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Validation of the Medication Box Task Assessment

Katherine Blank
Dominican University of California

Alison Chandler
Dominican University of California

Malcolm Isely
Dominican University of California

Serena Soria
Dominican University of California

Yamin Zaw
Dominican University of California

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Katherine Blank

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Serena Soria

Yamin Zaw

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Katherine Blank, Candidate Date: December 7, 2016

Alison Chandler, Candidate Date: December 7, 2016

Malcolm Isely, Candidate Date: December 7, 2016

Serena Soria, Candidate Date: December 7, 2016

Yamin Zaw, Candidate Date: December 7, 2016

Kitsum Li, OTD, OTR/L, CSRS. Faculty Adviser Date: December 7, 2016

Ruth Ramsey, Ed.D, OTR/L, Department Chair Date: December 7, 2016

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Abstract

There are a limited number of validated occupation-based cognitive assessments that are feasible in clinical settings. For individuals with acquired brain injury (ABI), ecologically valid cognitive assessments are needed to understand how cognition influences functional performance. This study implemented a quantitative exploratory correlational design using a battery of gold standard tabletop cognitive assessments as criterion measurements against the Medication Box Task assessment, an occupation-based cognitive assessment. Eight participants completed the test battery. The student researchers used Pearson correlations to analyze each participant's scores on the Medication Box Task assessment and the scores on the battery of gold standard assessments. Results indicated that no significant correlations existed between total scores of the battery of tabletop cognitive assessments and the Medication Box Task assessment. However significant correlations were found between scores of the total Type II errors made on the Tower of London and the total number of missing pills, extra pills, and total correct scores on the Medication Box Task assessment. Further findings indicated that seven out of eight participants made mistakes on the Medication Box Task assessment; six out of eight claimed that they managed their own medications.

Introduction

Acquired brain injury (ABI) is an injury within the brain that occurs after birth and is unrelated to degenerative diseases or conditions (Brain Injury, 2015). The most common causes of ABI are due to traumatic brain injury (TBI) and cerebrovascular accident (CVA) (Brain Injury, 2015). Following ABI, individuals may face new challenges and impairments in cognition and physical health that interfere with their return to everyday life (Arciniegas, Frey, Newman, & Wortzel, 2010; Lannin et al., 2014; Perna, Loughan, & Talka, 2012). Occupational therapists help individuals through a rehabilitation process that focuses on functional performance. Cognition is one of the challenges addressed in the rehabilitation process by occupational therapists, as it is a critical element of functioning in everyday life (Hartman-Maeir, Harel, & Katz, 2009).

The profession of occupational therapy has established a broad body of knowledge regarding the relationships of cognition and engagement in occupations (Hartman-Maeir et al., 2009). Occupational therapists often use assessments to understand an individual's cognition following ABI. Two types of cognitive assessments that are used to assess individuals with ABI are tabletop and occupation-based assessments. The tabletop assessments are more commonly used in clinical practice but they do not always address functional performance related to everyday tasks (Hartman-Maeir et al., 2009). There is a need for assessments that can evaluate cognitive performance in relation to everyday tasks for the ABI population.

On the other hand, critical aspects of functional performance can be observed and analyzed through administration of occupation-based cognitive assessments (Hartman-Maeir et al., 2009). Current research reveals that there are a limited number of valid and

clinically feasible occupation-based cognitive assessments for the ABI population (Cooke, McKenna, Fleming, & Darnell, 2006; Hartman-Maeir et al., 2009; Sansonetti & Hoffman, 2013). There is a need for clinically feasible occupation-based cognitive assessments that may be used with individuals with ABI.

This research study aimed to determine the validity the Medication Box Task assessment (MBTa) as a new occupation-based cognitive assessment for the ABI population. The MBTa involves an everyday medication management task that may be clinically feasible and ecologically valid. This study aimed to determine validity with significant correlations between the MBTa and gold standard tabletop cognitive assessments currently used with the population of ABI.

Literature Review

This literature review addressed the impacts of cognitive impairments on the everyday function of individuals with ABI. The literature reviewed common areas of cognition that are affected in individuals following ABI and the clinical importance of identifying cognitive impairments through the use of proper cognitive assessments. The literature review also examined the current evidence of two different approaches to cognitive assessment used for individuals with ABI: tabletop cognitive assessments and occupation-based cognitive assessments. These assessment methods were examined for ecological validity, reliability, and clinical feasibility when working with the ABI population. Research was reviewed to identify the effective tabletop cognitive assessments currently used in clinical practice, the gold standard. Current literature revealed a gap in the field of occupational therapy indicating a need for an ecologically valid occupation-based cognitive assessment for the ABI population.

Cognitive impairments in ABI

ABI is defined as any type of brain injury that occurs after birth due to either external forces or internal disruptions to brain structure (Brain Injury, 2015). External forces are factors outside of the body that result in traumatic injury of the brain, such as a blow to the head from a fall or injury. Additionally, ABI can also result from internal disruptions, such as CVA, tumor, poisoning, and infection. Annually, approximately 5.3 million Americans live with ABI and of those individuals, 1.4 million experience TBI (Brain Injury, 2015).

Even when physical trauma has healed, cognitive impairments continue to disrupt everyday life for individuals with ABI. Present research shows that cognitive impairments from ABI may impact an individual’s ability to initiate and participate in social activities and everyday occupations (Arciniegas et al., 2010; Lannin et al., 2014; Perna et al., 2012). Cognitive impairments may also cause changes in the quality of life for this population, such as difficulty in retaining family and social relationships, and difficulty in overall mental and physical health (Gottesman & Hillis, 2010; Holmqvist, Kamwendo, & Ivarsson, 2009; Perna et al., 2012). Functional performance in everyday tasks following an ABI is affected by the change in cognition and therefore, cognition is a critical component of ABI recovery.

ABI affects individuals in multiple ways. Cognitive impairments after ABI are a common occurrence, yet cognitive impairments present differently depending on the location and severity of the ABI (McDowd, Filion, Pohl, Richards, & Stiers, 2003). Due to cognitive impairments, ABI can interfere with an individual's ability to perform common everyday tasks. Impacted activities of daily living (ADLs) often include

feeding, dressing and grooming. Similarly, instrumental activities of daily living (IADLs) like cooking or bill paying, may also be impacted following brain injury. (Boelen, Spikman, Rietveld, & Fasotti, 2009; Gottesman & Hillis, 2010).

Cognitive impairments in individuals with ABI include impairments in attention, memory, and executive function (Gottesman, & Hillis, 2010; Holmqvist et al., 2009; Perna et al., 2012). Attention is the state of concentration focused on an object, idea, or situation. Different types include selective, divided, sustained, and alternating attention (American Psychological Association [APA], 2016). All types of attention are critical for engagement in everyday tasks (APA, 2016). Selective attention relates to the processing and filtering of relevant information from stimuli in the environment so that an individual may focus on one task at a time (Ries & Marks, 2005). Divided attention is utilized when an individual is completing two different tasks simultaneously such as driving a car and holding a conversation with a passenger (APA, 2016). Sustained attention supports tasks that require vigilance and the ability to maintain attention over time, such as a 30-minute cooking task (Whyte, Grieb-Neff, Gantz, & Polansky, 2006). Lastly, alternating attention is the ability to change attentive focus in a flexible or adaptive manner. Examples of alternating attention are seen in the shifting back and forth between two or more tasks, or dynamic tasks requiring focus in multiple areas. Example of alternating attention is a mother cooking a new recipe and attending to her toddler at the same time.

The American Psychological Association (APA) defines memory as, "...the mental capacity to encode, store, and retrieve information" (APA, 2016, "Glossary of Psychological Terms"). Memory is used every day for things like recalling what day it is, how to get to work, and what was on the grocery list. Individuals with ABI often struggle

with the processes of encoding or processing, storing or saving, and retrieving and recalling information (Hochstenbach, Prigatano, & Mulder, 2005). These processes are critical for taking in and understanding information and storing it for later use.

The definition of executive function continues to change as research advances. However, executive function is commonly explained as having multiple cognitive processes, including task switching, planning, organizing, sequencing, problem solving, reasoning, decision making, inhibition, initiation, monitoring, and cognitive flexibility (Jurado & Rosselli, 2007; Miyake et al., 2000). Executive function is a critical part of cognition, as this is how individuals function as successful and independent adults (Jurado & Rosselli, 2007; Miyake et al., 2000). Aspects of executive function involved in everyday activities range from basic to complex tasks such as following a recipe to driving a car (Jurado & Rosselli, 2007; Miyake et al., 2000).

After initial injuries, individuals with ABI may experience impairments with lasting effects in cognitive functions and daily life (Gottesman & Hillis, 2010; Hochstenbach et al., 2005; Holmqvist et al., 2009; Perna et al., 2012). Hochstenbach et al. (2005) conducted a study, using structured interviews and questionnaires, to quantify physical, cognitive, emotional, and behavioral changes in individuals after ABI. The sample population included 172 individuals ranging from 18 to 70 years of age and the average post-onset of ABI was 9 months. Results indicated that over 50% of the 172 individuals with ABI and their relatives reported issues in areas of attention and memory (Hochstenbach et al., 2005). Additional identified cognitive problems in daily life included difficulty with writing being forgetful, and processing information at a slower pace. Furthermore, 21% of individuals with ABI and 33% of caregivers reported

impairments with complex functional activities that involve executive dysfunction, such as managing money in a bank account (Hochstenbach et al., 2005). Accordingly, implications from this study illustrated that individuals with ABI may suffer both cognitive and functional impairments. This study reinforced the relationship between cognitive impairments and the impact on functional performance of individuals with ABI.

Another research study conducted by McDowd et al. (2003) examined the relationship between attention and functional performance outcomes following CVA. In the study, the sample group consisted of 55 older adults who experienced a CVA and the control group consisted of 39 healthy older adults. The study aimed to evaluate alternating attention and divided attention. The researchers used two outcome measures. The first measure was time tasks. These time tasks which uses a computer program to visually present various stimuli, such as different colored shapes and numbers and when a certain stimuli is presented, individuals had to identify the stimuli by hitting a sequence of micro switches. This task required both switching and divided attention to attend to the image on the computer and input the correct sequence of micro switches. The second outcome measure is the Stroke Impact Scale (SIS). The SIS is a 64 item self-report that measures quality of life and areas need of support for an individual with a CVA. Specifically the SIS asks questions about support needs in the areas of home living, community living, lifelong learning, employment, health and safety, social activities, protection, and advocacy. The SIS asks individuals to self-rate items on a scale of 1-5 of difficulty on five domains: physical function, memory and thinking, emotion, communication, and social participation. The researchers analyzed scores from the SIS and time tasks of individuals with CVA. Results of the study revealed significant positive

correlations between attention, physical function, and social participation outcome measures (McDowd et al., 2003). Poor attention directly correlated to impairment in functional performance. These findings indicate the impact of cognitive impairments as they directly relate to functional performance (McDowd et al., 2003).

The above literature review demonstrates how ABI may cause residual impairments in cognition and affect functional performance (Hochstenbach et al., 2005; McDowd et al., 2003; Perna et al., 2012; Zinn, Bosworth, Hoenig, & Swartzwelder, 2007). Therefore, it is imperative to assess and identify cognitive impairments that directly impact everyday tasks. Several assessments were developed and validated to better understand and quantify these cognitive impairments. Many of these assessments designed by neuropsychologists are termed “tabletop cognitive assessments” due to their method of using pen and paper at a table or bedside (Hartman-Maeir et al., 2009). Tabletop cognitive assessments are valid and feasible, in terms of both time and resources, to assess both general and specific cognitive impairments of individuals following an ABI (Hochstenbach et al., 2005; McDowd et al., 2003; Perna et al., 2012; Zinn, Bosworth, Hoenig, & Swartzwelder, 2007).

Tabletop cognitive assessments. In a simple and timely manner, tabletop cognitive assessments or neuropsychological assessments attempt to generalize and pinpoint areas of impaired cognition (Elhan et al., 2005). Cognitive screens can identify areas of cognitive impairment while cognitive assessments have the diagnostic ability to identify specific areas of cognitive impairment. Both cognitive assessments and screens can indicate cognitive impairments, but lack the ability to indicate an individual’s functional performance (Arciniegas, Frey, Newman, & Wortzel, 2010; Cooke et al.,

2006; Garcia-Molina et al., 2012; Lannin et al., 2014; Perna, Loughan, & Talka, 2012). Research has identified that it is imperative for clinicians to use effective cognitive assessments to identify what areas of cognition are impaired (Zinn et al., 2007). This review will identify valid and reliable gold standard tabletop cognitive assessments for the ABI population.

