IMPACT OF TRAUMATIC BRAIN INJURY ON AMERICAN SOLDIERS' MEMORY

WITH TECHNOLOGICAL COGNITIVE AIDS: A SUMMATIVE ASSESSMENT

by

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A DNP Project Presented in Partial Fulfillment

Of the Requirements for the Degree

Doctor of Nursing Practice

Capella University

August, 2016

Abstract

The purpose of this project was to evaluate an 8-week technology-based intervention involving the use of personal computer applications (i.e., "apps") to improve memory after mild traumatic brain injury among 10 Operation Enduring Freedom and Operation Iraqi Freedom male soldiers. Mild traumatic brain injury is the signature injury for these Veterans. The Veterans Affairs approved apps were loaded onto tablet PCs and given to the participants. Participants completed the Saint Louis University Mental Status (SLUMS) memory tool prior to and after the intervention. Participants were instructed to utilize the apps at least one hour per week and were contacted weekly to inquire about usage. The mean app usage per week was 4.30 hours. App usage ranged from a minimum of 2 hours to a maximum of 6 hours each week. Participants showed significant pre- to post-intervention improvements in memory, as measured by the SLUMS test, $t(9) = -3.35$, $p = .009$. The mean SLUMS score at pre-intervention was 20.20, increasing over four points to 24.30 at post-intervention. Participants displayed pre- to post-intervention increases in memory, as measured by the object identification test, $t(9) = -2.57$, $p = .030$. Prior to the intervention, participants recalled an average of 2.30 out of 5 objects; at post-intervention, they recalled an average of 3.50 out of 5 objects.

Keywords: traumatic brain injury, OEF/OIF Veterans, memory rehabilitation + Traumatic Brain Injury, and external memory aids.

Impact of Traumatic Brain Injury on American Soldiers' Memory with Technological Cognitive Aids: A Summative Assessment

Memory impairment is a concern for many individuals of various ages, with most problems being recognized more so in the elderly population with diagnoses such as dementia or Alzheimer's disease (National Institute of Neurological Disorders and Stroke, 2015). A new population is coming into focus with concerns of memory issues and this is the younger Veteran population of the United States of America military. These military members who served in either Iraq or Afghanistan during Operation Enduring Freedom/Operation Iraqi Freedom (OEF/OIF) are well-aware of the vast exposures and injuries from bombs, mortar blasts, and rocket propelled grenades, as well as the seriousness of these injuries (Rosenfield et al., 2013). An estimated 20% or more of OEF/OIF Veterans have incurred a mild traumatic brain injury (mTBI), often referred to as the signature, silent injury for this population (Mendez, Owens, Jimenez, Peppers, & Licht, 2013).

The three different classifications of traumatic brain injuries include mild, moderate or severe traumatic brain injury (Trudel, Scherer, & Elias, 2011). The focus of this project involves mTBI. The mTBI is diagnosed according to initial presenting symptoms, physical symptoms, cognitive symptoms, and the details of the injury, if any are remembered by the soldier. Iraqi and Afghanistan War Veterans have increased occurrences of TBI, which are considered the *signature injury* for these soldiers (Rosenfield et al., 2013). Mild TBIs may cause lifelong complications such as risks of memory impairment, cognitive decline with dementia, Parkinson's disease, seizure disorders, and many others (Rosenfield et al., 2013). By trying to improve the memory and coping skills of these Veterans, patients can work toward individual goals with their families, careers, and to help themselves personally and socially. In assisting Veterans with

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mTBI and memory issues, the underutilization of technological advances such as a tablet with Memory Applications in cognitive rehabilitation is reviewed. These military members used word cues or written memory cues to remind them of their task at hand or specific knowledge to be recalled. By implementing more advanced technological resources, such as the memory applications, improved cognitive rehabilitation can occur with quality outcomes. A program review and evaluation of the use of technological aids to assist in treatment of mTBI has reinforced the need for these services to be continued.

The target population consists of the American soldiers that served in OEF/OIF and suffered an mTBI with short term memory impairment. Moderate and severe brain injury patients were not included in this project. This population of the military were noted to be at an increased risk of suffering a TBI, whether it be a mild, moderate or severe injury. Mild TBI is the most common type of injury, but despite its name, the sequelae that follows is not always mild. Many of these Veterans with mTBI have memory concerns with short-term memory issues. Forgetting appointments, important dates, or forgetting to take prescribed medications are a few of the common concerns these soldiers experience.

