes place as synapses occur. The main reason why the brain can easily rewire itself is that the synapses of brain neurons are "not hardwired" (Arden, 2012). By changing the structure and functionality of the brain cells, Johnston (2009) explained that it is possible for the central nervous system to learn new motor or communication skills, recall present and past information, and train the nerve function to respond well to the environmental stimulus.

In summary, there is a high level of empirical evidence demonstrating the ability of the brain to form new synapses, reorganize structures, and adapt to perform psychomotor functions more proficiently (Muir et al., 2009). The evidence also suggests that the brain undergoes structural and functional changes with each dynamic experience or activity in which an individual engages. Therefore, it is vital that interventions addressing cognitive deficits secondary to ABI provide sufficient opportunities for practice of a new skill with increasing variation and novelty. Thereby, solidifying newly formed synapses and delivering contextual challenges in preparation for increasing demands of the learned or remediated skill.

Computer-Based Cognitive Retraining

Individuals with ABI often present with short and long-term memory loss, deficits in executive functioning and attention, and an inability to solve problems (Dehn, 2010). Furthermore, these individuals may face difficulties when communicating their thoughts and feelings to others (Silver, McAllister, & Yudofsky, 2011; Tam & Man, 2004). Limitations in these areas inhibit an individual's ability to communicate and participate socially, thereby necessitating external assistance in completing instrumental activities of daily living (IADLs) (tasks required for independent living, such as shopping, financial planning, medication management, cooking, and community mobility). For these reasons, individuals with ABI frequently experience a decrease in performance during occupations in which they previously engaged, prior to the onset of injury (Topolovec-Vranic et al., 2010). Individuals faced with these deficits can benefit from restorative interventions that challenge their executive functioning and problem solving skills.

Koehler, Wilhelm, and Shoulson (2011) advocated that individuals with ABI should receive computer-based cognitive retraining (CBCR) in order to improve their neuropsychological and cognitive functioning. For example, utilizing software like Microsoft-word, Microsoft-Excel, and Microsoft-PowerPoint can further improve individuals' verbal and visual memory function, prolong their attention span, and improve their overall verbal responses (Gunning & Clegg, 2005).

Even though individuals with ABI may experience cognitive, executive, and motor functioning problems, most individuals retain enough function to utilize computers for improving their cognitive functioning. For instance, Bergquist, Gehl, Lepore, Holzworth, and Beaulieu (2008) invited 10 participants with ABI and memory impairment to attend several sessions of an online cognitive rehabilitation program. Despite the severity of the participants' memory impairments, Bergquist et al. (2008) revealed that only two out of the 10 research participants were not able to adapt to the session plan.

A number of studies examined the effectiveness of using CBCR as part of the patients' rehabilitation program (Dou, Man, Ou, Zheng, & Tam, 2006; Kirsch, Shenton, Spirl, Rowan, & Simpson, 2004; Lindqvist & Borell, 2010; Lundqvist et al., 2010; Tam & Man, 2004; Topolovec-Vranic et al., 2010; Westerberg et al., 2007). All of these studies showed positive test results in the use of CBCR on clients presenting with cognitive deficits and attention and memory problems after the onset of injury. Westerberg et al. (2007) conducted a randomized pilot study with 18 stroke patients to determine the effects of a CBCR training program on their working memory. The researchers divided the participants into two groups, a passive control group, and a treatment group for a period of five weeks. Based on the neuropsychological battery test results and self-rating scores concerning the participants' cognitive functioning, Westerberg et al. (2007) found that the use of a CBCR training program was effective in decreasing the participants' symptoms of cognitive problems by improving their attention span and working memory.

To determine the long-term and short-term impact of using a CBCR training program with patients demonstrating memory problems, Lundqvist et al. (2010) conducted a controlled experimental study. Twenty-one patients participated in a computerized working memory intervention, five days per week for a period of five weeks. After the training ended, Lundqvist et al. (2010) compared the baseline scores with scores taken from the neuropsychological working memory tests. The researchers found that the participants scored higher in the neuropsychological working memory tests after receiving a five-week computerized working memory intervention on a daily basis. Although the use of a CBCR program did not improve quality-of-life or validate generalization to other tasks, this particular training intervention was effective in improving the participants' cognitive functioning (Lundqvist et al., 2010).

To evaluate the impact of using computer-assisted cognitive technology in a rehabilitation program for Chinese patients with TBI, Dou et al. (2006) conducted a quasi-experimental research study with 37 participants. The researchers divided the patients into three groups, either to receive computer-assisted memory training, a control group, or therapist-administered memory training for a period of one month. After comparing the pre- and post-test results, Dou et al. (2006) found that participants who received either computer-assisted memory training or a therapist-administered memory training intervention scored higher than the control group in neurobehavioral cognitive status examination and the Rivermead Behavioral Memory Test (RBMT).

Tam and Man (2004) conducted a controlled group quasi-experiment to examine the impact of implementing four different types of computer-assisted memory training strategies (i.e. self-paced practice, salient visual presentation, performance feedback, and personalized training contents) on the memory skills of 26 patients with ABI. To obtain baseline values, each patient received a pre-test before participating in at least one type of CBCR strategy. The researchers utilized RBMT to evaluate the participants' computer performance data and a self-efficacy scale test. After comparing the pre-test and post-test results, Tam and Man (2004) found that regardless of which of the four CBCR methods utilized, participants improved their memory function when compared to the participants in the control group. In addition, the researchers found that the use of the performance feedback strategy was more effective in improving the participants' self-efficacy (Tam & Man, 2004).

To determine the impact of CBCR in support of the patients' ADLs, Lindqvist and Borell (2010) conducted a qualitative research study by interviewing six patients post stroke. Based on the results of the interviews, Lindqvist and Borell (2010) determined that a computer-assisted calendar was useful in reminding the patients about their daily task schedules and that home sensors could effectively support and remind the patients to perform activities at home (i.e. lock the door, hang clothes after washing, turn off the rice cooker after cooking, etc.). The study results suggested that future computer-based interventions combined with functional tasks could increase the performance range in daily activities.

Similar to the research findings of Lindqvist and Borell (2010), Kirsch et al. (2004) confirmed through a selective review that the use of wireless, web-based, and interactive computer interventions are useful in improving the daily functioning of patients with cognitive impairment at home. In addition, Kirsch et al. (2004) conducted two case studies to assess the impact of assistive technology for cognition on improving the patients' cognitive performance in daily tasks. The researchers assigned a 19-year-old man with topographical disorientation and 71-year-old woman with memory decline to a navigational task. Kirsch et al. (2004) concluded that the use of assistive technology for cognition could improve not only the patients' adaptive learning skills but also their overall daily functioning.

Research conducted by Li et al. (2013) at Dominican University of California utilized the Parrot Software CBCR intervention in a population of individuals with chronic ABI. The study utilized a neuropsychological assessment tool that statistically demonstrated improvements in attention and memory following the use of the Parrot Software intervention. The design, target population, outcome measures, and results of the study, paralleled the Johansson and Tornmalm (2012) study. Both studies suggested that CBCR programs could be effective at improving cognitive skills as measured by a neuropsychological assessment tool. In addition, the researchers mutually found no correlation between the scope of improvement and various subsets of demographic data, which included the type of ABI sustained and time since the onset of injury (Li et al., 2013). However, neither study included a component that considered the generalization of skill to a real-life task.

In conclusion, the use of CBCR is effective in terms of remediating or compensating for deficits secondary to brain injury (Li et al., 2013; Lindqvist & Borell, 2010; Westerberg et al., 2007). In addition, improving an individual's overall cognition, self-efficacy, and daily functioning are vital to improving an individual's quality of life (Lindqvist & Borell, 2010; Lundqvist et al., 2010; Dou et al., 2006; Kirsch et al., 2004; Tam & Man, 2004). While gains in memory, attention, problem solving, and executive functioning look promising, research is limited in demonstrating the generalization of performance from CBCR programs to daily life activities.

Generalization of Skill

Individuals with ABI often have cognitive deficits that interfere with the transfer of learning from interventions to real-life contexts (Melton & Bourgeois, 2005). This concept, known as *generalization*, refers to any use of skill in a different context from the original learned environment. The transfer of skill refers to a more specific concept that describes applying a particular skill to a related task (Toglia, 1991). There are two main types of transfer of skill. Near transfer tasks, involve the application of a learned skill to another task that slightly changes from the original task. In near transfer tasks, the task physically remains the same, with one slight variation. An example that demonstrates near transfer is the ability to apply the originally learned techniques for microwaving a cup of tea to microwaving a cup of soup. A far transfer task describes the application of the learned skill to another task that is completely different from the original task, but remains conceptually similar. An example that demonstrates far transfer is the ability to apply the originally learned techniques for microwaving a cup of soup to heating soup on the stove top (Toglia, 1991). For individuals with an ABI, near and far transfer of skill is more likely to occur compared to generalization due to the close similarity between the skills learned in intervention and the real life tasks (Giuffrida et al., 2009; Ehlhardt, Sohlberg, Glang, & Albin, 2005; Toglia et al., 2010).

For many individuals post brain injury, generalization of skills between varied environments is difficult to attain when the context changes significantly (Finn & McDonald, 2011; McGraw-Hunter, Faw, & Davis, 2006). The study by Finn & McDonald (2011) found that there was no generalization to self-reported memory functioning or perceptions of control over memory following 30 sessions of the Lumosity Brain Training Games (Lumos Labs Inc, San Francisco, CA) in individuals with mild cognitive impairment. The researchers hypothesized that generalization did not occur due to the large discrepancy of similarity between the training exercises and everyday activities (Finn & McDonald, 2011).

Some of the more persistent cognitive impairments following a brain injury are deficits in attention, memory, and motivation (McGraw-Hunter et al., 2006). Interventions provided to address these symptoms often assume that individuals with ABI do not have the capability of generalizing skills between different contexts (Toglia et al., 2010). Therefore, the primary intervention utilized in rehabilitation is an adaptive approach. The adaptive approach to intervention focuses on the individual's strengths and compensates for their deficits. Evidence supports that this approach can have success in facilitating more independence in individuals with ABI by improving ADL skills (Kelly & Nikopoulos, 2010). However, the acquired skills from this type of approach are restricted to the learned context and, therefore, generalization is unlikely to occur (Toglia, 1991).

Another type of intervention is the cognitive remediation approach. This approach aims to improve cognitive deficits by retraining specific impaired areas of cognition. CBCR is one example of a remedial approach. The assumption for this method is that the skills learned during the retraining interventions will generalize to other tasks requiring similar skills and generalization is more likely to occur when the new task only slightly varies from the original intervention (Giuffrida et al., 2009). For many individuals post brain injury, generalization of skills between varied environments is difficult to attain when the context changes significantly.

Ehlhardt et al. (2005) conducted a study that emphasized the deficits of transferring skills in notably altered contexts. The study employed an experimental single-group design conducted at a university computer lab or the participant's home, per individual choice. The study was composed of four participants that all had severe cognitive impairments secondary to TBI. All participants received assistance in daily living tasks. The study involved teaching the participants the specific steps required to complete simple email tasks on a preconfigured email interface. The researchers administered a post-test version of the email interface and a computer game at the end of the intervention period to measure for generalization. The results of the study showed that all four participants completed the modified email with fewer errors than in the pre-test. However, there were no significant changes in the performance of the computer game in any of the participants. The study suggested that generalization might have occurred between the intervention and the modified email interface due to the similarity of contexts. Conversely, the participants were not capable of generalizing their skill to the computer game because it was an entirely new context domain from the intervention interface (Ehlhardt et al., 2005).