The Cognistat. The Cognistat is a screening tool that assesses an individual's general cognitive functions (Kiernan, Mueller, Langston, & Van Dike, 1987). The Cognistat (2013) is the current version of the assessment that has been developed and refined over the past 37 years. The Cognistat allows clinicians to learn more about the cognitive status of an individual, and identifies possible cognitive impairments. The assessment measures five cognitive areas: language, constructional ability, memory, calculation, and reasoning. The Cognistat also includes 10 subscales: orientation, attention, comprehension, repetition, naming, construction, memory, calculations, similarities, and judgments (Brown, Mapleston, Nairn, & Molloy, 2013). Most items on the Cognistat have quick screens that assess an individual's cognitive ability. If an individual fails the screen the administrator is instructed to test an individual with the metric a more indepth screen of the test item. The ease of administration and 10-20 minute duration of the assessment prove highly beneficial for most clinical settings. The Cognistat can guide therapists in intervention and treatment planning, or indicate a need for a full-scale cognitive diagnostic assessment (Doninger et al., 2006).

Brown et al. (2013) conducted a study that investigated the ability of cognitive assessments and visual perception tests to predict functional performance and independence in individuals who had recently had a CVA. The Developmental Test of

Visual Perception–Adolescents and Adults (DTVP-A) and the Cognistat were used to assess perception and cognition in 32 adult individuals from an inpatient rehab unit recovering from CVA. The Barthel Index was used to measure functional independence in these individuals. The Barthel Index consists of 10 ADL items that include: feeding, bathing, grooming, dressing, bowel continence, bladder continence, toilet use, transfers from bed to chair, and mobility on level surfaces. These 10 items sum to a total of 100 possible points and the closer an individual's score is to 100 the higher their functional ability is. The Barthel Index significantly correlated with four of the ten Cognistat subscales of orientation, comprehension, repetition, and construction (Brown et al., 2013). Analysis of the results indicated the Cognistat had a statistically significant ability to predict functional performance within this population as correlated to the Barthel Index scores, accounting for 64.4% prediction accuracy in a regression model (Brown et al., 2013). Based on the regression model, four of the Cognistat subscales were found as predictive indicators of functional independence in individuals who have had a CVA. Implications of this study suggests the Cognistat may not fully be able to predict functional performance (Brown et al., 2013).

Nøkleby et al. (2008) assessed the predictive concurrent validity of the Cognistat, the Screening Instrument for Neuropsychological impairment in Stroke (SINS), and the Clock Drawing Test for cognitive impairments after a CVA. The study assessed 49 individuals with CVA housed in a rehabilitation unit in Norway. Comparison of scores revealed that the Cognistat obtained higher levels of sensitivity for the detection of cognitive deficit (Nøkleby et al., 2008). Researchers identified that the Cognistat had a sensitivity score of 82%, while the SINS scored 71%, and the Clock Drawing Test scored

63% (Nøkleby et al., 2008). The researchers found the Cognistat suitable to be used as a screening tool to detect cognitive impairments in multiple areas of cognition. However, the Cognistat cannot specifically identify the impaired domains with a high level of confidence; researchers found that the measure accurately identified specific impairments at a rate of 67% (Nøkleby et al., 2008). Accordingly, Nøkleby et al. (2008) identified the Cognistat as a valid screening tool for cognition when used with individuals post CVA.

A study completed by Doninger et al. (2006) investigated the ability of the Cognistat to distinguish varying levels of cognitive impairment for individuals with TBI. The study consisted of 120 individuals with TBI in an acute inpatient rehabilitation unit and 186 individuals with TBI who were community dwelling. Researchers trained psychometrists to administer the Cognistat to both sample groups. Once data was collected, researchers conducted data analysis using the rating scale analysis (RSA) of the Cognistat to understand the psychometric properties for the population of TBI. The RSA calibrates an individual's ability to complete the test item from a scale of better to worse and the difficulty of each specific test item from a scale of easy to difficult. Researchers aimed to understand if there were differences in the ability of the Cognistat to detect differences in severity of cognitive impairment. Data analysis revealed that the Cognistat items that assessed basic language skills were easier for both sample groups and the Cognistat items that assessed memory, verbal reasoning, and constructional ability were the most difficult of the Cognistat items for both sample groups (Doninger et al., 2006). The researchers concluded from the RSA that the Cognistat is a psychometrically sound cognitive assessment for measuring the varying severity of cognitive impairment for

individuals with TBI. The researchers indicated that the Cognistat can be used a primary cognitive screen for the TBI population (Doninger et al., 2006).

Rice, Campbell, Friedman, Speechley, and Teasell (2015) analyzed the psychometric properties of the Cognistat (2011) to determine if the screen-metric design was a reliable method to administer the Cognistat. Additionally, the researchers assessed the construct validity of the Cognistat within the CVA population. An occupational therapist and trained student facilitators administered both the screen and metric of the Cognistat to 75 individuals with CVA who were receiving inpatient rehabilitation. The results showed inconsistency between five out of ten subscales. Some individuals who passed the screen items of the Cognistat failed the metric portion (Rice et al., 2015). The researchers suggested these findings indicated low sensitivity, and accuracy in detecting possible cognitive impairments using the screen-metric approach of the Cognistat in individuals with CVA (Rice et al., 2015).

In summary, therapists and neuropsychologists use the Cognistat as a screening tool to identify cognitive impairments with the ABI population. Overall, reviewed literature has shown that the Cognistat is sensitive in detecting cognitive impairments in individuals with TBI or CVA, but lacks the ability to fully predict functional impairments (Doninger et al., 2006; Man, Tam, & Hui-Chan, 2006; Nøkleby et al., 2008). However, one piece of literature suggests the screen-metric method of administration is unreliable compared to administering the Cognistat with both screen and metric items (Rice et al., 2015). The Cognistat may be a valid tabletop cognitive assessment used in clinical practice for individuals with ABI.

Mini mental state examination (MMSE). The MMSE is a screening tool that assesses multiple areas of cognition: orientation, registration of new information, language, visual spatial construction, recall, calculation, and attention (Elhan et al., 2005). The MMSE is a widely used cognitive screen in clinical practice. Validity and reliability of the tool has been established for individuals with mild dementia, but not for individuals with ABI. Elhan et al. (2005) designed a study to evaluate the properties of the MMSE and its feasibility for use with 207 individuals who had ABI. Researchers tested the reliability of MMSE against the person separation index, a measure of ability for a test to distinguish between two groups. External construct validity was analyzed using a Spearman correlation between the MMSE and Functional Independence Measure (FIM) cognitive scale. The researchers established reliability as adequate with a .76 Pearson separation index (Elhan et al., 2005). External construct validity is established through a significant correlation (r = .60 at admission, r = .53 at discharge) between FIM and MMSE (Elhan et al., 2005). Based on the results, researchers indicated that this assessment may be used as a reliable and valid cognitive screening for ABI individuals (Elhan et al., 2005).

Montreal cognitive assessment (MoCA©). The Montreal Cognitive Assessment (MoCA©) is designed to be a rapid screening assessment that assesses for mild cognitive impairment. It takes approximately 10 minutes to administer the test, which assesses various areas of cognition such as executive functions, memory, language, visuoconstructional skills, conceptual thinking, and orientation. The assessment is scored out of a possible 30 points, with a score of 26 and above considered normal cognition (MoCA©, 2015).

A study conducted in Hong Kong by Wong et al. (2013) aimed to validate the MoCA© and its psychometric properties with the TBI population. This cross-sectional observational study utilized 48 individuals diagnosed with TBI, and 40 healthy individuals served as the control group. Researchers assessed concurrent validity by using the MMSE as the screening tool for cognition, with the Glasgow Outcome Scale Extended (GOSE), Geriatric Depressive Scale (GDS), and a broad spectrum neuropsychological battery used to correlate and validate the scores and findings of the MoCA©. Statistical analysis was performed to determine the associations between MoCA© scores and cognitive z-scores. These z-scores described the distance of scores from mean in standard deviations, and between MoCA© scores and MMSE scores. The results showed that the individuals with TBI had poor cognitive performance in the MoCA© and the MMSE versus the control group and that both the cognitive z-scores and MMSE significantly correlated with performance in the MoCA© (Wong et al., 2013). Receiver operating characteristics (ROC) curves are used in the study to examine the ability of the MoCA© to differentiate between individuals with TBI and control individuals and the area under the curve (AUC) is calculated for each ROC curve. The ROC analysis revealed that the MoCA© had an optimal balance of sensitivity and specificity at 25/26 with an AUC of 0.70 (Wong et al., 2013). Based on these results, the MoCA© has the psychometric properties and applicability to be a valid screening tool for the assessment of gross cognitive function in individuals with TBI (Wong et al., 2013).

de Guise et al. (2013) aimed to evaluate the ability of the MoCA© to predict the outcome at discharge from the acute care setting in individuals with TBI by comparing results with those of the MMSE. The Researchers assessed 214 individuals during

hospital stays following a TBI. The scores of the MoCA© were compared to the MMSE with hospital discharge predictions measured by the Disability Rating Score (DRS). The DRS evaluates an individual's level of disability by looking at four parameters; arousability, cognitive ability in self-care activities, dependence on others and level of functioning, and psychosocial adaptability and employability. Researchers performed a linear regression on both the MoCA© and the MMSE scores to determine if they could be used to predict DRS outcomes. To determine which of the two tests was a better predictor of the DRS score at discharge, a regression models compared the root mean square error (RMSE). The results of the study showed that the MMSE had a RMSE of 1.707 and the MoCA© had a RMSE of 1.666 (de Guise et al., 2013). The MMSE showed a slightly better ability to predict outcome at discharge. Researchers attributed this finding to better R-squared value. However, the clinical significance of this finding was not illustrated by this study. MoCA© and the MMSE remain similar predictors of function for individuals with TBI at time of discharge. In summary, the Cognistat, the MMSE, and MoCA© have been validated with the population of ABI. These assessments are useful tools for identifying general impairments for clinical practice in a rapid and feasible manner (de Guise et al., 2013). Researchers and occupational therapists have designed other cognitive assessments that are able to identify higher levels of cognitive impairment, specifically impairment in executive function.

Executive function assessments. Impairments in executive function, also known as executive dysfunction, are commonly found in individuals following an ABI. Impairments in executive function may lead to an overall decrease in an individual's functional performance (Ord, Greve, Bianchini, & Aguerrevere, 2010). Executive

function assessments can be utilized to further understand how this complex cognitive domain may affect an individual in the utilization of: planning, sequencing, and problem solving processes. The following reviewed gold standard executive function assessments include: the Wisconsin Card Sorting Test, Wechsler Memory Scale, Delis-Kaplan Executive Function System, Tower of London, and Trail Making Test, part B.

Wisconsin card sorting test. The Wisconsin Card Sorting Test (WCST) is used to assess abstract thinking and is considered a gold standard measurement of executive function. The WCST assesses executive functioning, specifically an individual's ability to shift between cognitive sets, problem solving, and feedback (García-Molina, Tormos, Bernabeu, Junqu, & Roig-Rovira, 2012). During administration, individuals are required to match stimulus cards to one of four key cards by either concepts of color, shape, or number. Individuals must determine a sorting method based on the feedback given by the examiner. Once the individual has made 10 consecutive correct arrangements, the examiner switches the concept (Garcia-Molina et al., 2012).

Ord et al. (2010) used the WCST to assess executive dysfunction in individuals with TBI. A clinical trial with 109 mild and 67 moderate to severe individuals with TBI was performed in an effort to establish the WCST as a valid assessment. Researchers classified TBI cases as mild or moderate to severe according to initial injury characteristics based on a thorough review of medical records. Results reported that individuals with mild TBI showed no measurable impairments in the WCST performance while individuals with moderate to severe TBI showed greater levels of impairment on some the WCST indices (Ord et al., 2010). Although WCST is a validated assessment,

this study indicated it is not sensitive enough to detect executive function impairment in individuals with mild TBI.

Another study conducted by Jodzio and Biechowska (2010) investigated the predictive power of the WCST in detecting impairments in executive function. The researchers recruited 44 individuals with CVA. Each individual was assessed using the WCST, Polish edition. Additionally, the researchers evaluated the severity of executive dysfunction of individuals based on their performance of three tasks: Word-Fluency Test, Trail-Making Test Part B, and the Go/No Go Task (Jodzio & Biechowska, 2010). Researchers found that there was an average negative predictive power rate of 81%, this result illustrated that individuals with normal executive function were detected at higher rates than those with impairment (Jodzio & Biechowska, 2010). WCST was inconsistent in detecting variant levels of executive dysfunction for individuals with CVA, but consistent with identifying individuals with normal executive function (Jodzio & Biechowska, 2010). In addition, findings indicated that the WCST can measure multiple domains of executive functioning rather than just one cognitive domain (Jodzio & Biechowska, 2010). Therefore, the WCST may be a reliable measure for the absence of executive dysfunction within the ABI population, but needs further research to measure sensitivity for executive function impairments.