The site of this project is a small, rural-based clinic that primarily serves Veterans to evaluate program outcomes after utilization of the tablet with memory applications in OEF/OIF Veterans with mTBI. Recognizing how memory impairments can affect an individual holistically is vital. Watching a patient struggle to answer questions regarding their personal history, including their medications, or feedback of patient education is disconcerting. Stakeholders in this project include the organization's Polytrauma Team, the administration of the facility, and especially the OEF/OIF Veterans suffering from mTBI. All are key players in this summative assessment. With the current budget cuts in the Veterans' healthcare system, it

was imperative to validate the value of technological rehabilitative resources available, being the tablet with memory applications.

Review of Literature

A comprehensive, systematic literature review was conducted for published research using various electronic databases and over 78 articles were explored. The following databases were utilized during this review: Cinhaul, Ebscohost, PubMed, ProQuest, and Scientific Citation, all in English language.

The literature review consisted of research regarding the prevalence of mTBI in the OEF/OIF Veteran population, the issue of memory impairment in this specific population, screening for memory impairment utilizing the SLUMS test, the issues of cognitive and memory rehabilitation in these patients, and the use of technological aids in improving the memory. These 78 studies were published between years 2005 – 2015. The information from the below research studies are valid and consistent in the data reported. These studies focused on the OEF/OIF population and the future provision of quality health care for military service members with a history of mTBI. The studies reviewed consisted of different research methods such as 29 journal articles of literature reviews of evidence-based literature, 24 quantitative studies (including random controlled studies, cross-sectional designs), two case-study review articles focusing on TBIs, 10 retrospective chart reviews regarding traumatic brain injury in OEF/OIF soldiers, and eight informative brief papers regarding TBI and its possible sequelae.

Relevance to Nursing Practice

Providing quality care to these veterans with mTBI and helping them rehabilitate as early as possible, can assist with future nursing knowledge and care by hopefully being able to monitor and work towards preventing other long-term complications that may arise with utilization of

evidence-based practices. Mild TBIs can cause lifelong complications such as memory impairment, cognitive decline with risks for dementia, Parkinson's disease, seizure disorders, and many other sequelae (Armstrong, McPherson, & Nayar, 2012; Hoge et al., 2008; Rosenfield et al., 2013; Zeitzer & Brooks, 2008). Hoge et al. (2011) acknowledges neurocognitive function does not recover as quickly in those soldiers with recurrent head injuries and may suffer a permanent decline in cognitive performance. Rosenfield et al. (2013) note the serious effect and implications for the soldier that has incurred multiple blast-related head injuries. The link between the severity of the blast and the frequency of the blast-related head injuries and the risk of neurocognitive decline, and also chronic traumatic encephalopathy was recognized by researchers (Rosenfield et al., 2013). By trying to improve the memory and coping skills with these new changes, patients can work toward individual goals with their families, health care teams, their careers, and their personalized goals and societal functioning.

Research indicates that individuals with traumatic brain injury have an increased risk for death decades after the injury has occurred (Bay & Chartier, 2014). Bay and Chartier (2014) also acknowledged that within one year after the traumatic brain injury, these patients are 49 times more likely to die from aspiration pneumonia or 22 times more likely to die from seizures in comparison to the general population (Bay & Chartier, 2014). A reduction in life expectancy by seven years has also been noted in the traumatic brain injury population (Bay & Chartier, 2014). These deaths were often associated with a general decline in their overall health including the risk of substance abuse, and these patients were noted to be more likely to have lived alone (Bay & Chartier, 2014).

Cognitive Rehabilitation

In the past, word puzzles have been used with mTBI patients in order to assist them with 'working their brain' in an attempt to help improve cognitive deficits such as impaired memory (Skotko, Rubin & Tupler, 2008). Working daily puzzles has also been utilized in other cognitive areas and has been acknowledged to slow memory decline in early dementia, and has been shown to improve cognitive reserves in patients (Pillai et al., 2014). Ruthirakuhan et al. (2012) researched the use of physical and intellectual activities in the management of cognitive decline in dementia. Working word puzzles is listed as an intellectual stimulator, and computer training to help memory is actually cognitive training (Ruthirakuhan et al., 2012). Recommendations of working word puzzles to help improve cognition were endorsed in the past (Pillai et al., 2014; Skotko et al., 2008; Valenzuela & Sachdev, 2009). This data reveals the need for improved 'cognitive training' for memory impairment instead of a daily word puzzle. According to the U.S. Department of Veterans Affairs (2015), using restorative cognitive rehabilitation in the mild TBI Veteran is recommended and one example of this is the completion of a daily word puzzle. Other recommendations include good sleep habits, a review of medications and also any psychiatric symptoms that may need evaluated (U.S. Department of Veteran Affairs, 2015).