A multiple probe across participant study by McGraw-Hunter et al. (2006) evaluated the effect that a self-modeling video intervention had on teaching cooking skills to four individuals with TBI. The researchers created individual videos of each participant performing the steps for cooking rice. The intervention involved repeating the same cooking activity with the use of the video and prompts from the researchers. At the end of the intervention period, participants cooked a different dish that required different cooking steps and different cooking times. The purpose was to assess the generalization of skill. All participants performed 92-100% of the steps in the generalization test independently. Results from this study suggested that generalization of skill was possible because the context of both the intervention and the generalization test were similar (McGraw-Hunter et al., 2006). However, the small sample size and lack of comparison group were evident.

The specific method of administering cognitive remediation interventions can also affect generalization (Guiffrida et al., 2009). A quasi-experimental multi-group design conducted by Guiffrida et al. (2009) composed a crossover intervention for individuals with TBI that utilized different practice schedules. The study involved six male participants who demonstrated chronic cognitive impairments. The researchers randomly assigned participants to either a block practice group or a random practice group. Those in the block practice group practiced typing on a computer, adding on an adding machine, and learning a subway schedule for a specific amount of time and in a specific order. The participants in the random practice group practiced the same activities but with varied practice times and alternating order each session. Both participant groups received a generalization skill test that required participants to perform the novel task of typing a dictated note. The results from the study demonstrated that participants in the block practice group performed better in skill acquisition than the random practice group.

However, the random practice group performed better in skill retention after two weeks and transfer of skill compared to the block practice group. Although random practice enabled better transfer of skill compared to blocked practice, both remain task-specific methods (Giuffrida et al., 2009). The results of this study support the idea that interventions require a task specific method to facilitate generalization of skill.

In the past, many in the rehabilitative profession considered generalization from cognitive remediation an automatic process. Remediation of specific cognitive skills aimed for newly acquired skills to transfer spontaneously between relevant contexts (Toglia, 1991). However, current research indicates that the set-up of the intervention needs to include some aspect of generalization during treatment (Toglia, et al., 2010). Research has shown that the transfer of skill is more likely to occur when a variety of contexts, activities, and strategies are implemented during treatment (Toglia, 1991; McGraw-Hunter et.al, 2006; Toglia et al., 2010).

Toglia et al., (2010) investigated the incidence of generalization with four individuals with TBI. The design of the study was a single-subject repeated measures design that utilized two performance-based assessments. The intervention was composed of several performance-based sessions that specifically focused on the transfer of skills. The researchers incorporated a generalization component into each activity. For example, in session one, the participants chose one fruit salad recipe. In session two, each participant made fruit salad from their chosen recipe. This demonstrated a near transfer of skill since both activities involved fruit and were both conducted in the kitchen. The next activity consisted of making and baking cookies. This was in the same context as the fruit salad activities but involved a different type of food. Each session contained a similar structure where the different activities varied slightly in context, theme, and difficulty. The results of the study showed that all participants decreased their errors in both performance-based tests. These findings suggested a transfer of skill from trained activities to non-trained activities. The results supported the idea that methodical planning for the incidence of generalization of skill is necessary for transfer to occur (McGraw-Hunter et al., 2006; Toglia, 1991). However, all participants returned to their prior level of function less than four weeks after the intervention was completed. The short duration of improvement as well as the small sample size (N = 4) must be taken into consideration.

Ecologically valid CBCR programs that utilize a virtual-reality interface may facilitate generalization to the community. A study by Yip & Man (2009) utilized a quasi-experimental design that included four participants with ABI that had at least one cognitive deficit affecting daily life tasks. The intervention was composed of two real-life tasks that participants could navigate within an interactive virtual-reality computer program. The researchers measured each participant's performance on several tasks in the real environment before and after the intervention. All four participants improved in their real environment tasks following 10 intervention sessions. The results of the study suggest that ecologically valid interventions can be more effective in promoting generalization.

In conclusion, individuals with ABI often have cognitive deficits that interfere with the acquisition, transfer, and generalization of skill (Melton & Bourgeois, 2005). Interventions that are ecologically valid and utilize task-specific activities, limit context variance, and purposely address the transfer of skill have demonstrated more success in generalization of cognitive skill. However, the aforementioned studies lacked a large sample size, comparison group, or did not directly assess the occurrence of skill generalization from CBCR programs. Minimal evidence and limited research exist on the generalization of skill attained from CBCR programs to daily-living tasks in individuals with ABI.

Cognitive Assessments

Occupational therapists use various forms of assessments. In a rehabilitation setting, occupational therapists utilize different assessments during the evaluation process to measure an individual's current level of abilities. For individuals with ABI, an occupational therapist is concerned with how safe and independently a person is able to perform ADLs and IADLs as part of their everyday routine (Toneman, Brayshay, Lange, & Trimboli, 2010). Specific types of cognitive assessments can identify cognitive deficits among individuals with ABI. Neuropsychological testing and performance-based assessments are examples of cognitive assessments utilized by occupational therapists to identify deficits in cognition that impact performance in everyday tasks.

Neuropsychological testing. The Mini-Mental State Examination (MMSE) is a cognitive screening tool used primarily to detect dementia. The MMSE contains 19 items assessing orientation, registration, language, and memory skills (Aggarwal & Kean, 2010; Marioni, Chatfield, Brayne, & Matthews, 2011). Marioni et al., (2011) investigated the reliability of the MMSE on a group of 2,275 individuals, 65 years of age or older, recruited from the Medical Research Council Cognitive Function and Aging Study. The researchers utilized a two-phase sample design to collect data. Participants were administered the MMSE once during the screening interview and again during the assessment interview process. The screening interview and assessment interview were two months apart to reduce the potential for a further cognitive decline of the participants. The researchers found that most participants scored similar at both screen and follow-up times. Hence, the researchers concluded that the MMSE is found to be a reliable screening tool used to detect cognitive deficits, similar to symptoms of dementia in older adults over 65 years old (Marioni et al., 2011). Conversely, research supports poor sensitivity of the MMSE when used to detect mild cognitive impairments (Aggarwal & Kean, 2010; Marioni et al., 2011; Schweizer, Al-Khindi, & Macdonald, 2012).

The Montreal Cognitive Assessment (MoCA©) is a quick cognitive screening tool used by occupational therapists to detect if individuals display mild cognitive impairment. In a longitudinal study, Aggarwal and Kean (2010) compared the MMSE and MoCA© scores of 50 individuals who suffered a stroke. They found 10 participants who scored normal on the MMSE but scored 25 or less on the MoCA©, indicating a mild cognitive impairment. The results of the study indicated that the MoCA© was more sensitive in the screening of individuals for mild cognitive impairment when compared with the MMSE (Aggarwal & Kean, 2010; Schweizer et al., 2012). Schweizer et al. (2012) examined the MoCA© scores of 32 individuals who suffered a stroke and found MoCA© scores correlated to real-world outcomes and the individuals' capability to return to work. However, researchers found that the high sensitivity of the MoCA©'s might also show cognitive impairment when none is present.

Performance-based assessments. Individuals with ABI often have difficulty in performing ADLs and IADLs independently due to cognitive deficits. Occupational therapy facilitates performance in these activities and promotes participation for independent living (Douglas, Letts, Eva, & Richardson, 2012). Occupational therapists utilize performance-based assessments to determine the focus of intervention and the level of assistance an individual might require in everyday activities following discharge. The Kitchen Task Assessment (KTA) and the Cognitive Performance Test (CPT) are examples of performance-based assessments utilized by occupational therapists.

Baum and Edwards (1993) completed a longitudinal study consisting of healthy aging individuals and individuals with Senile Dementia of Alzheimer's Type (SDAT). The researchers investigated the validity and internal consistency of the KTA in 106 participants recruited from the Memory and Aging Project at Washington University. The KTA is a standardized performance-based assessment measuring change in an individual's performance over time and the level of support required for successful task completion. The score reflects the performance of task initiation, organization, sequencing, judgment and safety, and task-completion. This study confirmed the validity and internal consistency of the KTA by comparing scores across all stages of SDAT between men and women. Baum and Edwards (1993) also suggested using the KTA to assist in discharge planning for individuals returning to the community. These results suggested that using a performance-based assessment could be an accurate measure of how an individual will perform in everyday tasks.

The CPT assesses cognition and its effects on performance in everyday-living tasks. It quantifies and organizes the skilled observation of the detailed performance of individuals in ADL and IADL tasks. Douglas et al. (2012) conducted a study to determine the CPT's concurrent validity and its similarity to other measures in identifying cognitive impairments. The researchers compared the scores of the CPT with the MMSE, the chronic medical illness burden (CIRS-G), the Functional Independence Measure (FIM) and the Assessment of Motor and Process Skills (AMPS) in individuals referred to occupational therapy for suspicion of cognitive impairments. The results indicated that the CPT had an internal consistency that was acceptable and was a valid measure of cognitive impairment. In addition, the CPT was able to identify task areas that might require varying levels of assistance. However, there were weak associations between measures when considering impairment designations (Douglas et al., 2012). While the CPT was not sensitive enough to identify deficits in specific cognitive domains, the study revealed that the CPT was a valid measure of overall cognition and performance in everyday-living tasks.

Ecological validity. The use of an ecologically valid performance-based assessment allows occupational therapists to predict how individuals will behave and perform in community settings such as at home, work, or school (Gioia & Brekke, 2009; Zgaljardic, Yancy, Temple, Watford, & Miller, 2011). Ecological assessments are vital in clinical settings due to the simulated context and artificial demands placed on task performance (Maeir, Krauss, & Katz, 2011). The Multiple Errands Test (MET) and the Neuropsychological Assessment Battery (NAB) are examples of ecologically valid assessments utilized to predict an individual's performance in real-life community situations.

The MET is a performance-based assessment administered in a real shopping mall or hospital environment that requires multitasking and involves completing 12 subtasks while following a list of nine rules. Maeir et al. (2011) investigated the ecological validity of the MET by measuring an individual's participation in the community three months post-discharge from a neurorehabilitation hospital using the Participation Index (M2PI) from the Mayo-Portland Adaptability Inventory (MPAI-4). The objectives of the MPAI-4 are for the clinical assessment and evaluation of rehabilitation programs for individuals with ABI. The M2PI measures community participation by individuals rating their participation in eight different domains with high scores reflecting more restrictions in participation (Maeir et al., 2011). This study included 30 individuals with ABI admitted to the neurorehabilitation department that were independent in ADLs and had functional use of his or her dominant hand one week before discharge back into the community. The researchers investigated the relationship between MET scores at discharge and follow-up scores reported by each individual or their significant other using Pearson correlation analysis. They found a positive correlation between the number of errors made on the MET at discharge and more restrictions in participation on the M2PI. The study supports evidence of the MET as an ecologically valid measure that can predict an individual's performance in the community post-discharge from neurorehabilitation.

Zgaljardic et al. (2010) completed a study confirming the ecological validity of the Screening modules and Daily Living tests from the NAB in patients with moderate to severe TBI. The NAB is a neuropsychological assessment designed to evaluate cognitive skills in adults with a variety of neurological disorders. The NAB Daily Living test measures skills identical to functional skills needed for everyday tasks. The researchers recruited 47 participants with a Glasgow Coma Scale score representing TBI from a residential rehabilitation program for post-acute brain injury. Participants were administered the NAB Screening modules and NAB Daily Living test as part of admission to the rehabilitation program. The results provide evidence for the ecological validity of the NAB Screening modules and Daily Living test regarding functional skills and everyday tasks.

In conclusion, it is essential to utilize a performance-based assessment with CBCR interventions, as ADLs and IADLs are at the core of the occupational therapy practice. A performance-based assessment consisting of a medication-box task can measure an individual's performance on a common everyday task in the targeted population. The medication-box task requires the basic cognitive skills such as attention and memory. By utilizing a performance-based assessment, results will show if an individual's gains in cognitive skills were able to generalize to improved performance following a CBCR intervention.