Wechsler memory scale. The Wechsler Memory Scale is a neurological test that measures various memory functions and takes 45-60 minutes to administer. The test is designed for individuals between the ages of 16 and 90. Measurement of functional ability and cognitive impairment are based on five index scores: auditory memory, visual memory, visual working memory, immediate memory, and delayed memory (Clinical

Assessment, 2015). Carlozzi, Grech, and Tusky (2013) aimed to examine the construct validity of the Wechsler Memory Scale IV (WMS-IV) in individuals with TBI. The researchers evaluated 100 individuals with TBI ranging from mild to severe. The sample consisted of 35 individuals who had mild to moderate TBI; the remaining 65 individuals were diagnosed with severe TBI. The researchers administered ten memory subtests of the WMS-IV. Researchers then combined the subtest scores to create five index scores of memory: perceptual reasoning, verbal comprehension, processing speed, working memory, and memory. The researchers compared the scores of the individuals with mild to moderate TBI and severe TBI to a healthy control group from the WMS-IV normative database. The results on all subtests indicated that individuals with mild to moderate TBI and severe TBI performed significantly worse than the healthy control group (Carlozzi et al., 2013). When comparing the results between the mild to moderate TBI group and the severe TBI group, only four out of the ten subtests of the WMS-IV revealed a significant difference in performance (Carlozzi et al., 2013). The researchers concluded that the WMS-IV is a valid assessment for individuals with TBI. However, the researchers also acknowledged that a limitation of the study was that WMS-IV did not make a distinction between mild TBI and moderate TBI as two separate entities. Therefore, Carlozzi et al., (2013) advised further exploration of mild TBI and WMS-IV.

Delis-Kaplan executive function system. Delis-Kaplan Executive Function System (D-KEFS) is a comprehensive executive function standardized assessment (Homack, Lee, & Riccio, 2005). D-KEFS is comprised of nine subtests: a Trail Making Test, Verbal Fluency Test, Design Fluency Test, Color-Word Interference Test, Sorting Test, Twenty Questions Test, Word Context Test, Tower Test, and Proverb Test

(Homack et al., 2005). All of the subtests assess one to multiple subcomponents of executive function: problem solving, impulse control, flexibility of thinking, inhibition, planning, creativity, concept formation, and abstract thinking (Homack et al., 2005). The subtests can be administered together or as separate individual assessments (Homack et al., 2005). However, assessing the D-KEFS as one test takes 90 minutes; clinicians and researchers generally opt to assess individuals without using the full battery of subtests (Homack et al., 2005). In particular, research conducted on the subtests of the D-KEFS indicated that the Trail Making Test, Tower Test, and Sorting test are accurate in identifying impairments in executive function (Heled, Hoofien, Margalit, Natovich, & Arganov, 2012; Mitchell & Miller, 2008; Wolf & Rognstad, 2013).

Tower of London. The Tower of London (TOL) is a tabletop cognitive assessment that evaluates executive function. Studies have indicated that the TOL is a reliable cognitive assessment for detecting impairments related to planning ability, a crucial element of executive function (Köstering et al., 2015). The TOL consists of two pegboards, wooden rods, and three differently colored beads. The objective of the assessment is for the test taker to rearrange the three different colored beads to match ten patterns presented by the test administrator on his or her pegboard. The TOL is scored by counting the number of moves made and the amount of time the test taker uses to complete each pattern (Shum et al., 2009). The TOL can be administered in 10-15 minutes, making it a feasible assessment for various clinical settings due to its short administration time (Andrews, Halford, Chappell, Maujean, & Shum, 2014).

Köstering et al. (2015) completed a study to examine the reliability and criterion validity of the computerized version of the Tower of London (Freiburg version, TOL- F).

The study compared 60 individuals with CVA, 51 individuals with Parkinson's syndrome, and 29 individuals with mild cognitive impairment (MCI), to a control group of 155 healthy individuals. Köstering et al. (2015) administered the TOL-F to individuals with left and right ischemic CVA, 6 months post-onset. Each individual completed the TOL-F on a computer and finished eight problems. Results reported criterion-related and concurrent validity by utilizing an analysis of variance (ANOVA) to analyze each group's planning accuracy when taking the TOL-F (Köstering et al., 2015). A split half reliability is a measure of internal consistency based on dividing the items of an instrument into two halves and correlating the results (Portney & Watkins, 2009, p. 90). Köstering et al. (2015) used a split half reliability of the TOL-F for each group to find if the measures could accurately relate and predict outcomes. Mean split half reliability was found as adequate for both stroke $r=.783$ and healthy controls r=.717, and high for the individuals with MCI r=.826 (Köstering et al., 2015). The results of the study indicated that the TOL-F possessed reliability in all three groups: CVA, Parkinson's syndrome, and MCI. The results also indicated that the internal structure of TOL-F is reliable within this population and allows for the understanding of an individual's overall planning ability. Therefore, TOL-F assessment has been distinguished as having adequate criterion-related validity and reliability for individuals with CVA. In conclusion, the TOL-F is ideal for use in finding specific and overall impairments in planning, sequencing, and overall executive function (Köstering et al., 2015).

Trail making test. The Trail Making Test (TMT), Parts A (TMT-A) and B (TMT-B), are among the most popular neuropsychological assessments used in practice due to their ease of administration and sensitivity to cognitive dysfunction (Kopp et al., 2015).

TMT is a neuropsychological assessment that measures several components of executive function: sequencing, cognitive flexibility, set shifting ability, capacity for attention, and visuomotor speed (Lange, Iverson, Zakrzewski, Ethel-King, & Franzen, 2005). These assessments may be used with a variety of populations facing cognitive challenges. In TMT-A, there are 25 encircled numbers randomly arranged on a page. The individual completing the test needs to connect these numbers in ascending order by drawing a line (i.e., 1-2-3...25) (Kopp et al., 2015). The same applies to TMT-B, except there are 25 encircled letters and numbers that must be connected by drawing a line in alternating ascending order from 1 to A, then A to 2, 2 to B and so on until the individual reaches the last letter in the sequence (Kopp et al., 2015). TMT-B evaluates an individual's executive function specifically how well one can shift and sequence from numbers to letters in sequential order (Kopp et al., 2015). The following studies illustrated the differences between TMT-A and TMT-B and identified TMT-B as a sensitive assessment to cognitive impairment.

Kopp et al. (2015) conducted a study to investigate the completion times and accuracy of TMT in detecting impairments of individuals with CVA who have frontal lobe damage. Researchers recruited 30 individuals with CVA. The study hypothesized that individual's results of TMT-B completion accuracy would be more sensitive to impairment than that of TMT-A. Individuals' results compared average completion time of TMT-A to TMT-B, in relation to errors committed within both assessments. Sequencing errors on TMT-A happened infrequently, with only 6.7% of individuals making two or more errors, comparing to 43% of individuals who made two or more sequencing errors on TMT-B (Kopp et al., 2015). Individuals with CVA had greater

difficulty with TMT-B than TMT-A because TMT-B requires the ability to shift and sequence between numbers and letters within the TMT-B tasks, which presents more of a challenge to individuals' cognitive demand, visual motor skills, and mental flexibility. Additionally, the length and time taken to complete TMT-B is longer than TMT-A. These results, therefore, indicated that TMT-B is a more appropriate assessment than TMT-A to evaluate executive function for those following an acquired brain injury (Kopp et al., 2015).

Lange et al. (2005) explored the clinical application of the scores of the TMT-B for individuals with ABI. The researchers administered TMT-B to 571 individuals with ABI within 23 days after onset of their ABI. Data revealed that as severity of injury increased, so did completion time. This finding presented a positive linear correlation between performance on the assessment and severity of injury in individuals (Lange et al., 2005). The results confirmed that TMT-B can identify executive function impairments in individuals with ABI.

In summary, tabletop cognitive assessments are found to be valid and reliable measures for assessing cognition within the ABI population. Tabletop cognitive assessments may be completed in a timely manner and are typically preferred within clinical practice, as they can efficiently and accurately assess areas of cognition. The Cognistat, MoCA©, TMT-B and TOL have been established as valid standards for assessing cognition and executive function in individuals with ABI. However, these assessments may not reflect functional performance in everyday tasks. Research suggested that tabletop cognitive assessments are frequently used with individuals with

ABI as a quick method to gain a snapshot of cognitive impairment, but often lack a predictive component of functional performance (Garcia-Molina et al., 2012).

Occupation-based cognitive assessments. Occupation-based cognitive assessments offer several advantages that tabletop cognitive assessments do not provide. Occupation-based cognitive assessments employ common everyday tasks, such as dressing, meal preparation, medication management, and shopping, to assess and analyze an individual's cognition. Occupational therapists focus on individuals' functional performance in daily life and strive to assess individuals with the most accurate assessments that generalize functional performance. Occupation-based cognitive assessments may be used to identify cognitive impairment, and are particularly sensitive to executive dysfunction and its effects on functional performance (Maeir, Krauss, & Katz, 2011).

Throughout all settings of practice occupational therapists use occupation-based cognitive assessments to gain a better understanding of real life impairments (Maeir et al., 2011). In regards to occupational therapy's role in cognitive rehabilitation, the American Occupational Therapy Association (AOTA, 2013) asserts that cognition cannot be separated from function. The relationship of cognition and function is an integral part of each individual (AOTA, 2013). Through the stages of the occupational therapy process of evaluation, intervention, and discharge therapists can understand the relationship between cognition and function while remaining occupation-based and client centered (Cooke et al., 2006). The occupational therapy process of evaluation can take two different perspectives "top-down" and "bottom-up" to approach cognitive impairment of individuals with ABI (Cooke et al., 2006). Occupation-based cognitive assessments use a

"top-down" approach to analyze an individual's ability to complete everyday tasks in order to identify cognitive impairments (Cooke et al., 2006). In contrast, tabletop cognitive assessments typically use a "bottom-up" approach, focusing on the cognitive impairments first, then drawing conclusions from assessment scores and analyzing how they may impact an individual's functional performance (Cooke et al., 2006). The difference between "top-down" versus "bottom-up" approaches to assessment is important to occupational therapists.

The important difference between tabletop cognitive assessments and occupation-based cognitive assessments is the generalizability of results, meaning how well an assessment score can represent how an individual with ABI will perform in everyday tasks. Tabletop cognitive assessments separate cognitive impairment from functional performance, which limits the ability to generalize results of a tabletop cognitive assessment to an individual's ability to perform everyday tasks (Cooke et al., 2006). Generalizability of results from an individual's results on an occupation-based cognitive assessment can help occupational therapists understand existing cognitive impairments that inhibit functional performance because impairments in functional performance can be predictive of cognitive impairments (Cooke et al., 2006).

However, while there is a need for more occupation-based cognitive assessments to be created and implemented, only a limited number have been validated for the ABI population (Hartman-Maeir et al., 2009). Additionally, implementation of occupation-based cognitive assessments in occupational therapy practice may be restricted by their infeasibility in most clinical settings (Hartman-Maeir et al., 2009). Time, resources, and environmental contexts such as limited space may deter a therapist from the use of

occupation-based cognitive assessments. The reviewed literature defines the term ecologically validity, identifies existing issues of infeasibility with occupation-based cognitive assessments, and describes the current occupation-based cognitive assessments for the ABI population.

Ecological validity. Ecological validity of an assessment refers to the “representativeness” of the assessment’s tasks to “real world” activities, such as ADLs and IADLs (Burgess et al., 2006). Ecological validity measures the generalizability of an individual’s assessment results as it relates to functional performance in real life situations (Burgess et al., 2006). Ecological validity is an integral aspect of occupation-based cognitive assessments, as compared to tabletop cognitive assessments, there is a discrepancy in the strength of ecological validity (Cooke et al., 2006; Maeir et al., 2011).

Currently there are gold standard tabletop cognitive assessments, which means that the assessments are valid and clinically feasible (Villain et al., 2015). However, tabletop cognitive assessments often lack ecological validity, because the nature of tasks within the assessments is not oriented to functional performance (Cooke et al., 2006). Hence, research suggested that tabletop cognitive assessments, used exclusively, would not be an adequate reflection of functional performance within the ABI population (Cooke et al., 2006; Maeir et al., 2011; Villain et al., 2015). Conversely, occupation-based cognitive assessments at face value have ecological validity because they are based on functional performance, yet often may not be clinically feasible (Cooke et al., 2006; Maeir et al., 2011).