Prior to technological advances, the only recommendations utilized for memory rehabilitation were using written cues or keeping a notebook with daily needed information. This type of memory rehabilitation was encouraged for patients to use in order to help improve cognitive functioning (Cornis-Pop et al., 2012; Pallai et al., 2011; Rosenfield et al., 2013; Valenzuela & Sachdev, 2009; Wild, 2013). Huggins et al. (2011) acknowledged medication adherence in veterans with traumatic brain injury and recognized the effect of a poor memory in relation to a TBI and the effect this has in the veterans' lives. These findings recognized an

increase in medication adherence in those traumatic brain injury patients that did own a memory-assisting device. Now, in the age of technology, more advanced resources are being researched and implemented with success in improving cognition in patients with mild traumatic brain injury (Cornis-Pop et al., 2012; Des Roches, Balachandran, Ascenso, Tripodis & Kiran, 2015; Lannin et al., 2014; Torrence, DeCristofaro, & Elliot, 2011).

Advanced Cognitive Rehabilitative Methods

Newer research in cognitive rehabilitation involves the use of external memory aids and the tablet with memory applications has been a new approach in therapy for TBI patients. Using a compensatory approach in memory rehabilitation with memory building applications "apps" and accessing the other memory aids, such as the tablet's electronic calendar organizer, availability and daily access to email, and also the calculator tools are reasons the tablet is a valuable resource tool.   Using technological-based computer aids to assist in memory enhancement and improvement can increase the independence of the patient (Sohlberg, 2011). By increasing a patient's independence, their personal well-being, health, social interactions, and emotional well-being will be affected automatically (Sohlberg, 2011). The patient's memory may not be "restored," but the rehabilitative external aids, such as using the IPad, can assist with cognitive support and psychological functioning (Mateer & Sira, 2006). At times, these rehabilitative strategies are enough to assist the patient with the mTBI in returning back to employment and other social functions (Mateer & Sira, 2006). Memory rehabilitation is needed early and efficiently in the mTBI population.

Assistive technology for cognition use been used to support cognitive abilities such as attention, calculation, emotion, self-reflection, and other cognitive functions, such as time management and planning (Gillespie, Best, & O'Neill, 2011). To improve cognitive

rehabilitation, the Department of Defense requested assistance from the Institute of Medicine (IOM) to research cognitive rehabilitative therapy interventions for Veterans suffering from a TBI. The Institute of Medicine (2011) formed a committee of experts to initiate this research. Assisting TBI patients with enhancing their quality of life was the goal of this expert committee, along with the process of recovering from cognitive problems or managing a way around the deficits with the use of resources and therapies (Institute of Medicine, 2011). This information revealed the need for better 'cognitive training' for memory impairment instead of working a daily word puzzle.

Assisting OEF/OIF TBI Veterans with their current cognitive state as a form of rehabilitation is one method of treatment rather than re-teaching a thinking process from the beginning. Lannin et al. (2014) researched the effectiveness of personal digital assistant (PDA) devices in memory improvement post-TBI and found in a random controlled trial a significant improvement in functional memory goals. By improving cognition and memory, many positive outcomes can result for the patient personally, at home, and in the work force. The long-term positive benefits of these effects are needed for the OEF/OIF Veterans' post-deployment life. Armstrong et al. (2012) explored the use of external memory aids after TBI and the effectiveness this memory rehabilitative method has in increasing the patients' independence, within their personal life and also within their occupation. Gillespie et al. (2011) performed a systematic review of literature researching assistive technology for cognition (ATC) in regards to assisting cognition in patients. These researchers acknowledged the significant role ATC plays in assisting cognitive rehabilitation with attention, emotions-regulation, and also with memory. The future impact of ATC in cognitive rehabilitation is very noteworthy.

Theoretical Framework

Roy's adaptation model (RAM) is the theoretical framework used for the basis of this clinical project. This theoretical framework was chosen due to the Veteran learning how to adapt to their new life with traumatic brain injury. RAM refers to the individual as an adaptive system (Nayback, 2009). This system involves interaction between both internal and external stimuli (Nayback, 2009). Internal stimuli come from within the individual and external stimuli is from the environment that produces a response in the individual being affected (Nayback, 2009). The OEF/OIF returning soldiers that experienced a mTBI has internal stimuli such as their age, their own beliefs, morals, gender, and heredity. The external stimuli include the war zone and the blasts which the soldier may have experienced that resulted in the mild traumatic brain injury. Other external stimuli include health care services received, medication management, financial stability, and job resources.

Roy coined the term *coping processes* to explain how an individual learns how to adapt and cope with the effect of now having difficulty with short-term memory due to the mild TBI (Nayback, 2009). These coping processes are categorized as innate coping processes (genetic and automatically present), or acquired coping processes (how the individual has learned how to deal with the issue; Nayback , 2009). It is imperative to note that cognitive dysfunction can result from traumatic brain function and can affect an individual's ability to have proper judgment, coping and cognitive processing (Cornis-Pop et al., 2012).