Statement of Purpose

Individuals with ABI often experience overall cognitive impairments and deficits in attention and memory. This often creates many challenges in learning new tasks and restoring skills. These individuals also exhibit difficulties with transferring skills learned from interventions to everyday contexts. Many individuals do not have the ability to generalize relearned skills from one situation to another. As a result, the roles, occupations, and the overall quality of life of individuals with ABI are often affected.

CBCR is a common intervention approach utilized by occupational therapists to help improve cognitive deficits in individuals with ABI. Although research has shown that CBCR programs are effective in improving cognitive domains, there is limited research to support that the skills learned in CBCR programs can generalize to functional daily living tasks. Pervious research conducted by Dominican University of California occupational therapy students (Li et al., 2013) found a significant increase in attention and memory in individuals with chronic ABI following participation in a CBCR intervention. The research team utilized the Parrot Software CBCR intervention and evaluated changes in cognitive domains with a neuropsychological assessment.

The primary purpose of this study was to assess the occurrence of generalizing gains in overall cognition, attention, and memory skills from a CBCR program to a daily living task in individuals with ABI. This study utilized the Parrot Software program for the CBCR intervention and evaluated changes in overall cognition, and attention and memory skills with a neuropsychological test, the MoCA©, and generalization of those skills to a performance-based medication-box task. Accordingly, the research questions and hypotheses for the study were:

1. Does the Parrot Software CBCR have an effect on overall cognitive, and/or attention and/or memory skills as measured by the MoCA©?

    a. Null Hypothesis: The Parrot CBCR Software will have no effect on overall cognition and/or attention and/or memory.

    b. Alternative Hypothesis: The Parrot CBCR Software will have an effect on overall cognition and/or attention and/or memory.

2. Will the effect of the Parrot Software CBCR on overall cognitive, and/or attention and memory skills generalize to a performance-based task?

    a. Null Hypothesis: Effects on overall cognition, and/or attention and/or memory will not generalize to a performance-based task.

    b. Alternative Hypothesis: Effects on overall cognition, and/or attention and memory will generalize to a performance-based task.

Theoretical Framework: Ecology of Human Performance (EHP) Model

The EHP model developed by occupational therapists, Winnie Dunn, Catana Brown, and Ann McGuigan guided the development of this research-based study. The model incorporates two principal objectives. These objectives aim to establish a unifying tool for treatment planning across multi-disciplines and to conceptualize the environmental context and its influence on occupational performance (Dunn, Brown, & McGuigan, 1994). The recognition that the individual is comprised of unique characteristics that simultaneously interact with their surrounding context, and the inclusive language that encourages application among multi-disciplines make the EHP model appropriate for guiding this research-based study.

The core constructs within the EHP model are the person, the context, the task and the person's performance range (Dunn, Brown, & Youngstrom, 2003). The EHP model is a client-centered approach that considers the relationship among the person, the context, and the task, and the impact of that relationship on performance (Dunbar, 2007). According to Dunn et al. (2003), the person is unique and complex. Each person brings his or her own personal variables to the task or an objective that dictates behavior presented in the environment. Personal variables include individuals' experiences, values, interests, and sensorimotor, cognitive, and psychosocial skills.

The authors utilize the term "task" because it is more common in everyday language than the term "occupation" (Dunn et al., 1994, 2003). The personal variables that an individual possesses influence chosen tasks and the outcome of performance on those tasks. When single tasks come together, it allows individuals to engage in performance that accomplish a common goal. The demands of the task determine the required sets of behaviors for optimal performance. Each different task presents different skills and abilities that an individual needs to perform the task successfully.

Context refers to the conditions surrounding the person. There are two different types of context to consider using the EHP model. Temporal context includes considering the individuals age, developmental stage, and health status. Environment context includes the physical, social, and cultural aspects (Dunn et al, 1994, 2003). The interaction between the person and context has an effect on his or her behavior and performance. Context can either support or inhibit an individual's ability to perform the task. Performance occurs when an individual uses their skills and abilities to engage successfully in tasks within a context (Dunbar, 2007).

The core constructs within the EHP model are constantly interacting (Dunbar 2007). The personal variables are continually changing as the person has new experiences and learns new skills. The context is variable and changes across time. The tasks available to the individual depend on both the contextual supports and the personal variables. The person's skills and abilities determine the amount of tasks available and the size of the performance range. The optimal performance range decreases when an individual loses skills and abilities due to illness or other medical reason, thereby, limiting the amount of tasks available to the person. Alternatively, the optimal performance range can increase by restoring the person's skills and abilities.

The EHP model offers five intervention approaches to support the performance needs of the individual (Dunn et al., 1994, 2003). The five intervention approaches within the EHP model include establish/restore, alter, adapt/modify, prevent, and create. Establish/restore refers to improving the person's skills and abilities. Alter refers to changing the context in which tasks occur. Adapt/modify intervention approaches focus on adapting the context or task to support performance. Prevent refers to changing the context, task variables, or the person in order to prevent poor performance. Create refers to creating an environment that will optimize performance. While the intervention approaches address the core constructs in a different manner, they share the common goal of optimizing the person's performance range (Dunbar, 2007).

Individuals with ABI present with deficits in overall cognition, and attention and memory skills. These deficits can limit the individual's performance range. According to the EHP model, improvement in cognitive abilities will simultaneously increase the individual's performance range. This increase in performance range will maximize the available tasks and provide opportunities for engagement in meaningful occupation. The Parrot Software CBCR program utilizes an establish/restore approach to intervention with an aim to improve an individual's overall cognition, and attention and memory skills. This study explored the effectiveness of the Parrot Software CBCR program in restoring those skills and the occurrence of generalization. The researchers utilized a performance-based task relevant to daily living and assessed the intervention's effect on the individual's performance range.

Figure 1. The Ecology of Human Performance (EHP) Model. The core constructs of the EHP model: The person (individual sitting at computer), the context (the CBCR), the task (an IADL performance-based task; medication management), and the person's performance range (blue spectrum originating from the computer). Adapted from "The Ecology of Human Performance: A Framework for Considering the Effect of Context," by W. Dunn, C. Brown, and A. McGuigan, 1994, *American Journal Of Occupational Therapy*, *48*(7), p. 600. Copyright 1994 by the American Occupational Therapy Association.

Definitions and Variables

Definitions

- Cognitive Retraining. Utilizing specific tools, strategies, and methods appropriate to an individual's current abilities in order to remediate an impaired cognitive function (Katz, 2005).
- Performance. The abilities individuals demonstrate and "the act of doing and accomplishing a selected activity or occupation that results from the dynamic transaction among the individual, the context, and the activity" (AOTA, 2008, p. 662). Improving performance skills and/or patterns leads to successful engagement in desired occupations or activities.
- Performance-Based Assessment. Any assessment strategy designed to estimate an individual's knowledge, understanding, ability, skill, and/or attitudes in a consistent fashion across a dynamic set of contexts or within the parameters of specific task demands. Performance-based assessments typically include written or oral responses, and completion of exhibitions, investigations, and/or demonstrations (Writer, Schillerstrom, Regwan, & Harlan, 2010).

Variables

The independent variable in this study was the CBCR program. The dependent variables were the resultant scores on the MoCA© and the medication-box task. Consideration of extraneous demographic variables such as age, gender, level of education prior to injury, previous experience with other CBCR programs, and history of medication management took place during the data analysis phase of the study.

Methodology

Design of the Study

The study utilized a quasi-experimental single group repeated measures design. The repeated measures design increased the validity of the research by controlling for a maturation effect within the group. Furthermore, implementing a non-intervention period compensated for the lack of a control group. Phase one of the study consisted of a cognitive screening and pretest with the MoCA© original version 7.1 (Nasreddine et al., 2005). The phase one interval also included the initial-test medication-box task. These provided baseline measurements. Following a minimum two-week non-intervention period, the phase two interval consisted of a pretest measurement with the second medication-box task prior to beginning the intervention. Following the intervention, the phase three interval consisted of posttest measurements with the MoCA© alternative version 7.2 and the third medication-box task. The three measurement intervals allowed the researchers to better assess for a relationship between the intervention and changes in posttest scores. The analysis of scores taken during the measurement intervals helped to answer the research questions.

The researchers utilized a performance-based medication-box task to measure the participants' ability to generalize the gained cognitive skills by counting the number of correct decisions made during the task (see Appendix A, Appendix B, and Appendix C). In addition, the researchers utilized the Montreal Cognitive Assessment (MoCA©) 7.1 (see Appendix D) in the recruitment screening and pretest phases and the MoCA© 7.2 (see Appendix E) in the posttest phase. To guard against the Hawthorne effect, participants received systematic verbal instructions for completing each medication-box task, but the researchers were not present during the task performance. The participants had 15 minutes to complete the medication-box task or informed the researchers when the task was completed. In a separate room from the participants, the researchers counted and recorded the number of correct mornings and evenings that the participants placed the pills in the medication-box. The maximum number of correct pill placements a participant could make was 14 and the minimum was zero. The primary goal of the design and medication-box task was to quantify changes in overall cognition, attention, and memory following the Parrot CBCR intervention utilizing a performance-based measurement.

Recruitment and Selection Process

The study utilized a convenience sample of community-dwelling, fluent English-speaking adults 18 years of age or older, and who were one-year post diagnoses of ABI. The researchers primarily recruited potential participants presenting with ABI from the Brain Injury Network of the Bay Area (BINBA), located in Marin County, California. In addition, potential participants made self-referrals from flyers, and postings on Craigslist and reputable stroke-related websites, (www.stroke-for-stroke.com and www.stroke-network.com; see Appendix F & Appendix G for information). After obtaining approval from Dominican University of California's Institutional Review Board for the Protection of Human Subjects (see Appendix H for IRBPHS Application, # 10081) and BINBA staff, a posted flyer, announcements at the facility, and e-blasts to the greater BINBA community commenced. There were no restrictions for participation based on gender or ethnicity classifications.

Recruitment processes took place in two phases. To meet the requirements of phase one, participants must have had the diagnoses of ABI based on medical history no earlier than one-year prior to the study's execution. The ABI could be due to brain tumors, brain injury, hypoxia, and anoxia, any type of cerebrovascular accident, encephalopathy, meningitis, infection, or TBI. In addition, participants were required to be fluent in English and 18 years of age or older. The researchers completed phase one screening via telephone, email communications, or in person at the BINBA facility. After meeting phase one requirements, each potential participant received "Participant's Bill of Rights" and informed consent documentation (see Appendix I and Appendix J). Participants received a proxy consent form (see Appendix K) if the participant was under legal guardianship before advancing to the second phase of recruitment. Upon receiving consent to participate, potential participants completed the pretest MoCA© 7.1 (see Appendix D), the initial medication-box task (see Appendix A), and a brief demographic questionnaire (see Appendix L). The questionnaire collected the participants' information regarding age, gender, education level, and previous experience with the Parrot Software or other CBCR programs, the type of ABI sustained and time of onset, prior experience with medication management, and co-intervention with other CBCR programs. Potential participants must have demonstrated deficits in overall cognitive functioning and in both attention and memory. The pretest MoCA© 7.1 and initial-test medication-box task scores evidenced these deficits. Potential participants must have scored less than 26 out of 30 on the MoCA© 7.1 and could not score 14 out of 14 on the initial-test medication-box task to be included in the study. A score below the norm (< 26) on the MoCA© 7.1 indicated cognitive impairments. In addition, a score of 4 or below out of 5 on the memory component and a 5 or below out of 6 on the attention component of the MoCA© 7.1 were required. These scores indicated cognitive deficits in attention and memory.