Clinical feasibility. Australian and American occupational therapy national associations conducted surveys to understand occupational therapists’ preferences

between general occupation-based assessments, occupation-based cognitive assessments and tabletop cognitive assessments for the population of ABI (Alotaibi, Reed, & Nadar, 2009; Korner-Bitensky, Barrett-Bernstein, Bibas, & Poulin, 2011; Sansonetti & Hoffman, 2013). The surveys focused on collecting data on the types of clinical assessments and why they are used in clinical practice.

Alotaibi et al. (2009) conducted an exploratory study using a national survey within the United States that attempted to understand the current use of general occupation-based assessments across all clinical settings. The researchers distributed 300 surveys to occupational therapists at the annual AOTA conference and analyzed 260 returned surveys (Alotaibi et al., 2009). Survey results reported that 65.8% of clinicians said they used assessments on the basis of what was available within their setting (Alotaibi et al., 2009). Survey responses also showed more than 35% of clinicians from all settings indicated they select and utilize assessments based on the factors of clinical utility and standardization. These factors include time efficiency, ease of administration and scoring, and reliability and validity (Alotaibi et al., 2009). This survey also collected data on specific types of assessments used in practice and found that most of the assessments utilized were “bottom-up” assessments. This data revealed that occupational therapists in the United States may not be using “top down” assessments, which evaluate individuals’ impairments in functional performance. Therefore, the researchers suggested that the limited use of general occupation-based assessments may be due to inaccessibility and the lack of clinical utility (Alotaibi et al., 2009).

Sansonetti and Hoffman (2013) conducted a study in Australia that specifically focused on the use of occupation-based cognitive assessments within all settings of

occupational therapy practice. The researchers surveyed occupational therapists to understand the process clinicians utilized when selecting a cognitive assessment for individuals with ABI. Additionally, they examined the utility of tabletop cognitive assessments versus occupation-based cognitive assessments within clinical practice. The researchers analyzed a total of 209 surveys. The researchers reported that 69% of clinicians used occupation-based cognitive assessments to evaluate more than 75% of their patients with cognitive impairment (Sansonetti & Hoffman, 2013). Results of the survey indicated that clinicians frequently emphasized the importance of occupation-based cognitive assessments across all occupational therapy settings (Sansonetti & Hoffman, 2013). However, the surveyed clinicians reinforced the need for more objectively scored and clinically feasible occupation-based cognitive assessments (Sansonetti & Hoffman, 2013).

The literature reviewed considered occupation-based cognitive assessments that were specific to the ABI population, possessed reliability and validity, aimed to evaluate executive function, and involved components of the IADL task of managing medication. Based on current evidence conducted through surveys, it is clear that many occupational therapists support the need for more occupation-based cognitive assessments. However, some clinicians reported that they are not utilizing current occupation-based cognitive assessments in practice because of the inability to use in a variety of settings, the length on administration, and the lack of standardized and objective scoring (Alotaibi et al., 2009; Hartman-Maeir et al., 2009; Sansonetti & Hoffman, 2013).

Student researchers determined criteria for clinical feasibility of occupation-based cognitive assessments for the ABI population based on the current evidence. The criteria

for clinical feasibility of occupation-based cognitive assessments would include (a) application to a variety of practice settings, (b) minimal use of materials required to administer the assessment, (c) administration time of less than 20 minutes, (d) objective scoring, and (e) standardization.

Multiple errands test. The Multiple Errands Test (MET) is an occupation-based cognitive assessment that can be performed in a variety of settings. This test requires individuals to follow particular rules and complete a certain number of tasks in a specific time frame (Rand, Rukan, Weiss, & Katz, 2009). The MET is a structured test that aims to assess executive function in a real-world environment (Rand et al., 2009). There are several different versions of MET covered within this literature review, including the Multiple Errands Test - Revised (MET-R), Multiple Errands Test - Hospital Version (MET-HV) and the Virtual Multiple Errands Test (VMET). Both versions have been validated for the ABI population, and results have indicated significance in ecological validity (Castiel, Alderman, Jenkins, Knight, & Burgess, 2012; Dawson et al., 2009; Maeir et al., 2011). Within this study, the MET demonstrated more sensitivity in detecting executive dysfunction than tabletop cognitive assessments (Castiel et al., 2012; Cuberos-Urbano et al., 2013; Dawson et al., 2009; Hartman-Maeir et al., 2009)

Morrison et al. (2013) discussed how tabletop cognitive assessments are limited in assessing executive function and explained how current occupation-based assessments emulating routine ADLs and IADLs due to lack of novelty were not the best measures of executive function. Researchers determined a clinical difficulty in identifying individuals with ABI who presented without apparent impairments in memory, attention, or motor skills, but experienced executive dysfunction that impacted functional performance. The

researchers examined the MET-R and its ability to discriminate between 25 individuals with mild cerebrovascular accident (mCVA) and a control group of 21 healthy individuals to detect the impact of executive dysfunction on functional performance. The researchers administered the MET-R to the 25 individuals with mCVA at their 6-month follow up appointment on the main floor of a large hospital. The researchers gave instructions for the individuals to self-initiate the test and provided a map of the hospital, money, and a list of tasks to complete. The time limit to complete the assessment for each individual was 45 minutes (Morrison et al., 2013).

Morrison et al. (2013) found that the simple scoring system of total time, number of locations visited, number of tasks completed, and total rule breaks was sensitive in differentiating between individuals with mCVA and a control group. The researchers found frequencies and sum of all types of rule breaks to be highly sensitive to post-mCVA executive function impairments. Additionally, 88% of the control group had fewer total rule breaks than individuals in the mCVA group (Morrison et al., 2013). The control group performed 69% more efficiently than the average individual in the mCVA group. There was a difference between groups in performance efficiency of the assessment tasks (Morrison et al., 2013). Results of the study supported validity of the MET-R as a occupation-based cognitive assessment of detecting executive dysfunction for individuals with mCVA (Morrison et al., 2013).

Another study by Rand et al. (2009) intended to establish the construct validity and ecological validity of the V-MET for individuals with CVA. The researchers of the study aimed to create a version of the MET that is more feasible in many settings by developing a virtual version (Rand et al., 2009). The study included nine individuals with

CVA and 40 healthy individuals separated into two control groups. The two control groups included a young adult group of 20 healthy individuals with a mean age of 26.3, and an older adult group of 20 healthy individuals with a mean age of 64. Researchers designed the study with a large control group and division by age to determine how sensitive the V-MET was as a occupation-based cognitive assessment. Rand et al. (2009) assessed individuals within the study to determine validity of the V-MET with each subtest as follows: MET-HV, The Zoo Map subtest, and the IADL questionnaire.

During the procedure, MET-HV and V-MET were administered to individuals to correlate results to determine ecological validity (Rand et al., 2009). Individuals that participated in the study included adults with CVA and two control groups of healthy older adults and younger adults. The results demonstrated significant moderate to high correlations between the group of individuals with CVA and the healthy older adult control group. Comparatively, the researchers found no significant correlations between V-MET and MET-HV scores for the healthy young adult control group and the healthy older adult control group; both groups had high scores for the two different versions of the MET (Rand et al., 2009). As a result of the high scores, the researchers questioned whether ceiling effects occurred for the young adult control group scores in both the V-MET and MET-HV. Rule breaking errors made by post-stroke individuals in both V-MET and MET-HV resulted in high correlation. Examples of these mistakes include mistakes in planning, inability to multi-task, and individuals with CVA not detecting their own mistakes, and social mistakes. Finally, the researchers concluded that the V-MET had strong ecological validity and construct validity from the statistical analysis between

the scores of the individuals with CVA group and the older adult control group (Rand et al., 2009).

This research study demonstrates that the V-MET can possess strong ecological validity. However, accessibility to purchase and maintain the V-MET is not cost-effective. In addition to expense, the MET may not be appropriate in some clinical settings due to the length of time to complete, which can be up to 45 minutes (Castiel et al., 2012; Dawson et al., 2009; Maeir et al., 2011). The MET assessment did not meet the clinical feasibility aspects of cost and 20- minute time constraint. Because the assessment is not a simplified assessment for clinical use, the MET is less compelling for use in everyday occupational therapy practice. Therefore a shorter occupation-based assessment that involves a single IADL is considered to be more feasible in clinical practice.

Executive function performance test and cognitive performance test. The Executive Function Performance Test (EFPT) and Cognitive Performance Test (CPT) are occupation-based cognitive assessments that evaluate IADLs to assess cognition. The EFPT assesses different components of executive functioning through IADL tasks of cooking a light meal, using the telephone, managing medication, and paying bills (Wolf, Stift, Connor, Baum; The Cognitive Rehabilitation Research Group, 2010). Similarly, the CPT aims to evaluate cognition through completion of ADLs such as dressing, and IADLs such as managing medication, shopping for items, using the telephone, toasting a piece of bread, washing items, and traveling within the community (Douglas, Letts, Eva, & Richardson, 2012). Both the EFPT and the CPT overlap in tasks and attempt to determine the level of assistance an individual will need when returning to his or her home community (Baum et al., 2008; Douglas et al., 2012). Additionally, EFPT and CPT

have similar scoring based on the amount of cueing an individual needs to complete a task (Baum et al., 2008; Douglas et al., 2012; Wolf et al., 2010). During the administration of the EFPT or the CPT, an occupational therapist observes individuals and scores them according to verbal cues required, incomplete task, or errors made on the task (Baum et al., 2008; Douglas et al., 2012; Wolf et al., 2010). The following studies demonstrated how the CPT and the EFPT are representative of everyday tasks.

The CPT takes approximately 30 minutes to administer and requires direct observation of an individual completing up to seven tasks. Each task is scored individually with higher scores indicating little to no cueing was necessary and lower scores indicate cues were needed for the individual to fully complete the task. The scores of each task are added together and divided to make an average or total score. The total score is also then converted into a cognitive level based on the Large Allen Cognitive Levels (Douglas et al., 2012).

Douglas et al. (2012), conducted a correlation study to determine if the CPT, an assessment for persons with dementia, possessed ecological and concurrent validity within the population of older adults with possible cognitive impairments. The study recruited 47 individuals who were older than 65 years old from an older adult rehabilitation site. The researchers correlated the CPT against other measures of cognition such as, the FIM, the Standardized Mini Mental State Exam (SSMSE), and motor scale of AMPS, to establish its validity. Researchers analyzed the individuals' scores from each of the assessments using a Pearson correlation. A weaker correlation was found with CPT and FIM $r < 0.32$, $p = .05$ (Douglas et al., 2012). The results of concurrent validity showed a statistically significant correlation between the CPT and the

SMMSE $r = 0.47$, $p < .01$ and the CPT and the AMPS $r = 0.53$, $p < .01$(Douglas et al., 2012). While the correlation between the CPT and the SMMSE and the CPT and the AMPS were statistically significant in distinguishing unimpaired individuals from impaired individuals, the strength of this association was weak (phi coefficient less than 0.5) (Douglas et al., 2012). Individuals who scored impaired on one assessment measure scored unimpaired on the other measure, meaning that the sensitivity for detecting impairment was not consistent in all cases. While the findings from this study indicate the CPT as being a valid measure of cognition, it is not consistent in detecting impairment therefore making it unreliable.

The EFPT was designed to determine the level of support an individual with cognitive impairment needs to complete everyday tasks (Baum et al., 2008). The EFPT is made up of four everyday tasks that include: preparing a light meal, using the telephone, paying bills, and managing medication. The assessment includes a box containing 32 varying items that are needed to complete the tasks, including cookware, a phonebook, a checkbook, and medication bottles (Baum, Morrison, Hahn, & Edwards, 2003). The assessment uses a standardized cueing system as a way to determine and record the assistance level that was required to successfully finish the task. There are five levels of cueing, 0 indicating no cue was required, 5 indicating that the administrator needed to do the task for the individual. All scores are then summed up and the total score can range from 0 to 20 with a higher score reflecting more severe executive dysfunction (Baum et al., 2003; Baum et al., 2008).

Baum et al. (2008), sought to establish the reliability and the validity of the EFPT with the individuals with CVA. The sample population composed of 73 individuals with

mild to moderate CVA six months post-onset of CVA, and 22 healthy individuals who comprised the control group. The researchers used a battery of tabletop cognitive assessments to determine reliability and validity of the EFPT including the Animal Naming, TMT-A and B, and two subtests of the Wechsler Memory Scale-Revised (WMS-R). Additionally, the researchers evaluated functional performance by using an interview version of the Functional Independence Measure (FIM) and the Functional Assessment Measure (FAM). Administration of the EFPT occurred in a simulated laboratory kitchen environment and the tabletop cognitive assessments followed.