Roy's adaptation model has four adaptive modes in which the Veterans' behaviors in response to the coping activities can be followed. These adaptive modes include the following: Physiological/Physical Mode, Self-Concept Mode, Role Function Mode, and the Interdependence Mode (Nayback, 2009). According to Roy's explanation of the Physiological

Mode, this "is the sum of all the physical and chemical processes involved in the function and activities of a living organism" (Nayback, 2009, p.306). The soldier's body undergoes many internal responses with the effect of an incident such as a bomb or IED explosion. The Physiological Mode describes this autonomic response of fight or flight response that the individual experienced and is part of the adaptive response physically (Nayback, 2009). The Self-Concept Mode of Roy's Adaptive Model is next and it is the feelings or beliefs that the Veteran has about him- or herself (Ordin, Karayurt, & Wellard, 2012). The Veteran with an mTBI with memory impairment may have low self-esteem, which can affect their personal relationships with their spouses or significant others, affect their families and how they feel about their future. The next mode, the Role Function Mode, evaluates the roles the individual has (Ordin et al., 2012). These roles include the Veterans' roles in their family unit, their jobs, and also in society. The last mode is the Interdependence Mode. This mode reviews the love, respect and values given to the individual (Nayback, 2009). With the Roy Adaptation Model, these behaviors are identified as being adaptive or non-adaptive (Ordin et al., 2012). Soldiers with adaptive behaviors work toward positive adaptation in their life, home and environment, while those with non-adaptive behaviors will have a struggle ahead (Nayback, 2009). An OEF/OIF Veteran with a mild traumatic brain injury with short-term memory challenges can have adaptive and non-adaptive behaviors. With memory rehabilitation, this can increase the adaptive behaviors to help these soldiers.

<div align="center">**Project Focus**</div>

The project focuses on OEF/OIF Veterans with mTBI assessing the effects of using a tablet with memory apps over a period of two months to evaluate improvement of short term memory issues. Acknowledging the outcomes of cognitive rehabilitation implementation allows

health care professionals (clinicians and nurses) as well as OEF/OIF Veterans to recognize the importance of treatment and program utilization for memory impairment.

Project Aims

The initial aims for this project include an improvement in memory rehabilitation for the OEF/OIF Veterans and facilitate utilization of resources for quality cognitive rehabilitative care for these patients. Striving toward an improvement in cognitive rehabilitation is a goal to improve patient outcomes and using these external aids for memory rehabilitation will assist these patients with the cognitive trials they may be experiencing following mTBI (Wild, 2013). The second aim is to encourage acknowledgement and recognition of the cognitive rehabilitation program among health care professionals that is available for these OEF/OIF Veterans.

Context

The contextual elements considered important in establishing the intervention include the population to which the program evaluation belongs to. Military members are often advised to not show weakness, and by admitting they are being *overly forgetful* they may perceive this as a sign of weakness. Forgetting conversations with employers, friends, and families is troublesome for an individual that once was in a war zone as a part of the United States military. This is an even more important reason to encourage use of cognitive rehabilitative programs and resources.

Setting

The setting chosen for this project was a Veteran healthcare clinic serving local Veterans located in northeastern United States. This center contains a specialty-focused polytrauma clinic that screens OEF/OIF Veterans with reported histories of personal TBI exposure(s). This clinic is a subset to larger polytrauma Veteran type clinics and is the first stop for the OEF/OIF Veteran in this locale to be evaluated for possible TBI. Six large polytrauma regional centers are located

across the United States of America to serve Veterans with TBI and other traumatic type injuries. The largest regional center near this facility is almost six hours away. This long trip was also identified as a barrier for patients as many decline to travel this far, and no care is sought or received for the TBI at all. By offering this subspecialty in this small rural based facility, this helps determine if a larger-scale type of care for a positive TBI injury is even warranted. If so, arrangements are made to assist the Veteran. Most of the mTBI care is provided at the local center to assist the Veterans in avoiding any unnecessary long-trip appointments.

Planning the Intervention

After an approval of the project idea was obtained by the organization, the stakeholders were identified and several meeting ensued to maintain open communication throughout the project. The stakeholders involved included those individuals linked with the Traumatic Brain Injury Clinic and the facility's administrative management. The local OEF/OIF Veterans are the primary key stakeholders of this project. Other important stakeholders include the Polytrauma Clinic nurse practitioner and the facility OEF/OIF Coordinator. The coordinator receives the initial consult and screens the OEF/OIF Veteran and schedules an appointment within the TBI Clinic. Another stakeholder is the speech therapist. The speech therapist for the TBI Clinic issues the tablet and memory applications and provides education as to the proper use of the tablet as a part of cognitive rehabilitation. The health care facility as a unit is another primary stakeholder including involved administrative management, being the clinic supervisor. The organization as a whole was an advocate for evidence-based practice and follows directives and policies set forth by administration. The organization does encourage learning and education of the staff and follows national guidelines for quality health care. The facility is open to change, but the process of change implementation is very slow. Potential limitations identified for

implementing a change within the organization includes the time factor. One decision made to help decrease this potential barrier was to have a more narrowed time focus for this project, making it specific as well as short to ensure potential for completion. This was a possible barrier, but with a shorter time frame, this assisted in the completion of the project in a timely manner.