Exclusion criteria for participation in the study included anyone less than 18 years of age, not fluent in the English language, or presenting with no cognitive impairments or attention and memory difficulties, as indicated by a score of 26 or greater on the pretest MoCA© 7.1 or 14 out of 14 on the initial medication-box task. Furthermore, the study excluded individuals who displayed visual perception or visual acuity impairments, disorientation, as well as individuals with bilateral upper extremity motor impairments that interfered with computer use. An inability to complete the pretest MoCA© 7.1 and the initial-test medication-box task evidenced these deficits. Additionally, the study excluded individuals with cognitive deficits secondary to neurodegenerative conditions and those with onset of ABI less than one-year of the study's execution.

Intervention

Previous research conducted by occupational therapy students at Dominican University of California (Li et al., 2013) utilized the Parrot Software intervention with a similar population. The study utilized a psychometric assessment tool, Cognistat, which statistically demonstrated improvements in attention and memory following the Parrot Software intervention. The previous study also demonstrated that improvements were independent from varying periods spent on the Parrot Software intervention.

For this study, the researchers utilized modules directed at improving attention and memory for the intervention. The intervention protocol followed similar guidelines implemented by the previous Dominican University research team. Participants completed eight modules at their own pace in one-hour sessions per week for a total of eight hours. If the participant completed the assigned module prior to the one-hour session concluding, the participant repeated the module until the one-hour time limit.

Description of the CBCR software. Developed by Dr. Frederick F. Weiner, the Parrot Software is an interactive Internet rehabilitation platform and is commercially available through Internet access or by CD Software. The target populations for the program are individuals presenting with cognitive deficits secondary to stroke and various forms of brain injury. There are over 100 different programs targeting cognitive reasoning, memory and attention, reading, speech and language, vocabulary and grammar, and word recall (Weiner, 2009). Per the researchers' request, Dr. Weiner authorized a free subscription for the duration of the study (Appendix M).

Description of Parrot Software modules. For the study, participants completed eight modules within the Parrot Software program. Four of the Parrot modules addressed attention and four addressed memory. The four attention modules included *Visual Instructions, Attention Perception and Discrimination, Concentration,* and *Visual Attention Training*. The *Visual Instructions* module presented the participants with four geometric forms. The geometric forms varied in size (large or small), color (red, green, blue, yellow), and shape (circle, triangle, square, oval). The program provided visual instructions for the participants to choose a form based on its size, color, or shape. The *Attention Perception and Discrimination* module presented participants with a target picture alongside a grouping of four similar pictures. The program provided instructions to click a picture that accurately resembled the target picture. As the difficulty level progressed, the program instructed the participants to choose the picture that did not belong in the grouping. The *Concentration* module presented participants with a number of matching pictures in various locations. Depending on the difficulty level, the pictures remained on the screen for a set amount of time before the pictures disappeared. The program instructed the participants to click on a blank box. The picture would reappear and the participants had to locate the picture's matching pair. The *Visual Attention Training* module required participants to prepare for a colored box to appear on the screen that corresponded to the color bar on top of the page. The colored box appeared randomly and only for a short period on the screen. As the lesson progressed, the program included visual distractions, such as additional colors and boxes. These distractions required the participants to divide their attention between multiple colors and the corresponding color shown on the screen.

The four memory modules utilized in the intervention included *Remembering Written Directions, Remembering Visual Patterns, Remembering Written Letters,* and *Remembering Written Numbers*. The *Remembering Written Directions* module provided participants with written directions to place a picture in relation to a certain location relative to various pictures shown on the screen. When the participants clicked on the picture, the written directions disappeared from the screen. The *Remembering Visual Patterns* module presented a grid of 16 pictures to the participants. When the participants clicked on the screen, the program temporarily removed certain pictures from the screen. This action exposed a pattern of pictures. The program asked the participants to remember the pattern. The 16 pictures reappeared and the participant was required to identify the pictures that made up the previous pattern. In the *Remembering Written Numbers* and *Remembering Written Letters* modules, the program presented a list of numbers or letters to the participants. The program required the participants to remember the list in the correct order and identify the numbers or letters previously displayed. The amount of displayed numbers and letters varied depending on the level of the lessons. As individual lessons on the attention and memory modules progressed, the difficulty level increased.

Ethical and legal considerations. The researchers obtained approval from the Dominican University of California Institutional Review Board for the Protection of Human Subjects (IRBPHS) (see Appendix H for IRBPHS Application, # 10081). The researchers followed the guidelines established by IRBPHS and submitted recruitment forms in the application. The researchers abided by the American Occupational Therapy Association (AOTA) Code of Ethics and the regulations set forth by IRBPHS. The researchers upheld the principles of beneficence, nonmaleficence, autonomy and confidentiality, and social justice.

The principle of beneficence states that the researchers will protect the welfare and safety of all participants. The researchers upheld this by providing alternative solutions to complete the study for any participant that encountered health or safety concerns during any part of the intervention process. Participants were able to discontinue the session at any time and allowed the opportunity to complete the session later. The participants consented to partake in the study without coercion from the researchers. In addition, the researchers contained the study to areas of competence and did not conduct actions that extended beyond qualifications or experience.

In order to decrease attrition rates during the study, the researchers sent emails and phone call reminders throughout the study's implementation period regarding the dates and times of scheduled appointments. In addition, the researchers implemented strategies to minimize the potential for physical, psychological, and socio-economic harm to participants. The researchers provided breaks during each intervention session and allowed the participants to take any unscheduled breaks during the sessions. Furthermore, the researchers reminded the participants of their right to withdraw from the study with no retribution. The researchers provided all participants with a schedule of intervention times and dates so that participants could make necessary travel arrangements ahead of time. Participants could either contact the researchers to schedule or reschedule suitable session times, or allowed to complete two Parrot sessions per visit with appropriate rest breaks between sessions. These strategies aided in decreasing attrition rates and facilitated the participants' motivation to continue in the study.

The principle of nonmaleficence prohibits the researchers from any action that could potentially cause injury or maltreatment to the participants. The researchers informed the participants of their right to withdraw from the study at any time. The participants were able to continue a session at a later day if the session was not completed. The researchers determined that the proportion of risk to benefit for participants supported maximum benefits and minimized risks.

The principles of autonomy and confidentiality express that the participants have the right to assert their own free will and self-determination. The researchers provided the participants with full disclosure on the purpose of the study, the process of the sessions, the risks, benefits, potential outcomes of the study, and the right to terminate participation at any time without consequences. The research team provided consent or proxy consent forms that required full completion before the initiation of any aspects of the study. The research team ensured that all participant information obtained during the study remained confidential and safely secured. This included verbal, non-verbal, written, or electronic information. Upon completion of the demographic questionnaire and before the start of the study, the research team created a pseudonym for each participant to protect his or her identity. The research team stored all original written data in a locked cabinet at the study site. The research team inputted and accessed all data through a secured password protected file.

The principle of social justice requires that occupational therapists provide services in a fair and reasonable manner. The research team did not prohibit the services of this study to participants who did not qualify for the study. Instead, the researchers offered information on Parrot Software and an opportunity to participate in one Parrot Software module for trial to any participant who did not meet the inclusion criteria. Data collection did not take place for these individuals.

Data Collection

If participants showed memory and attention deficits, as demonstrated by the results from the pretest MoCA© 7.1 (see Appendix D) and scored less than 14 out of 14 on the initial medication-box task (see Appendix A), they were included in the study. The results from the MoCA© 7.1 and the initial-test medication-box task established the first baseline. To maintain reliability of the repeated measurements, the same researcher met with individual participants during all measurement intervals of the study. After the two-week period with no intervention, the same researcher re-measured the individual participant with the pretest medication-box (see Appendix B) task prior to beginning the

Parrot Software intervention. All participants waited no less than two weeks and no more than three weeks between the baseline measurements and intervention to begin.

The Parrot Software was the CBCR program utilized for this study. Participants completed eight one-hour sessions using the attention and memory modules within the Parrot Software program. The researchers supervised and documented the participants' time spent on the modules. The entire intervention took place on desktop computers located at BINBA. Following the eighth Parrot module, participants waited a minimum of 24 hours before posttest measurements. All participants completed posttest measurements within one week of completing the eight Parrot Software training modules. Posttest measurements included the posttest medication-box task and posttest MoCA© 7.2 (see Appendix C & Appendix E).

Description of the assessment tools. Medication management is an IADL that requires the individual to read and organize information. The purpose of the medication-box task was to assess the participants' abilities to attend and recall information in order to perform the novel task of organizing a medication-box of one week's worth of medications with a minimal number of errors. The participants received five prescription medication bottles containing beads of varying colors that correlated to pseudo-prescription medications and two weekly medication boxes, one labeled "morning" and one labeled "evening." The researchers provided verbal instructions that directed the participant to read the directions on the prescription medication bottles and organize the medications based on frequency per day, time per day, and days per week (see Appendix A, Appendix B, & Appendix C for verbal instructions). To guard against a learned effect of the instrument, there were slight variations between the frequency per day, time per day, and days per week instructions for the initial-test, pretest, and posttest medication-box tasks. In addition, zero to five over-the-counter (OTC) medication bottles served as "distractors" in each assessment. The added distractors increased the variability of the three medication-box tasks and closely simulated the real-life experience of using both prescription and OTC medications. Rolling a dice before each assessment allowed for randomization of OTC bottles to be included in the medication-box task (see Appendix N). The number six designated adding zero bottle of OTC, while the other numbers represented the quantity of OTC bottles to add to the assessment. These served as additional distractors and increased the variability of the three medication-box tasks.

The researchers counted the number of morning and evening pill compartments that the participants could correctly place the appropriate medications needed for that time of day in the weekly medication boxes. Each morning and evening medication-box had seven medication compartments labeled Sunday through Saturday. If the participant incorrectly placed a pseudo-prescription or one of the OTC medications into one of the 14 pill compartments, it counted as an error. Fourteen was the maximum number of correct responses a participant could score and zero correct was the minimum. Once the researchers provided verbal instruction, they exited the room and were not available to guide the participant or to direct them during the medication-box tasks. Therefore, participants were not aware that the assessments were taking place. In addition, without the researchers present, the participants would need to rely on their ability to attend and recall information from the verbal instructions and written directions on the pseudo-prescription bottles in order to perform the task without assistance.

The MoCA© assessment is a screening tool utilized by healthcare professionals to identify cognitive impairments (Schweizer et al., 2012). The researchers obtained permission from the MoCA© developers to include the assessment in the study (see Appendix O). The MoCA© does not require special certification to administer and is obtainable on the public domain. The screening takes approximately 15 minutes and it measures cognitive abilities in the areas of visual perception, executive functioning, attention, memory, orientation, abstraction, and delayed recall. For the purpose of this study, the MoCA© 7.1 (see Appendix D) served as both a screening tool for inclusion and a pretest measurement for baseline data. In addition, the researchers utilized the MoCA© 7.2 (see Appendix E) for the posttest measurements. The two versions of the MoCA© vary in item content. The variance served as a guard against a learned effect.

Data Analysis

Demographic data, MoCA©, and medication-box task scores entered into Microsoft Excel and transported to SPSS software version 12.0 (SPSS, Inc., Chicago, IL), allowed analysis of the data. The researchers utilized the consultation services of a statistician to assist with all data analysis processes. Descriptive statistics allowed the researchers to describe the sample and analyze any anomalies or significant findings in the results. In order to answer the research questions and test the hypotheses, the mean value of the initial, pretest, and posttest medication-box task and pretest and posttest MoCA© scores, including changes in these scores, were calculated. Utilizing two-tailed paired samples *t*-tests at a 95% confidence level allowed acceptance or rejection of the null hypotheses. In addition, utilizing a two-tailed independent samples *t*-test at a 95% confidence level allowed analysis of subsets of demographic data and its relation to measurement results. Furthermore, the researchers utilized a Pearson product-moment correlation coefficient to search for relationships between extraneous variables and scores on each MoCA© and medication-box tasks.