The researchers evaluated construct and concurrent validity by correlating scores from the EFPT, tabletop cognitive assessments, and occupation-based cognitive assessments. The EFPT scores indicated that the control group had the lowest scores followed by the mild CVA group while the moderate CVA group had higher mean scores on all measures (Baum et al., 2008). The researchers reported that the EFPT and the criterion assessments had significant correlations, the higher correlations between the EFPT and FAM, $r = -.68$, and FIM, $r = -.40$, support the concurrent validity of the EFPT in individuals with mild to moderate CVA (Baum et al., 2008). While the results of the study supported the EFPT to be a valid assessment in individuals with mild to moderate CVA, the materials of the assessment and the tasks are not likely to be feasible in all clinical settings.

Kettle test. The Kettle Test is an occupation-based cognitive assessment that aims to evaluate cognition through actual performance on a familiar IADL of making a hot beverage with an electric kettle (Hartman-Maier et al., 2009). Individuals are instructed to prepare a hot beverage after being presented an unassembled electric kettle and variety

of beverage ingredients. There are also additional kitchen utensils and ingredients placed in the immediate environment to serve as distractors. The rater is required to score the individual's performance based on 13 discrete steps of the task like turning on the faucet and filling the kettle with water. Each step is scored on a scale of 0 through 4, which indicates the degree of cueing that was needed to complete the step. Total scores range from 0 to 52 with higher scores indicating more assistance (Hartman-Maier et al., 2009).

Hartman-Maeir et al. (2009) aimed to examine the reliability and validity of the Kettle Test. The study included 36 individuals with CVA at discharge and 36 healthy individuals as the control group. The researchers aimed to validate the Kettle Test by correlating it to a battery of tabletop and occupation-based cognitive assessments that included the MMSE, Clock Drawing Test (CDT), Star Cancellation Test, IADL scale, Safety Rating scale and subtests of the FIM such as the Cognitive scale and the Motor scale. The Kettle Test scores of the CVA group were significantly higher than those of the control group, which resulted in significant construct validity (Hartman-maeir et al., 2009). Additionally, convergent validity of the Kettle Test to the tabletop assessments and occupation-based cognitive assessments revealed a moderate negative linear correlation ranging from -.478 to -.659 ($p < .01$). Furthermore, the Kettle Test had significant correlations to three of the occupation-based cognitive assessments: the IADL scale $r = -.505$, Safety Rating scale $r = -.571$, and the FIM Motor scale $r = -.759$ (Hartman-Maeir et al., 2009). The findings provided evidence to support the ecological validity of the Kettle Test. In summary, the Kettle Test presents as a valid assessment for clinical practice. The Kettle Test may identify cognitive impairments in everyday functional activities for individuals with CVA. However, a predominant limitation of the

study was the inability to generalize to the entire ABI population (Hartman-Maeir et al., 2009).

Conclusion. In summary, cognitive impairments are common for individuals with ABI. After physical injuries have healed, many individuals with ABI still struggle with residual cognitive impairments that affect their daily function. A common method of assessing individuals' cognition is standardized neuropsychological tabletop assessments, including cognitive assessments and executive function assessments. Tabletop assessments were identified as valid and clinically feasible for use in most occupational therapy practice settings. However, tabletop assessments cannot predict the functional performance of an individual, indicating a lack of ecological validity (Burgess et al., 2006).

In contrast, occupation-based cognitive assessments possess ecological validity and can generalize the individual's cognitive level to "real world" functional cognitive ability. Though the occupation-based cognitive assessments may be ideal for understanding cognition following ABI, the assessments currently available in practice do not meet the determined clinical feasibility criteria for use in practice (Alotaibi et al., 2009; Sansonetti & Hoffman, 2013). The literature review revealed this as a gap in assessment development. There is not a clinically feasible occupation-based cognitive assessment validated for the ABI population. The lack of occupation centered cognitive assessments in use is a concern for the client and performance centered practice of occupational therapy.

Statement of Purpose

The MBTa is intended to fill the gap of a feasible and valid occupation-based cognitive assessment for the ABI population. This study aimed to validate the MBTa in its use as an occupation-based cognitive assessment for individuals with ABI. A battery of gold standard tabletop cognitive assessments was used as criterion measurements against the MBTa. The results of the study answered the following question: is the MBTa a valid tool for measuring cognitive function in the ABI population, as measured against a battery of gold standard tabletop cognitive assessments? The null hypothesis stated that there was no correlation between the MBTa scores and the battery of tabletop cognitive assessment scores for the ABI population. The alternative hypothesis predicted that there was a correlation between the MBTa assessment scores and the battery of tabletop cognitive assessment scores for the ABI population.

Definitions and Variables

Definitions

- Cognitive impairments are deficits within any of the higher cognitive functions such as, attention, memory, and executive function (Gottesman & Hillis, 2010; Holmqvist et al., 2009; Perna et al., 2012).
- Attention is the, “a state of focused awareness on a subset of the available perceptual information” (APA, 2016, “Glossary of Psychological Terms”).
- Memory is, “the mental capacity to encode, store, and retrieve information” (APA, 2016, “Glossary of Psychological Terms”).

- Executive function consists of multiple cognitive processes, such as task switching, planning, organizing, sequencing, problem solving, reasoning, decision making, inhibition, initiation, monitoring and cognitive flexibility (Jurado & Rosselli, 2007; Miyake et al., 2000).
- Tabletop cognitive assessments are completed through interviewing and recording, filling out questionnaires, and simple tasks performed on paper (Hartman-Maier et al., 2009).
- Occupation-based assessments utilize functional activities or tasks to gain a better understanding of practical and real life impairments (Hartman-Maier et al., 2009).

Variables

The dependent variable in this study is the scores of the MBTa. The independent variable of this study is the scores of the tabletop cognitive assessments.

Theoretical Framework

The Ecology of Human Performance (EHP) is a model used in occupational therapy practice to shape assessment and intervention. Occupational therapists Dunn, Brown, and McGuan (1994) developed the EHP model as a client centered and holistic approach to occupational therapy practice. The model identifies four main constructs: person, context, task, and performance. According to the EHP model, context is defined as physical, social, cultural, and temporal conditions that surround the person. The model also defines the term person as an individual who consists of different variables. These “person variables” (Dunn, 2007, p.128) include: experiences of an individual, sensorimotor, cognitive, and psychosocial abilities, and skills (Dunn, 2007). The EHP

model identifies performance range as the outcome of the interaction between an individual and their contexts; tasks are the goal directed behaviors that an individual needs to complete a set of objectives (Dunn et al., 1994). The number and types of tasks available to individuals are dependent on performance range. The EHP model attempts to capture the dynamic relationship between the individual and context and how this interaction determines an individual's performance and participation in tasks.

The main constructs of the EHP model are the individual and context. The relationship of these two constructs predicts an individual's performance in a range of different tasks. The model's emphasis on human ecology, and an individual's relationship with their context, offers a way to better understand how a person is supported and/or hindered in a context, and how the context can affect performance of a task. The model reinforces the idea that an individual, who is supported by their context, will have greater performance in his or her task and therefore have a wider range of tasks available. Hence, the EHP model emphasizes that if an individual can optimize the relationship between the constructs of person and context, performance ability of tasks will also be enhanced.

Occupational therapists strive to assist individuals to attain their optimal levels of performance in everyday tasks but first; occupational therapists must assess an individual's baseline of performance (AOTA, 2015). The EHP model provides a perspective to further understand relationship between context and individuals throughout the process of occupational therapy, including assessment. Occupational therapists utilize a variety of assessments, observation, and clinical reasoning to understand the relationship between individuals and context. The EHP model complements the use of

occupation-based assessments to understand an individual’s functional performance as the assessments include observation and quantification of a task within a realistic context.

This study applied the EHP model to gain a new perspective on application of assessment methods for the ABI population. Two main EHP constructs of person and context are addressed in this study. Student researchers applied these constructs of the model to the facets of validation of a new occupation-based cognitive assessment. The first construct of person applied to the cognitive abilities of the individual. The second construct of context applied to the two types of cognitive assessments: tabletop assessments or occupation-based assessments. Constructs of the EHP model were used to support the methodology of this study, and determine validity of the MBTa and identify potential predictive ability of an individual's performance range or cognitive ability. The EHP model supported this study because it emphasizes the use of ecologically valid methods and the EHP models relation to assessment to help occupational therapists understand the full extent of how context impacts an individual's functional performance (Dunn et al., 1994).

Ethical and Legal Considerations

For this study, the student researchers obtained approval from the Institutional Review Board for the Protection of Human Participants (IRBPHP) approval application (#10406) (Appendix A). The study adhered to the American Occupational Therapy Association Code of Ethics (2015), upholding the principles of beneficence, nonmaleficence, autonomy and confidentiality, and veracity.

The principle of beneficence asks that the student researchers will demonstrate a concern for the wellbeing and safety of the recipients of their services (AOTA, 2015).

The participants had consent to be in the study without coercion from the student researchers. If the participant was not able to give own consent and had conservatorship, beneficence was kept in receiving a proxy consent from their conservator (Appendices B and C). This principle promoted good for all participants within the study by taking steps to promote legal and safe practices.

The principle of nonmaleficence included an obligation to not cause harm, even if the potential risk was without malicious or harmful intent (AOTA, 2015). The student researchers informed all participants that they had the right to terminate participation in the study at any time. Due to the duration of the assessment battery, feelings of fatigue could possibly arise. Mandatory rest breaks were given, but if a participant reported feeling, depression, frustration, and other symptoms of distress at any time throughout the assessments, student researchers gave the participant another optional rest break. The student researchers informed the staff members at Brain Injury Network of the Bay Area (BINBA), the collaborating agencies, or the conservator if a participant reported any feelings or symptoms of distress.

The principles of autonomy and confidentiality express the concept that the participant had the right to self-determination and privacy (AOTA, 2015). The student researchers provided the participants with full disclosure on the purpose of the study and assessments (Appendix D). Participants were provided consent or proxy consent forms prior to initial participation. The research team also respected participant’s right to withdraw from the study at any time. The student researchers maintained confidentially of all verbal, written, or electronic communications. After completion of the demographic questionnaire and before the start of the study, the student researchers assigned a code

number corresponding to each participant to protect his or her identity. This information was stored on a password protected Excel spreadsheet on password protected desktop computers. Student researchers removed all names from the assessment sheets and scores were kept within a locked file cabinet either at BINBA or faculty office at Dominican University of California at all times.

The principle of veracity is based on the virtues of truthfulness and honesty and refers to accurate transmission of information (AOTA, 2015). The student researchers ensured that the recruitment and description of the study were truthful and accurate to avoid misleading participants to participate in the study. The student researchers recorded and reported in an accurate and timely manner the results of the various assessments. The agency received the assessment forms with recorded scores. Duplicates of data were kept in a locked file cabinet within agencies or within faculty advisor's office. The data was accessible to the student researchers and faculty advisor only. Results of the assessment were also given to participants' health care professional to interpret results of the assessments in order to allow for accurate clinical interpretations and follow up. All data stored by Dominican University was destroyed 1 year after completion of the study.

Throughout the study, the student researchers utilized a variety of assessments to assess participants' cognition and functional performance. To remain in compliance with copyright laws student researchers received written proof of permission or proof of donation of the assessment tools used in the study. Publishers of the Montreal Cognitive Assessment (MoCA©) gave permission to use the assessment in this study with no changes or adaptations to the MoCA© test or instructions (Appendices E and F). Gina Musser donated Cognistat, 2013 version on October 21, 2014 to the department of

occupational therapy at Dominican University of California (Appendix G). The department of occupational therapy at Dominican University of California purchased the Tower of London assessment. The Trail-Making Test B is in public domain; therefore, it was used in accordance with fair use law. The MBTa is the intellectual property of Dr. Kitsum Li, the faculty advisor for this study. In summary, the student researchers took necessary steps to uphold ethical standards.

Methodology

Research Design

The design of this research study was a quantitative exploratory correlation study that aimed to investigate the construct validity of the MBTa as an occupation-based cognitive assessment. The study included a battery of gold standard tabletop cognitive assessments as criterion measurements against the MBTa.