Implementation Phase

The planned intervention was to increase the utilization of technological rehabilitative measures for the OEF/OIF mTBI Veterans in an effort to improve short term memory issues by evaluating the current program to examine its' effectiveness. Ten OEF/OIF Veterans that consented to participation and screened positive for an mTBI underwent an initial SLUMS exam. These Veterans then received a tablet with memory applications from the TBI Clinic Speech Therapist with provided education on the utilization of the tablet with the memory apps. The TBI Speech Therapist would give the same list of instructions to each participant and the participant would demonstrate ability to use the tablet back to the therapist. The memory applications were the same for all mTBI Veterans participating in this project, which are the same apps used in cognitive rehabilitation at this facility. After the Speech Therapist issued and educated the Veteran about the tablet and apps, the project leader completed the remainder of the project's implementations and interventions. A weekly phone call was made by the project leader to encourage use of the memory applications, and also to encourage participation. During this weekly phone call, the project leader also inquired how often and how much time was being spent on the tablet utilizing the memory applications. A confidential log without identifying personal information (contained pseudonym labels 1-10) was maintained to track the time the tablet with memory applications was reported to be used by each participant weekly. After eight

weeks of tablet with memory application use, at least one hour a week, a repeat SLUMS exam was performed by the project leader again, to assess for any improvement in memory and any feedback in improvement the Veteran had noted. The project intervention remained the same with any unexpected needs for change or obstacles throughout the course of the program evaluation.   To assess if any improvements occurred or did not occur post-intervention, the pre-intervention SLUMS scores were compared to the post-intervention SLUMS scores and statistical analyses was performed.

Measures

Each of the 10 voluntary participants had a SLUMS evaluation prior to receiving the tablet with memory apps and had the test repeated again eight weeks after using tablet memory applications to assess for any improvement in memory.   The SLUMS instrument, published in 2002, is an 11-item questionnaire with scores ranging from 0-30 (Department of Veterans Affairs Health Services Research & Development Service, 2010). The SLUMS examination takes 7-minutes, and a 30-point cognitive screening measure that is easily administered and assesses various cognitive domains such as attention, calculation, immediate and delayed recall, animal naming, abstract thinking, and visuospatial skills (Cummings-Vaughn et al., 2014; Feliciano et al., 2013; Tariq, Tumosa, Chibnall, Perry, & Morley, 2006). This instrument is specifically designed to measure orientation, memory, attention, and executive functions (Department of Veterans Affairs Health Services Research & Development Service, 2010). The tasks on this instrument focuses on different aspects of memory assessment such as attention, simple math calculation, recall of items and evaluation of delayed recall (Department of Veterans Affairs Health Services Research & Development Service, 2010). It also focuses on clock drawing, recognition of figures/shapes, differentiation of size, and being able to recall details from

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paragraph read aloud to the patient (Department of Veterans Affairs Health Services Research & Development Service, 2010). The average time to administer and complete a SLUMS questionnaire is seven minutes (Department of Veterans Affairs Health Services Research & Development Service, 2010). The age range studied in receiving a SLUMS evaluation is age 18 and older (Ellis & Savella, 2013).

These researchers completed a summary assessment of the SLUMS instrument and acknowledged the professional association recommendations to utilize this instrument as follows: American Physical Therapy Association's Multiple Sclerosis Taskforce, Parkinson's Taskforce, Spinal Cord Injury Taskforce, Stroke Taskforce, Traumatic Brain Injury Taskforce, and the Vestibular Taskforce (Ellis & Savella, 2013). These professional recommendations were developed by a research panel using clinical experts using a modified Delphi process (Ellis & Savella, 2013). Tariq et al. (2006) compared the SLUMS instrument with another well-known cognitive screening instrument, the Mini Mental State Examination (MMSE) in detection of dementia and also mild neurocognitive disorder (MNCD). These researchers had 705 participants in the study to compare the SLUMS instrument with the MMSE (Tariq et al., 2006). The analysis in this study revealed that the sensitivity and specificity appear similar for both the SLUMS and the MMSE in the detection of dementia. According to Tariq et al.'s statistical analysis (2006), the cutoff scores for MNCD and also for dementia in patients with a high school diploma or higher education are 25.5 and 21.5. The sensitivity/specificity values for these cutoffs are 0.95 / 0.76 and 0.98 / 1.0 (Tariq et al., 2006).