Results

Participant Demographics

The researchers screened 25 adults for inclusion in the study and 13 met inclusion criteria. One participant dropped out during the data collection phase due to difficulties with completing the Parrot Software modules. The final sample included in the data analysis ($N = 12$) remained throughout the study's duration. The average age of participants was 61 ($SD = 15.79$) and the majority (83%) of the participants were male. The diagnoses included strokes, TBIs, and brain tumors. Five participants were post-stroke and five were post-TBI. According to the self-report demographic questionnaire, seven of the participants had completed a college education or higher. In addition, seven of the participants had previous experience with CBCR, and six reported self-management of medications at home (refer to Table 1).

Table 1

Participant Demographics

Participant	Age	Gender	Education	ABI Type	Previous CBCR	Manage Medication
A	56	Male	College	BT	Yes	Yes
B	62	Male	College	TBI	No	Yes
C	49	Female	Some College	TBI	No	Yes
D	34	Male	High School	TBI	No	Yes
E	51	Male	College	Stroke	No	No
F	83	Female	College	Stroke	Yes	Yes
G	84	Male	College	Stroke	No	No
H	80	Male	College	Stroke	Yes	No
I	51	Male	Some College	TBI	Yes	No
J	73	Male	MBA	Stroke	Yes	No
K	59	Male	Some College	BT	Yes	Yes
L	50	Male	High School	TBI	Yes	No

Note. $N = 12$. BT = Brain Tumor. CBCR = computer-based cognitive retraining. Manage Medication = participants manage their own medication schedule.

MoCA© Scores

Differences between pretest and posttest MoCA© scores for overall cognition, and the attention and memory sub-scores were calculated utilizing two-tailed paired samples *t*-tests at a 95% confidence level. There was a significant difference in pretest ($M = 16.0$, $SD = 2.49$) and posttest ($M = 19.25$, $SD = 3.89$) overall cognition scores. The mean overall improvement was 3.25 with a standard deviation of 2.90 ($t(11) = 3.89$, $p = .003$). However, results showed no significant effect of either the attention or the memory sub-scores. The mean improvement for attention sub-scores was 0.42 with a standard deviation of 0.90 ($t(11) = 1.60$, $p = .137$). The mean improvement for memory sub-scores was 0.75 with a standard deviation of 1.76 ($t(11) = 1.47$, $p = .169$). These results indicate that the Parrot Software CBCR when completed for one hour per week for a total of eight weeks does have an effect on overall cognition, but not specifically in the cognitive domains of attention and memory (refer to Table 2).

Table 2

Pretest and Posttest Results for Overall MoCA©, Attention, and Memory Scores

Participant	Overall MoCA©			Attention			Memory		
	Pre	Post	Imp	Pre	Post	Imp	Pre	Post	Imp
A	17	19	2	4	4	0	2	0	-2
B	17	22	5	3	3	0	1	4	3
C	18	26	8	4	6	2	3	5	2
D	21	23	2	5	5	0	1	1	0
E	14	21	7	4	5	1	0	4	4
F	15	18	3	2	2	0	1	0	-1
G	13	21	8	4	6	2	0	1	1
H	13	14	1	4	4	0	2	1	-1
I	16	16	0	5	4	-1	0	0	0
J	18	21	3	3	3	0	3	5	2
K	17	19	2	6	6	0	0	0	0
L	13	13	0	3	4	1	0	1	1
mean	16.0	19.25	3.25	3.92	4.33	0.42	1.08	1.83	0.75
std dev	2.49	3.89	2.90	1.08	1.30	0.90	1.16	2.04	1.76

Note. $N = 12$. Imp = improvement. The total score for MoCA©, attention sub-test and memory sub-test are 30, six and five respectively.

Medication-Box Task Scores

Differences between the initial (M = 0.58, SD = 2.02) pretest (M = 1.67, SD = 2.74), and posttest (M = 1.17, SD = 4.04) scores (refer to Table 3 and Figure 2) were calculated utilizing two-tailed paired samples t-tests at a 95% confidence level. The p-values of medication-box scores indicated no significant changes in performance. The change in scores between the initial-test and pretest scores had a mean of 1.08 with a standard deviation of 3.70 ($t(11) = 1.01$, $p = .333$). The change in scores between the pretest and posttest had a mean of -0.50 with a standard deviation of 3.21 ($t(11) = -0.54$, $p = .600$). These results indicate that gains in overall cognition did not generalize to improved performance in the medication-box task. In addition, the researchers utilized a Pearson product-moment correlation coefficient to assess the relationship between the number of randomized OTC bottles (see Appendix N) and scores on the pretest and posttest medication-box tasks. There was no correlation between randomized OTC bottles and pretest scores ($r(10) = -.45$, $p = .147$). There was no correlation between randomized OTC bottles and posttest scores ($r(10) = .186$, $p = .563$). This indicates that the number of randomized OTC bottles had no significant effect on medication-box task scores.

Table 3

Initial-test, Pretest, and Posttest Results for Medication-Box Task

Participant	Initial-test Med-box	Pretest Med-box	Posttest Med-box
A	7	0	0
B	0	0	0
C	0	0	0
D	0	0	0
E	0	3	0
F	0	7	14
G	0	0	0
H	0	0	0
I	0	0	0
J	0	0	0
K	0	7	0
L	0	3	0
mean	0.58	1.67	1.17
std dev	2.02	2.74	4.04

Note. $N = 12$.

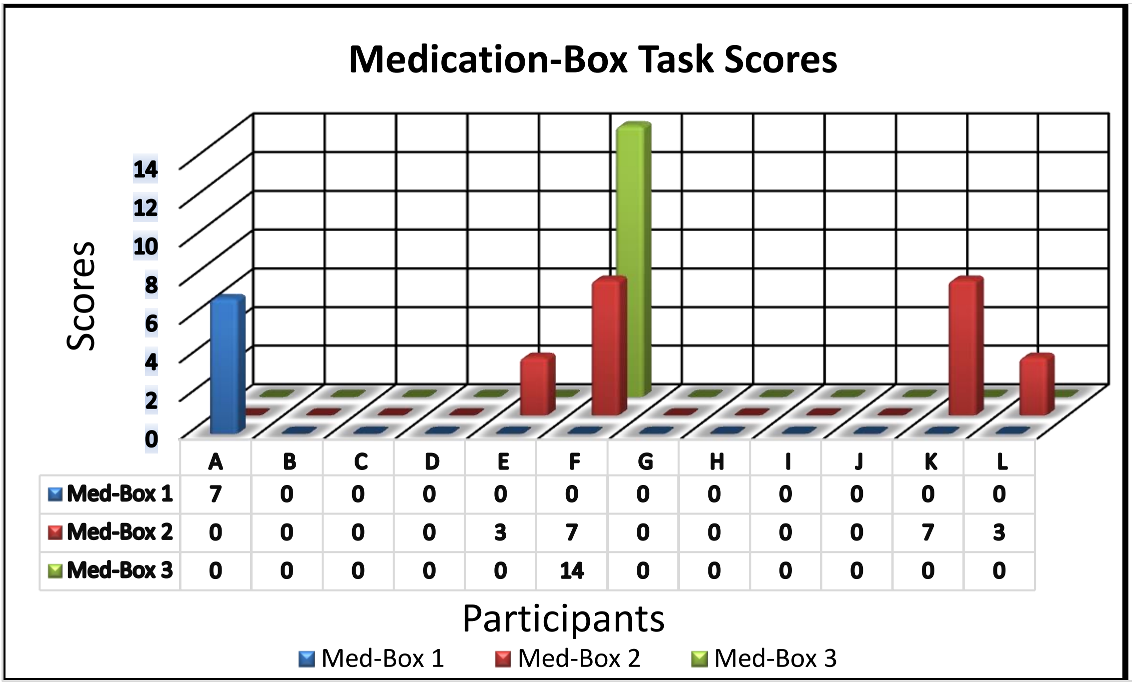

Figure 2. Initial-test, Pretest, and Posttest Results for Medication-Box Task

Demographic Subsets

The researchers utilized two-tailed independent samples *t*-tests at a 95% confidence level for analysis of subsets of demographic data and its relation to measurement results. There was no significant effect on MoCA© or medication-box scores based on extraneous factors such as age, education level, or type of ABI diagnosis. There was no significant effect on performance in the medication-box task for the participants that reported self-management of medications compared to the participants who reported they did not self-manage medications (refer to Table 4). There was a significant improvement in overall MoCA© scores in participants without previous CBCR experience compared to participants with previous CBCR experience (refer to Table 5).

Medication management. The researchers utilized an independent-samples *t*-test to compare the initial-test, pretest, and posttest medication-box task scores of participants who reported self-management of medication ($n = 6$) and participants who reported they did not self-manage medications ($n = 6$). With equal variances assumed, there was a no significant difference in the initial-test baseline medication-box scores for participants who reported self-management of medication ($M = 1.17$, $SD = 2.86$) compared to the participants who reported they did not self-manage medications ($M = 0.0$, SD = 0.0) ($t(10) = -1.00$, $p = .341$). With equal variances assumed, there was no significant difference in the pretest medication-box scores prior to the CBCR intervention for participants who reported self-management of medication ($M = 2.33$, $SD = 3.61$) compared to the participants who reported they did not self-manage medications ($M = 1.00$, $SD = 1.55$) ($t(10) = -0.83$, $p = .426$). With equal variances assumed, there was a no significant difference in the posttest medication-box scores following the CBCR intervention for participants who reported self-management of medication ($M = 2.33$, $SD = 5.72$) compared to the participants who reported they did not self-manage medications ($M = 0.0$, $SD = 0.0$) ($t(10) = -1.00$, $p = .341$). These results indicate there was no significant difference in performance on the medication-box task between participants who reported self-management of medication and participants who reported they did not self-manage medications.

Table 4

Participants Who Self-Manage Medication Schedule (n = 6), Participants Who Do Not Self-Manage Medication Schedule (n = 6)

Participant	Manage Medication	
A	Yes	
B	Yes	
C	Yes	
D	Yes	
E		No
F	Yes	
G		No
H		No
I		No
J		No
K	Yes	
L		No
Total	*n* = 6	*n* = 6
Initial-Test Mean	1.17	0.0
Initial-Test std dev	2.86	0.0
Pretest Mean	2.33	1.00
Pretest std dev	3.62	1.55
Posttest Mean	2.33	0.0
Posttest std dev	5.72	0.0

Previous CBCR. The researchers utilized an independent-samples *t*-test to compare the overall MoCA© scores of participants with previous CBCR experience (n = 7) and participants without previous CBCR experience (n = 5). With equal variances assumed, there was a significant improvement in overall MoCA© scores for participants without previous CBCR (M = 5.80, SD = 2.39) experience compared to participants with previous CBCR (M = 1.43, SD = 1.51) experience ($t(10) = 3.91$, $p = .003$). These results indicate that individuals without previous CBCR experience saw greater improvements in overall cognition when compared to those with previous CBCR experience.

Table 5

Overall MoCA© scores for Participants without Previous CBCR Experience (n = 5), and Participants with Previous CBCR Experience (n = 7)

Participant	Previous CBCR	
A	Yes	
B		No
C		No
D		No
E		No
F	Yes	
G		No
H	Yes	
I	Yes	
J	Yes	
K	Yes	
L	Yes	
Total	$n = 7$	$n = 5$
Mean imp	1.43	5.80
std dev	1.51	2.39

Note. Imp = improvement in overall MoCA© scores.