The extraneous variables in this study included vision, literacy, endurance level, tolerance for mental fatigue, and physical limitations. To control for extraneous variables, two screening processes were implemented before participants engaged in the assessment process. A primary screen was over the phone to identify exclusion criteria such as neurodegenerative disorder and fluency in English (Appendix H). The secondary screen was a demographic survey (Appendix I) that the individual had to read and fill out. The survey validated their literacy in English. Additionally, participants were required to demonstrate opening a medication bottle without assistance to limit the impact of motor ability on cognitive performance. Variables not within the control of this study related to physical limitations, other than the ability to open a medication bottle, may include hemiparesis, hemiplegia, arthritis, carpal tunnel, and fractures.

Participants

The sample population for this study included English-speaking participants older than 18 with ABI. Examples of some of the conditions the participants presented with were brain tumor, encephalopathy, TBI, and CVA. Participants excluded from this study consisted of those with: neurodegenerative conditions, visual impairments interfering with reading instructions or identifying images, receptive aphasia affecting comprehension of verbal instruction, the inability to read written English interfering with the ability to read directions of the MBTa and the labels on the medication bottles, and upper extremity impairment possibly impeding the ability to open a medication bottle..

The study design utilized purposeful, convenience, and snowball sampling strategies to recruit participants. Student researchers recruited participants from organizations and community programs for persons with ABI (see Appendix J for letter of permission to organization). The Brain Injury Network of the Bay Area (BINBA) served as the primary recruitment and assessment administration site (Appendix K). The recruitment process included communicating with current members of BINBA, posting fliers, and sending email blasts to members of the organizations (Appendix L). Additionally, students used snowball sampling to recruit through word of mouth and posted additional flyers at the San Francisco VA Medical center and in the stroke rehabilitation unit at Laguna Honda Hospital and Rehabilitation Center.

Data Collection Procedures

Participants interested in participation completed two screening processes. Student researchers initially screened participants via telephone interview and invited

those identified as appropriate participants to the test administration site for an in-person screening process. The second screen utilized a demographic survey and opening a medication bottle to determine eligibility for participation. The individual's ability to complete the demographic survey and open a medication bottle served as evidence of adequate English literacy and physical ability to appropriately participate in the study. Immediately after participants completed the second screen, student researchers administered the assessment battery.

All student researchers received standardization training. Student researchers established inter-rater reliability prior to data collection through training with faculty advisor and standardization of assessment dialogue. To ensure accuracy in data collection, student researchers conducted the entire assessment battery as pairs: one student researcher administered the entire test battery and the other a recorded the scores from the assessments. Participants with ABI may experience mental fatigue and/or endurance issues (Hochstenbach et al., 2005; McDowd et al., 2003; Perna et al., 2012; Zinn et al., 2007). Mental fatigue and/or endurance issues were variables that threatened the accuracy of the data, as later scores may have been impacted by decreased stamina (Hochstenbach et al., 2005). To control for fatigue, participants were allowed a 15-minute break after completing the first three assessments, and additional breaks were granted upon request. All participants completed the assessments in the same standardized order: The Cognistat (2013), Trail Making Test Part B, MBTa, Tower of London, and Montreal Cognitive Assessment 7.3. All of the above table-top assessments were selected because they are gold standards for detecting cognitive impairment in the areas of global cognition, attention, memory, visuospatial, and executive functioning in planning,

sequencing and mental flexibility. Scores for each assessment were entered into a master data sheet that included scores for overall assessment and subtest scores for each assessment.

The Cognistat. The Cognistat is a screening tool that assesses areas of orientation, attention, language skills, and memory. The Cognistat includes 10 subscales: orientation, attention, comprehension, repetition, naming, construction, memory, calculations, similarities and judgment (Brown, Mapleston, Nairn, & Molloy, 2013). Each of these subscales is assigned a score after the screen is passed or a metric is completed. The assessment is designed to indicate impairment in specific areas of cognition. The assessment takes 10-20 minutes to complete and presents the overall cognitive status of an individual. The Cognistat scores are typically plotted on a status profile, ranging from average, mild impairment, moderate impairment, and severe impairment (Doninger et al., 2006). However, for this study, the total score and subtest scores were used as criterion measurements for cognitive impairment for the study population. For this study, the 2013 version of Cognistat was used.

Trail Making Part B. The TMT-B is an assessment that asks the participants to connect dots consisting of both numbers (1 – 13) and letters (A – L). As the participant connects the dots in ascending order, the participant is instructed to alternate between numbers and letters (i.e., 1-A-2-B-3-C). TMT- B assesses executive functioning through shifting and sequencing between letters and numbers and may identify impairment in executive function. TMT-B is scored in terms of time taken to complete the assessment. Lange et al., (2005) reported a positive linear correlation between performance measured in seconds on the assessment and severity of the injury.

Medication Box Task Assessment. The MBTa (Appendix M)**,** designed by previous occupational therapy students and faculty advisor Dr. Kitsum Li of Dominican University of California, is an occupation-based cognitive assessment that primarily focuses on assessing executive functioning, memory, and attention. During the MBTa, the participant is given instructions to fill AM/PM pill organizers. Dosage instructions are placed on the five prescription bottles. A random number (up to six) of over-the-counter medication bottles, which are not intended to be put into the pill organizers, act as "distractors" in the assessment. The student researchers rolled a die prior to the assessment to determine the number of over-the-counter bottles to be added to the assessment for each participant. The MBTa is scored by calculating total number of errors, which includes incorrect pill placement, incorrect number of pills, or placement of distractor pills in the pill organizers. Scores are also recorded for number of correct pill placement and amount of time (seconds) taken to complete the assessment. Participants were provided with written instruction and were given up to 20 minutes to complete the assessment without the presence of the student researchers

Tower of London. The Tower of London, a tabletop cognitive assessment that assesses executive function, involves a pegboard, blocks, and a sequence of simple patterned images. The student researcher arranged the blocks on the pegboard in a predetermined pattern and showed it to the participant. The participant then recreated the blocks with the least number of moves. The Tower of London is reliable in detecting impairments of executive function (Köstering et al., 2015). Specifically, the assessment is sensitive to planning abilities (Köstering et al., 2015). The student researchers assessed and scored the amount of moves it took the participant to recreate the presented pattern

along with the number of moves, total time, total patterns solved in the fewest moves possible, and rule violations. The participant is limited to 2 minutes to complete each pattern problem to be solved and the total number of moves is limited to 20 per each pattern. Rule violations include Type I and Type II errors. Type I errors involve placing too many beads on any of the pegs, and type II errors involve the participant moving more than one bead off of the pegs at a time (Köstering et al., 2015). When participants made these errors, the moves performed during the error are included in the total moves score. The number of mistakes a participant can make is limited by the maximum move count. The total scores are translated into a standard score that reflects cognitive function as compared to a population norm.

Montreal Cognitive Assessment 7.3©. The Montreal Cognitive Assessment (MoCA©) assesses orientation, attention, language skills, and memory, and also evaluates visual-spatial construction and executive function. The MoCA© is designed to be a rapid screening instrument to test for cognitive impairment and takes about 10 minutes to administer. A maximum of 30 total points is possible and a score of 26 and higher is considered normal (MoCA©, 2015). However, a score lower than 26 indicate an individual as having impaired cognition (MoCA©, 2015).

Data Analysis

The student researchers conducted descriptive data analysis, which included means and standard deviations, derived from the information on the demographic survey. Statistical analysis used a Pearson’s correlation to detect significant correlations between the MBTa scores and those of the battery of gold standard assessments. The student

researchers correlated and analyzed scores from each assessment using Statistical Package for the Social Sciences (version 22, SPSS).

The MBTa was further analyzed with Pearson's correlations. Statistical relationships were drawn from total correct and total errors on the Medication Box Assessment, the amount of time to complete the assessment, number of over-the-counter medication bottles, number of over-the-counter mistakes, number of missing pills, and number extra pills. The student researchers also used Pearson's correlations to analyze relationships between scores from the battery of gold standard assessments and the MBTa. Further analysis sought to identify relationships between components of assessments' subtests, like memory and attention from the Cognistat and MoCA©, and other subset data such as total type I and type II errors in the TOL assessment.

Results

In the study there were eight participants (62.5% female, 37.5% male) ranging in age from 56 to 73 with a mean age of 64.62. The months post injury of the participants ranged from 9 to 115. A calculated mean for the months post injury was 58.62 with a standard deviation of 34.39. Of the eight participants, four had the diagnosis of CVA, three were diagnosed with TBI, and one had a brain tumor (Table 1). All participants completed the assessment battery the scores were analyzed.

Pearson's correlations were used to analyze each participant's scores between the MBTa and the battery of the gold standard tabletop cognitive assessments. No significant correlations were found between the MBTa scores and the total scores of the assessment battery. However, when broken down into subtest scores, results indicated that total correct, total pills missing, and total extra pills correlated strongly with TOL type II

errors (Table 2). The MBTa total correct pill placements had a significant negative linear correlation with TOL type II errors $r = -.951$, $p < .01$, while total missing pills $r = .981$, $p < .01$ and total extra pills $r = .947$, $p < .01$ presented significant positive linear correlations. There was no significant correlation between participants' reports of medication management and their total number of errors made on the MBTa $r = .687$, $p = .06$. Data also presented that seven out of the eight participants reported management of their own medication and of these, four indicated that they used a medication box. Six out of the eight participants made more than one error on the MBTa. The mean of the MBTa errors was 8.85 with a standard deviation of 8.

Table 1

Participant Demographics

Participant ID	Age in years	Gender	Type of Injury	Months post injury
1	60	female	TBI	59
2	73	female	CVA	44
3	67	male	CVA	98
4	56	female	Other	30
5	63	female	CVA	62
6	63	male	TBI	52
7	74	male	CVA	115
8	61	female	TBI	9

Table 2

Medication Box Task Assessment Pearson Correlations

		MEDB TOTAL ERROR	*MEDB TIME*	*MEDB NUMBER OF DISTRACTOR BOTTLES*	*MEDB OC MISTAKES*	*MEDB MISSING PILLS*	*MEDB EXTRA PILLS*	*MEDB TOTAL CORRECT*
TOL Type II Error	Pearson Correlation	.178	.555	.036	-.397	.981**	.947**	-.951**
	Significance (2-Tailed)	.673	.195	.932	.330	.000	.000	.000
MoCA Total Score	Pearson Correlation	-.360	-.140	.147	-.468	.148	.272	-.224
	Significance (2-Tailed)	.381	.765	.729	.242	.726	.515	.594
TM Time	Pearson Correlation	.263	.147	-.720*	.398	-.333	-.164	.334
	Significance (2-Tailed)	.528	.753	.044	.329	.420	.698	.419
COG Total Score	Pearson Correlation	.439	-.393	.376	.370	-.001	.168	-.106
	Significance (2-Tailed)	.277	.383	.359	.367	.998	.691	.802

Discussion

From these results and overall low statistical power, student researchers were not able to determine validity of the MBTa. Student researchers accepted the null hypothesis that no relationship exists between the MBTa scores and the battery of tabletop cognitive assessment scores for the ABI population.

Although the MBTa may not be clearly established as a valid cognitive assessment, student researchers infer that an important relationship identified with the TOL and the MBTa may be a critical component for further research and analysis. Student researchers believe the implication of this may be due to similarities of task demands of both the TOL and the MBTa. The TOL involves replicating a pattern of beads on three different sized pegs. An individual uses motor action, planning, sequencing, and attention to complete the TOL assessment; these cognitive demands may be similar to the pill placement, sequence, and planning required of an individual to complete the MBTa. These similarities lead student researchers to believe that the MBTa might be best suited as an executive function assessment and could possibly be validated with other executive function assessments in future research.

While student researchers were eager to see the correlations and connection between the TOL and the MBTa, what they believed to be the most important finding came from what arose in the demographic survey. The fact that seven study participants claimed to manage their own medication and six of those individuals had multiple errors when completing the MBTa, was cause for great safety concern. While the tabletop cognitive assessments all had reports of minimal to no cognitive impairment, critical mistakes were still made with in the occupation-based cognitive assessment, the MBTa.

This was a significant indication to students that occupation-based assessments can be important in not just identifying functional ability, but in identifying critical safety concerns. Student researchers understand how important it is to use occupation-based cognitive assessments and not to solely rely on tabletop cognitive assessments alone, as they may miss critical components of an individual's functional performance and cognition.

Even though this study failed to validate the MBTa as an occupation-based cognitive assessment for the population of ABI, there is still a need for a valid and feasible occupation-based cognitive assessment that can indicate cognition in relation to function in everyday occupation. Filling this gap can allow occupational therapists to provide occupation-centered and client-centered care.