Tariq et al. (2006) also recognized the advantage that the SLUMS examination has in comparison to the MMSE in regards to MNCD evaluation. The SLUMS instrument can aid in the identification of patient with mild neurocognitive disorder on the first patient interaction and

not require an additional separate follow-up screening (Tariq et al., 2006). This allows the treating clinician to begin interventions earlier, which is important in the treatment of any cognitive disorder, including mild traumatic brain injury. Feliciano et al. (2013) researched the validity of the SLUMS instrument in comparison to the MMSE. These researchers sought to compare the skill of the SLUMS and MMSE in predicting performance in the neuropsychological measurements of memory and executive functioning. These researchers acknowledged the SLUMS examination's more thorough assessment of memory in comparison to the MMSE (Feliciano et al., 2013).

Using the SLUMS examination in the Veterans Affair Medical Center was chosen since it is already an approved screening examination for this organization to use. Past research reveals the SLUMS examination tool is possibly more adequate in the detection of a mild neurocognitive disorder (Tariq et al., 2006). The comparative well-known tool, the Mini Mental Status Exam (MMSE), failed to detect the mild neurocognitive disorder, but is acknowledged that further evaluation of this is needed (Tariq et al., 2006).

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Analysis

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Statistical analysis of this project was completed using IBM SPSS 23.0 statistical software. The primary focus of analyses was to compare SLUMS and 5-object recall scores at pretest (prior to the tablet intervention) t and posttest (after eight weeks of utilization of the tablet memory application software), with the expectation that scores would show significant increases at posttest. Intervention studies conducted with military personnel with mTBIs have shown significant associations between age and education level and memory performance (MacDonald et al., 2015; Roebuck-Spencer et al., 2008; Troyanskaya et al., 2015). This area of research has further shown that memory improves with practice and effort (Clark, Amick, Fortier, Milberg, &

McGlinchey, 2014; New, Ramage, Robin, & Tate, 2016). Covariate testing, through the use of correlational analyses, was conducted on age, education level, and number of hours per week using app and the SLUMS and the 5-object recall posttest scores. Descriptive data was provided on all variables.

Results

Data analysis was performed by a review descriptive statistics of the participants' ethnicity, educational level, and cause of their mTBI. Memory app usage was also examined, including the participants' 5-object recall scores pre-intervention and post-intervention. The pre-intervention SLUMS scores and post-intervention SLUMS scores were also assessed. Correlational analyses were conducted examining for any correlation between participants' age, hours of app use, SLUMS scores, and 5-object posttest scores. Paired samples t-tests were analyzed to evaluate for any increase in SLUMS and 5-object recall scores from pretest to posttest.

Descriptive Statistics

Of the 10 participants, all (100%) were male. All participants met inclusion criteria of having served in OEF/OIF and having experienced a mTBI with voiced memory concerns. Participants were asked to provide their ethnicity, education level, age, and the cause of their mTBI. The participants were predominantly Caucasian ($n = 9$; 90%); one participant was African American ($n = 1$; 10%). The majority of the participants identified as having a high school education ($n = 6$; 60%), while the remaining participants identified as having a college educational background ($n = 4$; 40%). The mean age of the participants was 41.90 years ($Md = 40.50$ years; $SD = 9.30$ years), and participants ranged in age from 29 to 55 years.   All

participants listed their cause of mTBI as relation to a blast exposure ($n = 10$; 100%). These descriptive statistics are presented in Table 1.

The variable of app usage per week (in hours) was included as a potential covariate (along with participant age and education). Descriptive statistics on the app usage per week (in hours) variable is presented in Table 2. Participants' mean app usage per week was 4.30 hours (*Md* = 4.50 hours; *SD* = 1.34 hours). The app usage ranged from a minimum of 2 hours to a maximum of 6 hours each week.

Descriptive data on participants' SLUMS and 5-object recall scores at pretest and posttest are presented in Table 3. The mean SLUMS score at pre-intervention was 20.20 (*Md* = 22.00; *SD* = 4.59) and pretest SLUMS scores ranged from 12.00 to 26.00 points. The mean SLUMS score at post-intervention was 24.30 (*Md* = 25.00; *SD* = 3.56); posttest SLUMS scores ranged from 17.00 to 29.00 points. Pre-intervention, the mean 5-object recall ranged from 0 to 5, with a mean of 2.30 out of 5 objects (*Md* = 2.50; *SD* = 1.57). Post-intervention, the mean 5-object recall was 3.50 out of 5 objects (*Md* = 4.00; *SD* = 1.58), with a range of 0 to 5 objects recalled. The SLUMS and 5-object recall pretest scores and the SLUMS and 5-object recall posttest scores did not display multicollinearity, as evidenced by variance inflation factors (VIFs) of 1.50 and 1.82, respectively, allowing for the use of both measures.