Discussion and Limitations

Discussion

The primary purpose of this study was to assess the occurrence of generalizing gained skills in overall cognition, attention, and memory from the Parrot CBCR program to a performance-based task. Twelve participants were included in the final data analysis of the study. Each participant completed eight one-hour Parrot Software sessions that specifically addressed attention and memory. The researchers utilized the MoCA© to measure changes in overall cognition and the attention and the memory subcomponents. In addition, the researchers utilized a performance-based medication-box task to measure the participants' ability to generalize gained cognitive skills.

Data analysis revealed that there was statistically significant improvement in overall cognitive skills, as measured by the MoCA©. These results demonstrate that the Parrot Software CBCR can be an effective intervention tool to improve overall cognitive skills in individuals with ABI. Scores on both the attention and the memory subcomponents also showed improvement. However, analysis of the attention and the memory scores separately found that there was no significant change in either the attention or the memory subcomponents. Therefore, the results may indicate that even though overall cognition did improve, the improvements did not emerge in any particular cognitive domain. Since there was a statistically significant effect on overall cognition, but not in attention and memory, the researchers could only partially reject the null hypothesis that stated that the Parrot Software CBCR would have no effect on overall cognition and/or attention and/or memory skills.

These findings contradict the results found by Li et al. (2013), which found statistically significant changes in both attention and memory after utilizing the Parrot Software with individuals with ABI. The lack of statistical significant change in attention and/or memory may be due to the study sample because the participants in this study were not required to have a minimum level of cognitive function in order to participate in the study. They were only required to score less than 26 out of 30 on the MoCA© 7.1, which indicated cognitive impairment. The participants may have had different degrees of severity in cognitive impairment. This differed from the Li et al. (2013) study that had a more narrow inclusion criteria regarding cognitive status and excluded those with severe cognitive impairments in attention and memory. In addition, the small sample size of the study might have contributed to these results. Therefore, further research should include a larger sample size.

Statistical analysis found that there were no significant changes in medication-box scores among the initial, pretest, and posttest measurements. Based on these results, the researchers were unable to reject the null hypothesis of the second research question that effects on overall cognition, and/or attention and/or memory skills will not generalize to a performance-based task. These results are consistent with the findings of Ehlhardt et al. (2005), which showed generalizing skills practiced in interventions to significantly varied contexts was difficult for individuals with ABI. While the practiced skills in the modules were similar to the requisite attention and memory skills required for managing a medication schedule, the Parrot Software CBCR was considerably different in context when compared to the context of the medication-box task. The lack of generalization of skill learned from the CBCR program to the medication-box task also coincides with findings by Toglia et al. (2010), which suggested that interventions should incorporate skill transfer and generalization. The multi-contextual approach used by Toglia et al. (2010), specifically addressed generalization in each intervention session by methodically modifying each activity and continually changing the context. The context in this study remained the same throughout each session. A second possible explanation might be that the medication-box task was too challenging for this population. Being a novel task in IADLs, the task requirements may be beyond the capabilities of the participants in spite of their overall improvement in cognition. Another possible explanation for the lack of generalization is that the eight one-hour Parrot Software sessions may not have been enough time to significantly improve attention or memory and promote changes in performance.

The researchers analyzed each subset of demographic data in order to examine extraneous factors such as age, education level, the type of ABI, previous CBCR experience, and self-management of medication. Analysis showed no significant difference between medication-box scores of participants who reported self-management of medications when compared to the participants who reported they did not manage their own medications. Experience managing personal medication was one of the questions on the self-report demographic questionnaire completed prior to the start of the study. However, the demographic questionnaire may not have been specific enough to identify what type of medication management method (i.e. with or without use of medication-box) the participants utilized. The lack of statistical significance indicates that even though participants reported self-management of medications, they were still unable to improve on the medication-box task. This suggests that the context and the task demands of the medication-box task may have differed in comparison to their own medication-management method at home, thus, not allowing a transfer of skill to occur. In addition, there was no relationship between OTC randomization and the changes in medication-box scores. This indicates that use of and randomization of the OTC distracters had no interference on the participants' performance on the medication-box tasks.

There was no significant difference in overall cognition based on age, education level, or type of ABI. However, there was a significant improvement in overall cognition for those participants without previous CBCR experience. One possible explanation could be that individuals without previous CBCR experience could have been more intrinsically motivated using the computer-training program since it was a novel task. The findings may also propose the idea that those participants with previous CBCR experience might have reached a plateau or ceiling effect, in which continuing CBCR sessions would have little effect on improving overall cognition. Gaitán et al. (2013) and Kwok et al. (2011) proposed a similar explanation following studies that utilized a CBCR intervention on individuals with mild cognitive impairments. The researchers suggested that the possibility of a ceiling effect might explain the lack of statistically significant improvements in cognitive function, as individuals recruited for the studies were already following a CBCR protocol.

While some of the results from this study are inconclusive, the study has created definite implications for the advancement of occupational therapy. The findings presented above suggest that CBCR as a stand-alone intervention may not be an effective rehabilitation method to facilitate generalization of skill in people with ABI. However, CBCR programs continue to gain popularity and provide increasing opportunities for individuals with cognitive impairment to participate and interact with the world (Yip & Man, 2009). As technology continues to progress, the field of occupational therapy must also continue to evolve. The results of the study increase awareness that although cognition may improve after using a CBCR program, the measure of improvement may only be exclusive to neuropsychological measurements. Furthermore, the cognitive improvements obtained through CBCR programs may not be able to generalize to an occupation-based task.

Limitations

This study addressed a population of individuals with ABI without degenerative conditions. Therefore, generalization of the results to a larger ABI population was not appropriate. Due to the use of non-standardized measurement tools, in this study the medication-box task, the researchers could not utilize a power analysis to determine the sample size needed to reach statistical significance. Therefore, within the constraint of the study time, the researchers allowed all individuals who met inclusion criteria to participate in the study. However, this also promoted the likelihood of a heterogeneous group.

In designing the study, the researchers wanted to utilize a novel task that represented an IADL, hence the medication-box task. However, the medication-box task developed by the researchers has not undergone validity or reliability testing with the ABI population and there was a potential for a learned effect of completing the test multiple times. The researchers chose to utilize two methods to address this limitation. The first, participants had to complete the MoCA© screening tool and score below the normal range (<26). This evidenced cognitive deficits. Second, the variance in each of the medication-box tasks and randomization of the OTC distractions addressed the learned effect. Nevertheless, whether the medication-box task was an appropriate representation of an IADL task for this study sample remains questionable.

Another limitation to the study was the self-report demographic questionnaire. The researchers provided the participants with a demographic questionnaire to complete. As cognitive impairment is one of the requirements to be included in the study, participants may have filled out the questions inaccurately when providing answers to the questionnaire. The demographic questionnaire addressed previous experience with self-medication management. However, it may not have been specific enough to delineate the methods for managing medications at home. Therefore, the validity of any results related to the demographic questionnaire remains uncertain, especially concerning history of self-management of medication.

Summary, Conclusion, and Recommendations

Individuals with ABI often have persistent and chronic residual deficits because of the assaults to the brain. The cognitive domains of attention and memory are most notably affected. These deficits can affect ADLs, IADLs, social participation, and the overall quality of life. Occupational therapy promotes the improvement of functional performance in daily life. Occupational therapists use cognitive remediation approaches to help improve these deficits in individuals with ABI. CBCR is one of the remedial approaches utilized by occupational therapists that focus on restoring cognition. Recent research has shown that CBCR programs are effective at remediating cognitive deficits in individuals with ABI. However, there is limited research that examines the occurrence of the generalization of skill to a novel daily living task.

This study evaluated the occurrence of skill generalization from change in cognition attained from a CBCR to a performance-based medication-box task. Essentially, the researchers discovered that the Parrot Software CBCR improved the participants' overall cognition, but that improvement was not able to generalize to a performance-based task. This study provides occupational therapists with evidence to guide intervention approaches, in the utilization of CBCR programs as an adjunctive therapy. The results of this study may assist occupational therapists and stakeholders in the rehabilitation of the ABI population and enable the development of protocols for utilizing CBCR as a therapeutic modality. With the primary focus of occupational therapists to facilitate improved performance in daily living tasks that support independence, the assessment instruments of the study address the appropriateness of ecological validity in the evaluation process. Future areas of research should include interventions that can bridge the gap between CBCR and performance in daily living tasks.

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Appendix A

Initial Medication-Box Assessment

Verbal Directions:

This activity is asking you to put the correct medication in the pillboxes. On the table, you will find two pillboxes, one for the morning and one for the evening. Please follow the directions so that you can set up the medications for one week. Please read the directions on the medication labels carefully.

Bottle #1: (30 White)	**Profnix** 2 tablets each morning
Bottle #2: (30 White)	**Zorbidal** 1 pill at bedtime
Bottle #3: (30 White)	**Sanitol** Take as needed for pain
Bottle #4: (30 Red)	**Diprozine** 2 tablets every other morning
Bottle #5: (30 Blue)	**Nexotram** 2 pills each day, 1 morning and 1 evening

Appendix B

Pre-Test Medication-Box Assessment

Verbal Directions:

This activity is asking you to put the correct medication in the pillboxes. On the table, you will find two pillboxes, one for the morning and one for the evening. Please follow the directions so that you can set up the medications for one week. Please read the directions on the medication labels carefully.

Bottle #1: (30 White)	**Profnix** 1 pill at bedtime
Bottle #2: (30 White)	**Zorbidal** 2 tablets each morning
Bottle #3: (30 White)	**Sanitol** 2 tablets every other morning
Bottle #4: (30 Red)	**Diprozine** Take as needed for pain
Bottle #5: (30 Blue)	**Nexotram** 2 pills each day, 1 morning and 1 evening

Appendix C

Post-Test Medication-Box Assessment

Verbal Directions:

This activity is asking you to put the correct medication in the pillboxes. On the table, you will find two pillboxes, one for the morning and one for the evening. Please follow the directions so that you can set up the medications for one week. Please read the directions on the medication labels carefully.

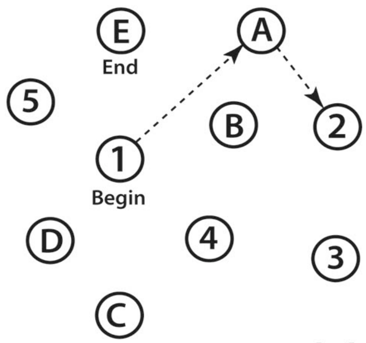
Bottle #1: (30 White)	**Profnix** 1 pill at bedtime
Bottle #2: (30 White)	**Zorbidal** 2 tablets each morning
Bottle #3: (30 White)	**Sanitol** Take as needed for pain
Bottle #4: (30 Red)	**Diprozine** 2 pills each day, 1 morning and 1 evening
Bottle #5: (30 Blue)	**Nexotram** 2 tablets every other morning

Appendix D
MoCA© Version 7.1 Pre-test

NAME :
Education : Date of birth :
Sex : DATE :

MONTREAL COGNITIVE ASSESSMENT (MOCA)
Version 7.1 Original Version

VISUOSPATIAL / EXECUTIVE



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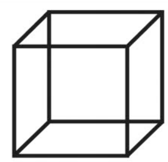
Copy cube



[ ]

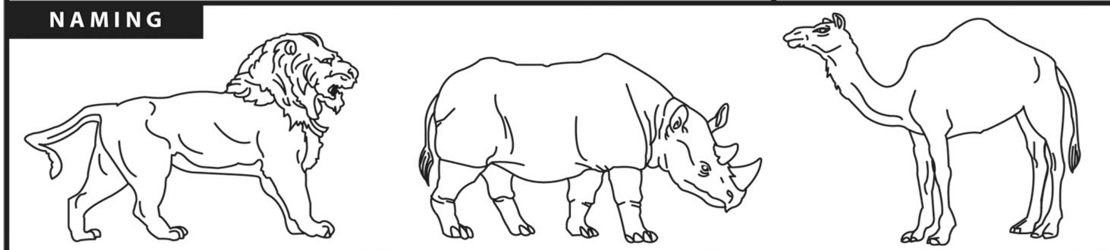
Draw CLOCK (Ten past eleven)
(3 points)

[ ] Contour [ ] Numbers [ ] Hands

POINTS

__/5

NAMING



[ ] [ ] [ ]

__/3

MEMORY Read list of words, subject must repeat them. Do 2 trials, even if 1st trial is successful. Do a recall after 5 minutes.