Limitations and Recommendation

The constraints of convenience sampling posed as a limitation for this study. The limited sample size of eight participants negatively impacted statistical power and therefore limited the validation of the MBTa with the ABI population. Another possible limitation within the sample population included the recruitment from only one local agency which resulted in a small number of recruited participants who had minimal to no cognitive impairment as measured by the results of the battery of tabletop cognitive assessments. This left little room to identify cognitive impairment with the assessment battery. Limitations also may have stemmed from the inclusion and exclusion criteria for participation. A broader sample of impaired participants may possibly lead to more correlations between the MBTa and the assessment battery within future research.

Individuals with lower levels of function may be more easily detected as having cognitive impairment. Future researchers can use this data to further refine the MBTa.

A continuation of this research study is recommended with a larger sample size and more diverse sample of cognitive impairment. This may further the research in identifying a feasible occupation-based cognitive assessment for the population of ABI and other populations. Future research should include an evaluation of the scoring system of the MBTa. Unlike the battery of gold standard tabletop cognitive assessments, the MBTa does not have specific criteria for timing a participant, and does not factor time of completion as part of the scoring. Further analysis of the MBTa may result in a better understanding of how initiation and completion time of the task relate to cognition.

Additionally, a study conducted Rice et al., (2015) found that the Cognistat assessment screening tools did not identify impairment in individuals with ABI. Based on their findings, Rice et al., (2015) recommend that OT practitioners administer both the screen and the metric tool regardless of the screening tool result. However, based on the standard assessment procedure as outlined in the Cognistat manual, the Cognistat was administered according to the best practices using the screening method. This may have posed as a limitation to this research study since student researchers followed the original the Cognistat guidelines.

As discussed previously, the results indicated that participants who claimed they manage their own medication and those who completed the MBTa with multiple errors warranted concern for safety. Student researchers recommend further validation of the MBTa as an occupation-based cognitive assessment. Furthermore, the MBTa may have

validity in as a tool to identify safety concerns in medication management. Additional research must be conducted to confirm validity in this context.

Conclusion

There is a need to further the research and develop the MBTa for the ABI population. The gap discovered through the literature review identified current limitations of tabletop cognitive assessments and occupation-based cognitive assessments for the population of ABI. The literature revealed that current occupational therapy practice has no valid, reliable, or feasible occupation-based cognitive assessment for the ABI population. The student researchers aimed to fill the gap with the MBTa as a feasible and valid occupation-based cognitive assessment for the population of ABI.

The student researchers used scores from a battery of tabletop cognitive assessments as criterion measurements against scores of the MBTa for determining validity. The results indicated that the MBTa cannot be established as a valid assessment for cognition for the population of ABI. However, the MBTa scores indicated there may be functional aspects of executive dysfunction not detected by tabletop cognitive assessments, which suggested minimal to no impairments. The significant correlation between type II errors on the TOL and the extra, missing, and correct pill placements of the MBTa, indicated a potential identification of cognitive impairments. The similarities of the TOL and the MBTa indicate a possibility of the MBTa being an identifier of executive dysfunction.

Results of just one type of cognitive assessment should not be utilized as the only evidence in understanding an individual’s cognition. The errors made on the MBTa illustrate the need for a clinically feasible occupation-based cognitive assessment in

occupational therapy practice. Addressing this need can integrate the use of occupation-based cognitive assessments in practice and promote more occupation centered and client centered practice of occupational therapy (Arciniegas, Frey, Newman, & Wortzel, 2010; Lannin et al., 2014; Perna, Loughan, & Talka, 2012).

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Appendix A
IRB Approval Letter

January 27, 2016

Katherine Blank
50 Acacia Ave.
San Rafael, CA 94901

Dear Katherine:

I have reviewed your proposal entitled *Validation of the Medication Box Task Assessment* submitted to the Dominican University Institutional Review Board for the Protection of Human Participants (IRBPHP Application, #10406). I am approving it as having met the requirements for minimizing risk and protecting the rights of the participants in your research.

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

I wish you well in your very interesting research effort.

Sincerely,

Martha Nelson, Ph.D.
Chair, IRBPHP
cc: Kitsum Li

Institutional Review Board for the Protection of Human Participants
Office of Academic Affairs • 50 Acacia Avenue, San Rafael, California 95901-2298 •
415-257-1310 www.dominican.edu

Appendix B

CONSENT FORM TO BE A RESEARCH PARTICIPANT

Validation of the Medication Box Task Assessment
DOMINICAN UNIVERSITY OF CALIFORNIA

1. I understand that I am being asked to participate as a participant in a research study designed to validate the medication box task assessment. This research is part of Alison Chandler, Katherine Blank, Malcolm Isely, Serena Soria, and Yamin Zaw's capstone research study at Dominican University of California, California. This research study is being supervised by (Kitsum Li, OTD, OTR/L, CSRS, Assistant Professor, Department of Occupational Therapy), Dominican University of California.

2. I understand that participation in this research will involve taking part in approximately a 90 minute session of a survey and completion of cognitive assessments administered by the researchers.

3. I understand that my participation in this study is completely voluntary and I am free to withdraw my participation at any time.

4. I have been made aware that the information collected will not be anonymous. The personal information will only be accessible by the authors of study. All personal references and identifying information will be eliminated when the data are transcribed. All participants will be identified by numerical code only, thereby assuring confidentiality regarding the participant's responses. No individual identities will be used in any reports or publications resulting from the study. One year after the completion of the research, all collected data will be destroyed.

5. I am aware that all study participants have the option of learning about the relevant findings and conclusions of this study. Such results will not be available until October, 2016.

6. I understand that my participation involves no physical risk, but may involve fatigue from spending energy on finishing the cognitive assessments.

7. I understand that if I have any further questions about the study, I may contact them at otmedbox@gmail.com or their research supervisor, Kitsum Li at kitsum.li@dominican.edu, If I have further questions or comments about participation in this study, I may contact the Dominican University of California Institutional Review Board for the Protection of Human Participants (IRBPHP), which is concerned with the protection of volunteers in research projects. I may reach the IRBPHP Office by calling (415) 482-3547 and leaving a voicemail message, by FAX at (415) 257-0165 or by writing to the IRBPHP, Office of the Associate Vice President for Academic Affairs, Dominican University of California, 50 Acacia Avenue, San Rafael, CA 94901.

8. All procedures related to this research project have been satisfactorily explained to me

Appendix B

CONSENT FORM TO BE A RESEARCH PARTICIPANT

prior to my voluntary election to participate.

I HAVE READ AND UNDERSTAND ALL OF THE ABOVE EXPLANATION REGARDING THIS STUDY. I VOLUNTARILY GIVE MY CONSENT TO PARTICIPATE. A COPY OF THIS FORM HAS BEEN GIVEN TO ME FOR MY FUTURE REFERENCE.

Signature Date

Appendix C
PROXY CONSENT FOR RESEARCH PARTICIPATION

Validation of the Medication Box Task Assessment
DOMINICAN UNIVERSITY of CALIFORNIA
PROXY CONSENT FOR RESEARCH PARTICIPATION

Purpose and Background

Katherine Blank, Alison Chandler, Malcolm Isely, Serena Soria, and Yamin Zaw, undergraduate students, and Kitsum Li, Assistant Professor, Department of Occupational Therapy at Dominican University of California, are doing a study to validate the medication box task assessment. many individuals with acquired brain injury have cognitive impairments that affect engagement in daily activities. Researchers are interested in validating the medication box task assessment to provide an important tool that assesses functional performance for the field of occupational therapy.

My conservatee is being asked to participate because s/he has an acquired brain injury.

<u>Procedures</u>
If I agree to allow my conservatee to be in this study, the following will happen:
1. My conservatee will complete a survey about demographics. Filling out the survey will take about 5 minutes.
2. My conservatee will partake in completing cognitive assessments administered by the researchers. The assessment period will be approximately 90 minutes.
3. The researchers will review my conservatee's results from the assessments to obtain information about possible impairments regarding her/his cognition.

<u>Risks and/or discomforts</u>
1. My conservatee may become fatigued or frustrated during the period of assessments. If this happens, the researchers will give give him/her a break to minimize fatigue. The researchers will clearly explain the instructions of each assessment to ensure full comprehension from my conservatee and prevent frustration before proceeding with the cognitive assessments.
2. Study records will be kept as confidential as is possible. No individual identities will be used in any reports or publications resulting from the study. All personal references and identifying information will be eliminated when the data are transcribed. All participants will be identified by numerical code only, thereby assuring confidentiality regarding the participant's responses. Only the researchers and their faculty advisor will see the participants' data. One year after the completion of the research, all written and recorded materials will be destroyed.

<u>Benefits</u>
The potential benefit for my conservatee is gaining the knowledge of possible impairments s/he may possess based on the results of the cognitive assessments. The

Appendix C

PROXY CONSENT FOR RESEARCH PARTICIPATION

anticipated benefit of this study is to provide a valid functional performance based assessment for the field of occupational therapy.

Costs/Financial Considerations

There may be transportation cost for me or my conservatee as a result of taking part in this study.

Payment/Reimbursement

My conservatee will be placed in a drawing for gift cards to local stores. Three to four gift cards will up for drawing, valued at twenty dollars for each card.

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 (otmedbox@gmail.com) or their research supervisor, Kitsum Li at (415) 458-3753. If I have any questions or comments about participation in this study, I should first talk with the researchers. If for some reason I do not wish to do this, I may contact the Dominican University of California Institutional Review Board for the Protection of Human Participants (IRBPHP), which is concerned with protection of volunteers in research projects. I may reach the IRBPHP Office by calling (415) 482-3547 and leaving a voicemail message, or FAX at (415) 257-0165, or by writing to IRBPHP, Office of 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 have my conservatee be in this study, or to withdraw my conservatee from it at any point without any repercussions.

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

________________________________ _________________________

Signature of Participant’s Parent/Guardian Date

________________________________ _________________________

Signature of Person Obtaining Consent Date

(Model letter adapted from USF IRBPHP Handbook

VALIDATION OF MEDICATION BOX TASK ASSESSMENT

Appendix D
LETTER TO PARTICIPANT

Dear Study Participant,

We are undergraduate occupational therapy majors at Dominican University of California. Our names are Katherine Blank, Alison Chandler, Malcolm Isely, Serena Soria, and Yamin Zaw. We are conducting a research project as part of our master's degree requirements, and this work is being supervised by Kitsum Li, OTD, OTR/L, CSRS, Assistant Professor of Occupational Therapy at Dominican University of California. We are requesting your voluntary participation in our study. Your voluntary participation would involve completing a battery of table top assessments of cognition and a functional assessment, the Medication Box Task, administered by the researchers. We are examining the results of the Medication Box Task assessment with table top assessments as criterion measurement to validate the Medication Box Task assessment.

Participation in this study involves filling out a (Number of questions) survey for demographic purposes, and completing a battery of cognitive assessments in a 90 minute session. Please note that your participation is **completely voluntary** and you are **free to withdraw your participation at any time.** Anonymity cannot be guaranteed, however, and in the unlikely event an identity becomes known, all information will be held as completely confidential.

If you have questions about the research you may contact us at at the email address below. If you have further questions you may contact our research supervisor, Kitsum Li at (415) 458-3753 or the Dominican University of California Institutional Review Board for the Protection of Human Participants (IRBPHP), which is concerned with protection of volunteers in research projects. You may reach the IRBPHP Office by calling (415) 482-3547 and leaving a voicemail message, or FAX at (415) 257-0165, or by writing to IRBPHP, Office of Associate Vice President for Academic Affairs, Dominican University of California, 50 Acacia Avenue, San Rafael, CA 95901.

If you would like to know the results of this study once it has been completed, a summary of the results will be presented at the OTAC Convention in October, 2016. Contact me at the email address below for further information.

Thank you in advance for your participation.

Sincerely,

Katherine Blank, Alison Chandler, Malcolm Isely, Serena Soria and Yamin Zaw
Dominican University of California
50 Acacia Avenue
San Rafael, CA 94901 Email address: otmedbox@gmail.com

Appendix E

PERMISSION FROM MoCA

Malcolm Isely <malcolm.isely@students.dominican.edu>

RE: MoCA(c) Permission Request

1 message

Li, Kitsum <kitsum.li@dominican.edu> Mon, Oct 26, 2015 at 8:37 AM
To: Katie Blank <katherine.blank@students.dominican.edu>
Cc: Malcolm Isely <malcolm.isely@students.dominican.edu>, Yamin Zaw <yamin.zaw@students.dominican.edu>, Alison Chandler <Alison.chandler@students.dominican.edu>, Serena Soria <serena.soria@students.dominican.edu>

From: "MoCa" <info@mocatest.org>

Date: Oct 26, 2015 6:52 AM
Subject: RE: MoCA© Permission Request
To: <kitsum.li@dominican.edu>
Cc: "Ziad Nasreddine" <ziad.nasreddine@mocaclinic.ca>

Hello,

Thank you for your interest in the MoCA©.