Covariate Testing

Correlational analyses were conducted for covariate testing. Pearson bivariate correlations were conducted between age and hours per week using app and SLUMS and 5-object recall posttest scores. Results from the Pearson bivariate correlation analyses, shown in Table 4, were non-significant. Age was not significantly correlated with the mean SLUMS posttest score, *r(10)* = -.187, *p* = .605, nor with the mean 5-object recall posttest score, *r(10)* = -

.125, $p = .732$. Similarly, number of hours spent per week using app was not significantly associated with the mean SLUMS posttest score, $r(10) = .492$, $p = .148$, nor with the mean 5-object recall posttest score, $r(10) = .447$, $p = .196$. A Spearman's rho correlation was conducted between participants' education level and the SLUMS and 5-object recall mean posttest score; results from these analyses are presented in Table 5. Education level was not significantly correlated with the mean SLUMS posttest score, $r_s(10) = .107$, $p = .768$, nor was it significantly associated with the mean 5-object recall posttest score, $r_s(10) = .447$, $p = .196$. Due to lack of significant results, age, education level, and number of hours per week using app were not included as covariates for hypothesis testing. As no covariates needed to be included in analyses, paired-samples (or matched-samples) t-tests were conducted for hypothesis testing to determine if participants showed significant mean score increases on the SLUMS and 5-object recall scores at posttest.

Results from Paired Samples *T*-tests

Two paired-samples t-tests were conducted to determine if participants demonstrated significant increases in their SLUMS and 5-object recall scores from pretest to posttest. Results from the two paired-samples t-test are shown in Table 6. The first paired-samples t-test was significant, $t(9) = -3.35$, $p = .009$. The Cohen's d of 1.05, an extremely large effect size, indicated that participants' mean SLUM posttest score ($M = 24.30$, $SD = 3.56$) was slightly over one standard deviation higher than their mean SLUM pretest score ($M = 20.20$, $SD = 4.59$). The second paired-samples t-test was also significant, $t(9) = -2.57$, $p = .030$, and demonstrated a large effect size, Cohen's $d = 0.81$. Participants' mean 5-object recall score at posttest ($M = 3.50$, $SD = 1.58$) was significantly higher than their mean 5-object recall score at pretest ($M = 2.30$ $SD = 1.57$).

Discussion

The results of this project did reveal a positive statistical trend toward better memory scores with the use of the tablet with memory applications, which is the desired outcome for memory rehabilitation for these soldiers. This information does provide encouragement for continuation of the program for the OEF/OIF Veterans and revealed the need for further evaluation in cognitive rehabilitation in this population. A strength of this project is the fact the Veteran facilities do encourage evidence-based practice and utilization of available resources.

The utilization of the tablet with memory apps among OEF/OIF Veterans with mTBI having memory impairments proves to be a positive outcome in this project evaluation. Participants showed significant pre- to post-intervention improvements in memory, as measured by the SLUMS test. Improvements in the ability to recall 5-objects in the memory test were also noteworthy. Research acknowledges assistive technology for cognition (ATC) and cognitive function has a positive relationship (Gillespie et al., 2011). The impact of cognitive rehabilitative outcomes for soldiers with mTBI is positive and the utilization of this resource needs to be increased. In Veteran facilities, the soldier with mTBI needing memory rehabilitation is issued a tablet with memory apps at no cost to the patient. This project reviewed the effects of this intervention and also allowed through stakeholder presentations, an increase in awareness of this resource that is available.

Limitations

The external validity of this project would have favorable results for the specific OEF/OIF population with mTBI. These outcomes cannot be compared to those patients with moderate or severe TBIs. Since this project was focused on military members only, the results are not generalizable to other populations and environments. Maturation and testing are possible

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threats to the internal validity of this project. The participants are given a SLUMS evaluation test and then it is repeated eight weeks later. A time frame of approximately 12 to 16 weeks may be more reasonable to assess for any improvement in answers on the post-intervention SLUMS exam. The project leader administered the pre-intervention SLUMS and the post-intervention SLUMS to decrease any threats to internal validity.

Conclusion

Operation Enduring Freedom and Operation Iraqi Freedom Veterans with mTBI are at increased risk for memory impairment and cognitive decline over their future years (Geiling, Rosen, & Edwards, 2012). By trying to improve short-term memory impairments with the use of technological memory aids, such as the tablet with memory apps, is a tremendous resource in helping these patients that truly deserve the best quality care.

It is imperative the resources for cognitive rehabilitation continue to grow and be utilized. Understanding the effects of a mTBI on an individual's life is an important part of providing quality and compassionate health care. By providing health care providers and nurses with education and knowledge about resources available, this will increase the likelihood of program use. By educating the patients about the possible outcomes of utilizing the interventions being offered, this will help increase the likelihood of improved memory and cognition. It is recommended this project be replicated for a larger sample size to capture a diverse population to evaluate the outcome on memory improvement. By working with these Veterans and striving to improve their livelihood takes time and utilization of resources. This is much deserving as it is a just a fraction of what they face daily, especially if they are having difficulty remembering what they did yesterday.

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Table 1

Descriptive Statistics: Participant Age, Ethnicity, Education Level, and Cause of mTBI (N =10)

Variable		N	M	Md	SD	Minimum	Maximum
Age		10	41.90	40.50	9.30	29.00	55.00

	n	*%*					
Ethnicity							
Caucasian	9	90.0					
African American	1	10.0					
Education Level							
High School Graduate	6	60.0					
College Graduate	4	40.0					
Cause of mTBI							
Blast Exposure	10	100.0					

Table 2

Descriptive Statistics: Participant App Usage per Week (in Hours) (N =10)

Variable	n	M	Md	SD	Minimum	Maximum
App Usage per Week (in Hours)	10	4.30	4.50	1.34	2	6

Table 3

Descriptive Statistics: Participants' SLUMS and Five-Object Recall Pretest and Posttest Scores (N =10)

Variable	N	M	Md	SD	Minimum	Maximum
SLUMS						
Pretest	10	20.20	22.00	4.59	12.00	26.00
Posttest	10	24.30	25.00	3.56	17.00	29.00
Five-Object Recall						
Pretest	10	2.30	2.50	1.57	0	5
Posttest	10	3.50	4.00	1.58	0	5

Table 4

Pearson Bivariate Correlations: Age and Hours per Week Using App and SLUMS and Five-Object Recall Posttest Scores (N =10)

Variable	SLUMS Posttest	Five-Object Recall Posttest
Age	-.187[a]	-.125[b]
Hours per Week Using App	.492[c]	.447[d]

Note. [a]*p* = .605; [b]*p* = .732; [c]*p* = .148; [a]*p* = .196

Table 5

Spearman's Rho Correlations: Education Level and SLUMS and Five-Object Recall Posttest Scores (N =10)

Variable	SLUMS Posttest	Five-Object Recall Posttest
Education Level	.107[a]	.110[b]

Note. Education level was coded where 0 = high school graduate and 1 = college graduate. [a] $p =$ .768; [b] $p =$ .763

Table 6

Paired Samples T-test: Differences between SLUMS Pretest and Posttest Scores and Five-Object Recall Pretest and Posttest Scores (N =10)

	Pretest		Posttest		t	df	p	Cohen's d
	M	SD	M	SD				
SLUMS	20.20	4.59	24.30	3.56	-3.35	9	.009	1.05
Five-Object Recall	2.30	1.57	3.50	1.58	-2.57	9	.030	0.81

Note. The Cohen's *d* of 1.05 indicated that the SLUMS posttest scores were slightly over one standard deviation higher than the SLUMS pretest scores.

STATEMENT OF ORIGINAL WORK

Academic Honesty Policy

Capella University's Academic Honesty Policy (3.01.01) holds learners accountable for the integrity of work they submit, which includes but is not limited to discussion postings, assignments, comprehensive exams, and the dissertation or capstone project.

Established in the Policy are the expectations for original work, rationale for the policy, definition of terms that pertain to academic honesty and original work, and disciplinary consequences of academic dishonesty. Also stated in the Policy is the expectation that learners will follow APA rules for citing another person's ideas or works.

The following standards for original work and definition of *plagiarism* are discussed in the Policy:

> Learners are expected to be the sole authors of their work and to acknowledge the authorship of others' work through proper citation and reference. Use of another person's ideas, including another learner's, without proper reference or citation constitutes plagiarism and academic dishonesty and is prohibited conduct. (p. 1)
> Plagiarism is one example of academic dishonesty. Plagiarism is presenting someone else's ideas or work as your own. Plagiarism also includes copying verbatim or rephrasing ideas without properly acknowledging the source by author, date, and publication medium. (p. 2)

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Learners failing to abide by these policies are subject to consequences, including but not limited to dismissal or revocation of the degree.

Statement of Original Work and Signature

I have read, understood, and abided by Capella University's Academic Honesty Policy (3.01.01) and Research Misconduct Policy (3.03.06), including the Policy Statements, Rationale, and Definitions.

I attest that this dissertation or capstone project is my own work. Where I have used the ideas or words of others, I have paraphrased, summarized, or used direct quotes following the guidelines set forth in the APA *Publication Manual*.

Learner name and date	Tammy R. Smith	Capella University	08-14-2016
Mentor name and school	Debbie Nogueras, Ph.D.	Capella University	08-14-2016