	FACE	VELVET	CHURCH	DAISY	RED
1st trial					
2nd trial					

No points

ATTENTION Read list of digits (1 digit/ sec.). Subject has to repeat them in the forward order [ ] 2 1 8 5 4
Subject has to repeat them in the backward order [ ] 7 4 2

__/2

Read list of letters. The subject must tap with his hand at each letter A. No points if ≥ 2 errors
[ ] F B A C M N A A J K L B A F A K D E A A A J A M O F A A B

__/1

Serial 7 subtraction starting at 100 [ ] 93 [ ] 86 [ ] 79 [ ] 72 [ ] 65
4 or 5 correct subtractions: **3 pts**, 2 or 3 correct: **2 pts**, 1 correct: **1 pt**, 0 correct: **0 pt**

__/3

LANGUAGE Repeat : I only know that John is the one to help today. [ ]
The cat always hid under the couch when dogs were in the room. [ ]

__/2

Fluency / Name maximum number of words in one minute that begin with the letter F [ ] _____ (N ≥ 11 words)

__/1

ABSTRACTION Similarity between e.g. banana - orange = fruit [ ] train – bicycle [ ] watch - ruler

__/2

DELAYED RECALL

Has to recall words	FACE	VELVET	CHURCH	DAISY	RED	
WITH NO CUE	[ ]	[ ]	[ ]	[ ]	[ ]	Points for UNCUED recall only
Optional Category cue						
Multiple choice cue						

__/5

ORIENTATION [ ] Date [ ] Month [ ] Year [ ] Day [ ] Place [ ] City

__/6

 www.mocatest.org Normal ≥ 26 / 30

TOTAL __/30
Add 1 point if ≤ 12 yr edu

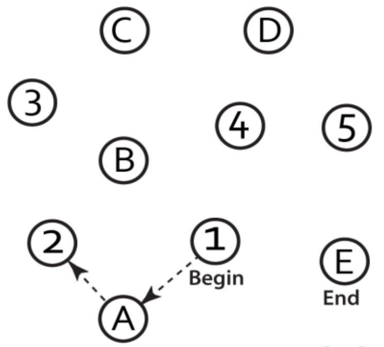
Administered by: ______________________

Appendix E
MoCA© Version 7.2 Post-test

MONTREAL COGNITIVE ASSESSMENT (MOCA)
Version 7.2 Alternative Version

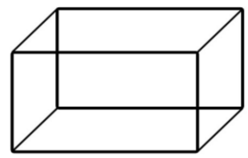
NAME :
Education : **Date of birth :**
Sex : **DATE :**

VISUOSPATIAL / EXECUTIVE



[ ]

Copy rectangle



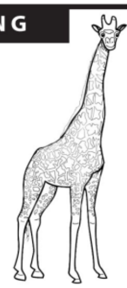
[ ]

Draw CLOCK (Five past four)
(3 points)

[ ] Contour [ ] Numbers [ ] Hands

POINTS ___/5

NAMING



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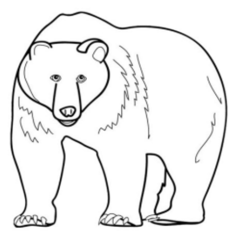

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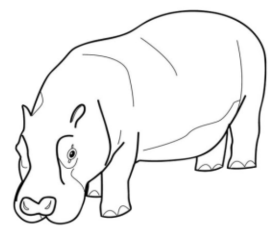


[ ]

___/3

MEMORY Read list of words, subject must repeat them. Do 2 trials, even if 1st trial is successful. Do a recall after 5 minutes.

	TRUCK	BANANA	VIOLIN	DESK	GREEN
1st trial					
2nd trial					

No points

ATTENTION Read list of digits (1 digit/ sec.).
Subject has to repeat them in the forward order [ ] 3 2 9 6 5
Subject has to repeat them in the backward order [ ] 8 5 2 ___/2

Read list of letters. The subject must tap with his hand at each letter A. No points if ≥ 2 errors
[ ] F B A C M N A A J K L B A F A K D E A A A J A M O F A A B ___/1

Serial 7 subtraction starting at 90 [ ] 83 [ ] 76 [ ] 69 [ ] 62 [ ] 55
4 or 5 correct subtractions: **3 pts**, 2 or 3 correct: **2 pts**, 1 correct: **1 pt**, 0 correct: **0 pt** ___/3

LANGUAGE Repeat : A bird can fly into closed windows when it's dark and windy. [ ]
The caring grandmother sent groceries over a week ago. [ ] ___/2

Fluency / Name maximum number of words in one minute that begin with the letter S [ ] _____ (N ≥ 11 words) ___/1

ABSTRACTION Similarity between e.g. carrot - potato = vegetable. [ ] diamond - ruby [ ] cannon - rifle ___/2

DELAYED RECALL

Has to recall words **WITH NO CUE**	TRUCK [ ]	BANANA [ ]	VIOLIN [ ]	DESK [ ]	GREEN [ ]	Points for UNCUED recall only
Optional Category cue						
Multiple choice cue						

___/5

ORIENTATION [ ] Date [ ] Month [ ] Year [ ] Day [ ] Place [ ] City ___/6

Adapted by : Z. Nasreddine MD, N. Phillips PhD, H. Chertkow MD
 www.mocatest.org
Administered by: ______________________

Normal ≥26 / 30

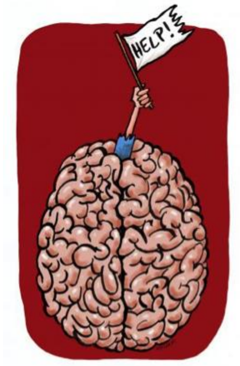
TOTAL ___/30
Add 1 point if ≤ 12 yr edu

Appendix F
Flyer

VOLUNTEERS NEEDED FOR RESEARCH STUDY

Would you like to?

- Improve your attention and memory
- Have the opportunity to develop computer skills
- Meet new people with similar challenges
- Contribute to the general knowledge of brain injury science, research, and rehabilitation



Students at Dominican University are conducting a study to investigate the effects of a computer program on memory and attention and the transfer of those effects to everyday living tasks

To participate in the study you need to:

- Be able to read and follow instructions in English
- Be 18 years of age or older
- Have a diagnosed acquired brain injury (Please read below)
- Have no vision difficulty in reading the computer screen
- Have no difficulty in using a mouse during computer use

Participants must have a diagnosed acquired brain injury more than 12 months ago resulting from one of the following:

- Brain tumor
- Hypoxia or anoxia
- Any type of stroke
- Encephalopathy
- Meningitis
- Infection
- Neurosurgical condition
- Traumatic brain injury (TBI)

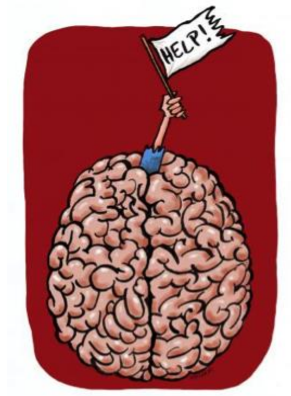
This study will be conducted at the Brain Injury Network of the Bay Area in Larkspur, CA
If you are interested or have any questions, please contact:
ducperformance@gmail.com
or call ***(415) 458 - 3753***

Appendix G
Postings on Craigslist, www.stroke-for-stroke.com and www.stroke-network.com

VOLUNTEERS NEEDED FOR RESEARCH STUDY! (Post Heading)

Would you like to?

- Improve your attention and memory
- Have the opportunity to develop computer skills
- Meet new people with similar challenges
- Contribute to the general knowledge of brain injury science, research, and rehabilitation



Students at Dominican University are conducting a study to investigate the effects of a computer program on memory and attention and the transfer of those effects to everyday living tasks

To participate in the study you need to:

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- Have a diagnosed acquired brain injury (Please read below)
- Have no visual difficulty in reading the computer screen
- Have no difficulty in using a mouse during computer use

Participants must have a diagnosed acquired brain injury more than 12 months ago resulting from one of the following:

- Brain tumor
- Hypoxia or anoxia
- Any type of stroke
- Encephalopathy
- Meningitis
- Infection
- Neurosurgical condition
- Traumatic brain injury (TBI)

This study will be conducted at the Brain Injury Network of the Bay Area in Larkspur, CA

If you are interested or have any questions, please contact:

ducperformance@gmail.com

or call ***(415) 458 - 3753***

Appendix H
IRB Approval Letter

DOMINICAN UNIVERSITY of CALIFORNIA 1890

December 12, 2012

Jonathan Alonso
2850 Rockridge Dr.
Pleasant Hill, CA 94523

Dear Jonathan:

The IRB Committee has reviewed your proposal (entitled, Skill Transfer from Computer- Based Cognitive Retraining to a Performance Skill in Individuals with Acquired Brain Injury) submitted to the Dominican University Institutional Review Board for the Protection of Human Subjects (IRBPHS Application, #10081). It is approved as having met the requirements for approval with one minor modification; in the Informed Consent Letter, you need to include the referral to the Brain Injury Network (phone, email, address) in case participation in the study raises any psychological discomfort.

In your final report or paper please indicate that your project was approved by the IRBPHS and indicate the identification number.

I wish you well in your very interesting research effort.

Sincerely,

Barbara Ganley

Barbara Ganley, PhD, MSN, RN
Associate Dean and Director of Academic
Assessment Co-Chair, IRBPHS

cc: Kitsum Li

Appendix I

DOMINICAN UNIVERSITY of CALIFORNIA RESEARCH PARTICIPANT'S BILL OF RIGHTS

Every person 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 has started 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 be in the study.

If you have questions about the research, you may contact the researchers (Mr. Jonathan Alonso, Ms. Nisha Chadha or Ms. Jennifer Pulido) at ducperformance@gmail.com. If you have further questions you may contact our research supervisor, Dr. Kitsum Li OTR/L, 415 458-3753 or 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. You may reach the IRBPHS Office by calling (415) 257-1389 and leaving a voicemail message, or FAX at (415) 257-0165, or by writing to IRBPHS, Office of Associate Vice President for Academic Affairs, Dominican University of California, 50 Acacia Avenue, San Rafael, CA 94901

Appendix J
CONSENT TO BE A RESEARCH SUBJECT
DOMINICAN UNIVERSITY of CALIFORNIA

Purpose and Background:
Mr. Jonathan Alonso, Ms. Nisha Chadha, and Ms. Jennifer Pulido, students in the Department of Occupational Therapy at Dominican University of California are conducting a research study designed to look at changes in attention and memory following a computer-based cognitive retraining program (CBCR). The researchers are interested in measuring the performance of individuals with brain injury before, during, and after the CBCR intervention.
I am being asked to participate because I am an individual with a brain injury greater than one-year prior to the study's implementation and I have difficulties with attention and memory.

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

1. I understand that all of the study's procedures will take place at the Brain Injury Network of the Bay Area (BINBA), located at 1132 Magnolia Avenue in Larkspur, California.
2. After providing informed consent documentation, I will fill out a demographic questionnaire and complete the Montreal Cognitive Assessment (MoCA©) original version 7.1 and medication-box activity. If my results indicate deficits in attention and memory, I will be included in the study.
3. After a waiting period of no less than 2 weeks, I will return to complete the second medication-box activity and begin using the Parrot Software cognitive training program.
4. I will complete eight modules in the Parrot Software intervention that are designed to improve attention and memory. Each module will take approximately one hour to complete.
5. After completing all eight Parrot Software modules, I will return to BINBA no earlier than one day to complete the third medication-box activity and the MoCA© alternative version 7.2.
6. I will complete the ninth Parrot module to conclude the study.

Risks and/or Discomforts:

1. I understand that my participation involves no direct physical risk, but may involve some mental or physical fatigue due to the time required to participate.
2. I understand there may be some psychological discomfort, given nature of the addressed topics in the demographic questionnaire. I will be discussing topics of a personal nature and I may refuse to answer any question that causes me distress or seems an invasion of my privacy. Should I experience adverse psychological harm, I will be referred to BINBA staff.
3. I understand that I may elect to stop filling out the demographic questionnaire at any time and may refuse to participate before or after the study begins without any adverse effects.
4. I understand that I may take rest breaks at my own discretion to resolve any fatigue, mental or physical, that I may be experiencing and I will be allowed to return to complete the module at a different date under my own desire.
5. I understand that during the period that I am in the study, if I decide to start another program or treatment to improve my attention and memory, I shall notify the research team.

Benefits:
The anticipated benefits of this study include:

- I may see improvements in my attention and memory skills.
- I will have the opportunity to develop my computer skills.
- I will meet individuals with similar injuries and challenges.
- I will contribute to the general knowledge of brain injury science, research, and rehabilitation.

Questions:
I have talked to the researchers about this study and have had my questions answered. If I have further questions about the study, I may contact them at (ducperformance@gmail.com) or their research supervisor, Dr. Kitsum Li, OTR/L, Department of Occupational Therapy, Dominican University of California, (415) 458-3753.

If I have any questions or comments about participation in this study, I should talk first with the researcher and the research supervisor. 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 the protection of volunteers in research projects. I may reach the IRBPHS Office by calling (415) 257- 1389 and leaving a voicemail message, by FAX at (415) 257-0165 or by writing to the IRBPHS, Office of the Associate Vice President for Academic Affairs, Dominican University of California, 50 Acacia Avenue, San Rafael, CA 94901.

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.

______________________________ __________________

PARTICIPANT’S’S SIGNATURE **DATE**

______________________________ __________________

PARTICIPANT’S NAME (PRINT) **DATE**

______________________________ __________________

SIGNATURE OF RESEARCHER **DATE**

Appendix K
PROXY CONSENT TO BE A RESEARCH SUBJECT
DOMINICAN UNIVERSITY of CALIFORNIA

Purpose and Background:
Mr. Jonathan Alonso, Ms. Nisha Chadha, and Ms. Jennifer Pulido, students in the Department of Occupational Therapy at Dominican University of California are conducting a research study designed to look at changes in attention memory following a computer-based cognitive retraining program (CBCR). The researchers are interested in measuring the performance of individuals with acquired brain injury before, during, and after the CBCR intervention. The adult under my guardianship is being asked to participate because he/she is an individual with a brain injury greater than one-year prior to the study's implementation and he/she has difficulties with attention and memory.

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

1. I understand that all of the study's procedures will take place at the Brain Injury Network of the Bay Area (BINBA), located at 1132 Magnolia Avenue in Larkspur, California.
2. After providing informed consent documentation, the adult under my guardianship will fill out a demographic questionnaire and complete the Montreal Cognitive Assessment (MoCA©) original version 7.1 and medication-box activity. If the results indicate deficits in attention and memory, he/she will be included in the study.
3. After a waiting period of two weeks, he/she will return to complete the second medication-box activity and begin using the Parrot Software cognitive training program.
4. I understand that my ward will complete eight modules in the Parrot Software program aiming at improving attention and memory. Each module will take approximately one hour to complete.
5. After completing all eight Parrot modules, my ward will return to BINBA no earlier than one day to complete the third medication-box activity and MoCA© alternative version 7.2.
6. My ward will complete the ninth Parrot module to conclude the study.

Risks and/or Discomforts:

1. I understand that my ward's participation involves no direct physical risk, but may involve some mental or physical fatigue due to the time required to participate.
2. I understand he/she may experience some psychological discomfort, given the nature of the addressed topics in the demographic questionnaire. He/she will be discussing topics of a personal nature and he/she may refuse to answer any question that causes him/her distress or seems an invasion of his/her privacy. Should my ward experience adverse psychological harm, he/she will be referred to BINBA staff.
3. I understand that my ward may elect to stop filling out the demographic questionnaire at any time and may refuse to participate before or after the study begins without any adverse effects.
4. I understand that my ward may take rest breaks at his/her discretion to resolve any fatigue, mental or physical, that he/she may be experiencing. My ward will also be allowed to return to complete the module at a different date under his/her own desire.
5. I understand that during the period, my ward is in the study, if he/she shall decide to start another program or treatment to improve his/her attention and memory, he/she or I shall notify the research team.

Benefits:
By participating in this study, the adult under my guardianship can anticipate the following benefits:

- He/she may see improvements in their attention and memory skills.
- He/she will have the opportunity to develop their computer skills.
- He/she will meet individuals with similar injuries and challenges.
- He/she will contribute to the general knowledge of brain injury science, research, and rehabilitation.

Questions:
I have talked to the researchers about this study and have had my questions answered. If I have further questions about the study, I may contact them at (ducperformance@gmail.com) or their research supervisor, Dr. Kitsum Li, OTR/L, Department of Occupational Therapy, Dominican University of California, (415) 458-3753.

If I have any questions or comments about participation in this study, I should talk first with the researcher and the research supervisor. 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 the protection of volunteers in research projects. I may reach the IRBPHS Office by calling (415) 257- 1389 and leaving a voicemail message, by FAX at (415) 257-0165 or by writing to the IRBPHS, Office of the Associate Vice President for Academic Affairs, Dominican University of California, 50 Acacia Avenue, San Rafael, CA 94901.

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

PARTICIPATION IN RESEARCH IS VOLUNTARY. I understand that I and/or my ward are free to decline to be in this study or withdraw participation at any time without fear of adverse consequences.

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

______________________________ ____________________

PARTICIPANT'S NAME **DATE**

______________________________ ____________________

GUARDIAN'S SIGNATURE **DATE**

______________________________ ____________________

SIGNATURE OF RESEARCHER **DATE**

Appendix L
Demographic Questionnaire

1. Name____________________ Date of Birth: ______________ Phone Number___________________

2. Address____

3. Gender: (circle answer) Male Female

4. Emergency Contact Information
____

5. Highest Education Earned
____

6. Type of acquired brain injury: (circle answer)

Stroke

Traumatic brain injury

Brain Tumor

Meningitis

Encephalopathy

Hypoxia/Anoxia

Other:_________________________

7. When did your injury occur?

8. Have you used Parrot Software before? (Circle answer) **yes** **no**

9. Have you used other computer software to help with attention and memory? (Circle answer) **yes** **no**

10. Do you manage your own medications? (Circle answer) **yes** **no**

11. Do you use a medication box? (Circle answer) **yes** **no**

Thank you !!!!!!!!!!! 

Appendix M
DOMINICAN UNIVERSITY of CALIFORNIA

LETTER REQUESTING PERMISSION TO USE A COGNITIVE INTEREVENTION

November 02, 2012

Parrot Software
P.O. Box 250755
West Bloomfield, MI 48322

RE: Attention and Memory Modules

Dear Frederick F. Weiner, Ph. D., SLP:

We are writing to request **written permission** to use the Parrot Software attention and memory modules in our graduate research project relating to transfer of skill in a population presenting with acquired brain injury. This project is part of a graduate thesis research requirement in occupational therapy at Dominican University of California.

We would appreciate receiving access to the Parrot Software from January 2013 through June 2013 and any standard instructions for administering the intervention.

Our research is being supervised by Kitsum Li, OT/L, Professor of Occupational Therapy at Dominican University of California, San Rafael, CA, 94901, (415)458-3753.

If this request meets with your approval, please sign, date, and return this letter to us. Please retain a copy for your records

If you have any questions, please do not hesitate to contact us at (925)705-0427. Thank you for your help.

Sincerely,

Jonathan Alonso, Nisha Chadha, and Jennifer Pulido
2850 Rockridge Dr.
Pleasant Hill, CA 94523

I agree to the above request.

______________________________ _______________
(Addressee's Signature) Date

Appendix N
OTC Randomization Chart

Participant	Initial Med-Box	Pre-test Med-Box	Post-Test Med-Box
A	0	5	2
B	5	0	3
C	0	1	0
D	4	4	2
E	4	3	0
F	3	1	4
G	4	0	2
H	2	4	5
I	0	3	1
J	0	2	3
K	3	5	4
L	1	2	1

Appendix O
MoCA© Approval

Li, Kitsum< kitsum.li@dominican.edu> Fri, Aug 30, 2013 at 4:39 PM
To: info@MoCA©test.org

Dr Nasreddine ,
I am writing to report a violation to MoCA© copyright. I bear the sole responsibility of this oversight. I have checked your website 2 years ago and noted that we could use MoCA© without permission in a clinic and university without permission. I have introduced MoCA© to my students and we have used it in our community service program at the University.
Last year, without further checking in the web information, I directed and supervised a group of students in the program of Occupational Therapy at Dominican University of California to conduct a small scale research study with the acquired brain injury population. This study is completed as part of the students' Master Thesis requirement. We used MoCA© 7.1 and 7.2 as our pre- and posttest to assess improvement in the domains of attention and memory in cognition after using a computer-based cognitive retraining program. We first used MoCA© in this study in Feb 2013 and completed in June 2013. A total of 12 participants completed the study. At this time, I am planning to use 7.3 as the 6-month follow up assessment. That's when I noted in your website that we required prior written approval to use MoCA© for research purpose. For this reason, I am writing to you to report my improper activity. Please believe me, it is never my intention to violate the copyright and not asking for prior permission before we began the study. With this violation, unless you will gratefully provide me with permission, I will not continue to use MoCA© 7.3 to complete the 6-month follow up assessment. I will cease all activity related to this study and report to our IRB regarding this violation. In addition, we will not submit this study to any journal for publication. Will these remedy actions be satisfactory to you? Is there any other action plan you would like me to put in place?
I sincerely hope that you will accept my apology on this oversight. And if there is any chance that you can grant us permission retrospectively to use MoCA© in completing this study and/or allowing us to submit our study to journal publication, I would be most grateful. Please let me know what are your recommended action and I shall provide you with my full cooperation. I sincerely hope you will accept my apology in this matter.

Kitsum Li, OTD, OTR/L
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415-458-3753

MoCA©< info@MoCA©test.org> Tue, Sep 3, 2013 at 6:12 AM
To: "Li, Kitsum" <kitsum.li@dominican.edu>
Cc: info@MoCA©test.org

Hello Kitsum,
I appreciate your honesty and professionalism.
You are welcome to use the MoCA© as you described below, and to use this permission retroactively to cover your previous study. Any changes or adaptations to the MoCA© test require prior written authorization.
All the best,
Ziad
Ziad Nasreddine MD FRCP(C) Professeur adjoint
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