You are welcome to use the MoCA© Test as you described below with no further permission requirements.

No changes or adaptations to the MoCA© Test and instructions are permitted.

All the best,

MoCA INSTITUT & CLINIQUE

Kathleen Gallant, MSOT
Occupational Therapist / Psychometrician
On behalf of Dr Ziad Nasreddine, Neurologist, MoCA© Copyright Owner

MoCA Clinic & Institute

4896 Taschereau Blvd, suite 230

Greenfield Park, Quebec, Canada, J4V 2J2

Tel : (450) 672-7766 #222 Fax : (450) 672-3899

kathleen.gallant@mocaclinic.ca

www.mocatest.org / www.alzheimer.TV

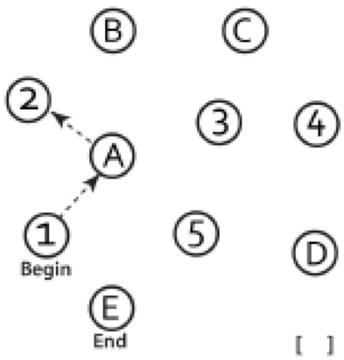
Get the latest Alzheimer News, brought to you by the MoCA Clinic and Institute:

Appendix F
MoCA FORM

MONTREAL COGNITIVE ASSESSMENT (MOCA)
Version 7.3 Alternative Version

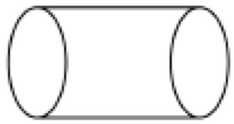
NAME :
Education :
Sex :
Date of birth :
DATE :

		POINTS
VISUOSPATIAL / EXECUTIVE	Copy cylinder / Draw CLOCK (Ten past nine) (3 points)	



[ ]

Copy cylinder



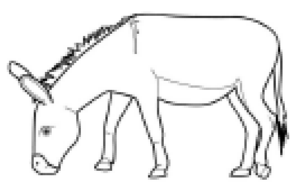
[ ]

Draw CLOCK (Ten past nine)
(3 points)

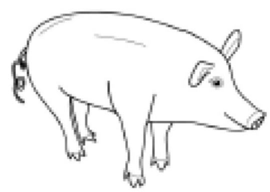
[ ] Contour [ ] Numbers [ ] Hands

___/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.

	TRAIN	EGG	HAT	CHAIR	BLUE
1st trial					
2nd trial					

No points

ATTENTION Read list of digits (1 digit/ sec.).
Subject has to repeat them in the forward order [ ] 5 4 1 8 7
Subject has to repeat them in the backward order [ ] 1 7 4
___/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 80 [ ] 73 [ ] 66 [ ] 59 [ ] 52 [ ] 45
4 or 5 correct subtractions: **3 pts**, 2 or 3 correct: **2 pts**, 1 correct: **1 pt**, 0 correct: **0 pt**
___/3

LANGUAGE Repeat : She heard his lawyer was the one to sue after the accident. [ ]
The little girls who were given too much candy got stomach aches. [ ]
___/2

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

ABSTRACTION Similarity between e.g. banana - orange = fruit [ ] eye – ear [ ] trumpet – piano
___/2

DELAYED RECALL	Has to recall words **WITH NO CUE**	TRAIN [ ]	EGG [ ]	HAT [ ]	CHAIR [ ]	BLUE [ ]	Points for UNCUED recall only	___/5
Optional	Category cue							
	Multiple choice cue							

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 G
COGNISTAT PERMISSION LETTER

DOMINICAN
UNIVERSITY
of CALIFORNIA
1890

October 22, 2014

Gina Musser
Cognistat
P.O. Box 460
Fairfax, CA 94978

Dear Gina,

On behalf of Dominican University of California, I am pleased to acknowledge receipt of forty (40) 2013 Cognistat assessment forms, manuals, and booklets. This generous donation was accepted for the University's Department of Occupational Therapy on October 21, 2014.

By contributing to the university, Cognistat recognizes and rewards Dominican's tradition of excellence. Gifts from alumni, parents, and friends of the university provide vital support for academic programs and student scholarships, as well as campus ministry and athletic programs. Your support makes it possible for Dominican to retain its unique character as a small community, while at the same time expanding the curriculum and providing the resources that attract exceptional faculty, coaches, and students.

Thank you for your organization's continued support of Dominican University of California.

Sincerely,

Ellen Donovan
Director of Annual Giving

Dominican University of California is a 501(c)(3) charitable organization, tax ID# 94-1156525. In accordance with IRS regulations, Dominican University of California does not assign a Fair Market Value to items donated.

Gina - thank you for your support

50 Acacia Avenue, San Rafael, California 94901-2298 • *p.* 415-257-1396 • *f.* 415-257-0162
www.dominican.edu

Appendix H
TELEPHONE SCREENING QUESTIONARE

DOMINICAN UNIVERSITY OF CALIFORNIA

TELEPHONE SCREENING QUESTIONARE

Telephone Screening Questionnaire:

1. What is your primary language?
2. What language do you read and write in?
3. What is your diagnosis? How long ago were you diagnosed?
4. Would you have any trouble opening a water bottle?
5. Do you wear glasses? If yes, can you read the label on a medicine bottle?
6. Are you under conservatorship? If yes, whom should I contact to obtain consent for you to participate in the study?

Appendix I
DEMOGRAPHIC SURVEY

DOMINICAN UNIVERSITY OF CALIFORNIA

DEMOGRAPHIC SURVEY

Name: (First, Last). ______________________________ Date of birth:
_____/____/______

Please answer the following questions to the best of your ability:

1. What is your age? _____
2. What is your identified gender?
   a. Male b. Female c. Other _____________
3. Is your diagnosis?
   a. Stroke b. Traumatic Brain Injury c. Other ____________
4. When was the initial onset of your injury?
   Date of onset: Month:__________/Year:___________
5. Has the brain injury (Stroke, TBI, other) appeared more than once?
   a. Yes b. No c. If yes, how many? _______
6. What is your ethnicity?
   a. Caucasian b. Asian c. Black or African American
   d. Native American e. Hispanic or Latino f. Other_______________
7. Please circle your highest level of education completed?
   a. Grammar school b. Middle school c. High school d. some college
   e. Bachelor's degree f. Master's degree g. Doctorate degree

8. Do you manage your own medication? (Circle your answer) yes no

9. Do you use a medication box? (Circle your answer) yes no

Appendix J
LETTER OF PERMISSION TO AGENCY DIRECTORS

Validation of the Medication Box Task Assessment

DOMINICAN UNIVERSITY of CALIFORNIA

LETTER OF PERMISSION TO AGENCY DIRECTORS

Name
Title, Establishment
Address
City, CA Zip code

Dear _______:

This letter confirms that you have been provided with a brief description of our capstone research study, which concerns validating the medication box task assessment, and that you give your consent for us to visit your facility to administer a battery of cognitive assessments to a select number of your clients, who voluntarily choose to participate in our study. This study is an important part of our graduate requirements as an occupational therapy major, and is being supervised by Dr. Kitsum Li, Assistant Professor of Occupational Therapy at Dominican University of California.

As we discussed in our phone conversation, we will make every effort to ensure that my data collection does not interfere with your regularly scheduled program and classes, and that your clients are treated with the utmost discretion and sensitivity. If you have questions about the research you may contact me at phone number or email address below. If you have further concerns you may contact our research supervisor, Dr. Li, at (415) 458-3753 or the Institutional Review Board for the Protection of Human Participants at Dominican University of California by calling (415) 482-3547.

Appendix J

LETTER OF PERMISSION TO AGENCY DIRECTORS

After our research study has been completed in October 2016, we will be glad to send you a summary of our research results.

If our request to visit your establishment and to administer cognitive assessments to your clients meets with your approval, please sign and date this letter below and return it to me in the enclosed self-addressed, stamped envelope as soon as possible. Please feel free to contact me if you have any questions about this project.

Thank you very much for your time and cooperation.

Sincerely,

Katherine Blank, Alison Chandler, Malcolm Isely, Serena Soria and Yamin Zaw
Dominican University of California
50 Acacia Avenue
San Rafael, CA 94901
Email address: otmedbox@gmail.com

I agree with the above request

________________________________ ____________________

Signature **Date**

Appendix K

LETTER OF PERMISSION TO BINBA

Validation of the Medication Box Task Assessment

DOMINICAN UNIVERSITY of CALIFORNIA

LETTER OF PERMISSION TO BRAIN INJURY NETWORK OF THE BAY AREA DIRECTORS

Maggie Smida, OTR/L

Brain Injury Network of the Bay Area

1132 Magnolia Ave

Larkspur, CA 94939

March 01, 2016

Dear Ms. Smida:

This letter confirms that you have been provided with a brief description of our capstone research study, which concerns validating the medication box task assessment, and that you are giving your consent for us to visit your facility to administer a battery of cognitive assessments to a selected number of your clients who voluntarily choose to participate in our study. This study is an important part of our graduate requirements in the occupational therapy program, and is being supervised by Dr. Kitsum Li, Assistant Professor of Occupational Therapy at Dominican University of California.

As we discussed in our phone conversation and in person meeting, we will make every effort to ensure that our data collection will not interfere with your regularly scheduled program and classes, and that your clients are treated with the utmost discretion and sensitivity. If you have questions about the research, you may contact us at phone number or email address below. If you have further concerns, you may contact our research advisor, Dr. Kitsum Li, at (415) 458-3753 or the Institutional Review Board for

Appendix K

LETTER OF PERMISSION TO BINBA

the Protection of Human Participants at Dominican University of California by calling (415) 482-3547.

After our research study has been completed in December 2016, we will be glad to send you a summary of our research results if you are interested. Please contact us at our email for more information.

If our request to visit your establishment and to administer cognitive assessments to your clients meets with your approval, please sign and date this letter below and return it to us in the enclosed self-addressed, stamped envelope as soon as possible. Please feel free to contact us if you have any questions about this project.

Thank you very much for your time and cooperation.

Sincerely,

Katherine Blank, Alison Chandler, Malcolm Isely, Serena Soria and Yamin Zaw

Dominican University of California

50 Acacia Avenue

San Rafael, CA 94901

Email address: otmedbox@gmail.com

I agree with the above request

[redacted]

Appendix L
RECRUITMENT FLIER

LEARN MORE ABOUT YOUR COGNITION!

Occupational Therapy students from DUC are seeking participants for a research study to validate a new cognitive assessment.

Benefits of Participation:

- **Learn more about your cognition!**
- **Be entered into drawing for a $20 Trader Joe's gift card!**
- **Opportunity for FREE Cognition Workshop!**
- **Help support future brain injury treatment!**

What's involved?

- Questionnaire and 5 brief cognitive assessments.
- Time commitment of 90 minutes
- Take place at BINBA, 1132 Magnolia Avenue, Larkspur, CA

Eligibility:

- 18 years or older
- Acquired Brain Injury
- Be able to open medication bottles
- Be able to read in English

If interested please contact: OTmedbox@gmail.com or call (415) 458-3753

Appendix M

MEDICATION BOX TASK ASSESSMENT SCORE SHEET

CLIENT ID:________
DATE AND TIME:___________
EXAM TOTAL TIME:_________

	S	M	T	W	TH	F	S
AM	Orange __/3 Blue __/1 White __/2	Orange __/3 Blue __/1 White __/2	Orange __/3 Blue __/1 White __/2	Orange __/3 Blue __/1 White __/2	Orange __/3 Blue __/1 White __/2	Orange __/3 Blue __/1 White __/2	Orange __/3 Blue __/1 White __/2
Errors	OC ___ MP ___ EP ___	OC ___ MP ___ EP ___	OC ___ MP ___ EP ___	OC ___ MP ___ EP ___	OC ___ MP ___ EP ___	OC ___ MP ___ EP ___	OC ___ MP ___ EP ___
Correct							
PM	Yellow __/1 Blue __/1 Red __/1 White __/1	Yellow __/1 Blue __/1 Red __/1 White __/1	Yellow __/1 Blue __/1 Red __/1 White __/1	Yellow __/1 Blue __/1 Red __/1 White __/1	Yellow __/1 Blue __/1 Red __/1 White __/1	Yellow __/1 Blue __/1 Red __/1 White __/1	Yellow __/1 Blue __/1 Red __/1 White __/1
Errors	OC ___ MP ___ EP ___	OC ___ MP ___ EP ___	OC ___ MP ___ EP ___	OC ___ MP ___ EP ___	OC ___ MP ___ EP ___	OC ___ MP ___ EP ___	OC ___ MP ___ EP ___
Correct							

Comments: