PREDICTORS OF PERFORMANCE-BASED MEASURES OF INSTRUMENTAL ACTIVITIES OF DAILY LIVING IN STROKE SURVIVORS

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PREDICTORS OF PERFORMANCE-BASED MEASURES OF INSTRUMENTAL ACTIVITIES OF DAILY LIVING IN STROKE SURVIVORS

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ABSTRACT

The aim of this dissertation was to investigate the relationship between cognitive domains/executive functions and performance on measures of Instrumental Activities of Daily Living (IADLs) in stroke survivors. Fifty-two stroke survivors completed assessments of immediate memory, visuospatial/constructional skills, language, attention, delayed memory, executive functions (i.e., inhibition and flexibility, concept-formation and problem solving, abstract thinking, deductive thinking, and verbal abstraction), and two performance-based measures of IADLs.

Results indicated significant correlations between the UCSD Performance-based Skills Assessment (UPSA), a measure of IADLS, and immediate memory, visuospatial/constructional skills, language, delayed memory, and executive functions (i.e., concept formation and problem solving, flexibility of thinking, and verbal abstraction). In regards to the Executive Function Performance Test (EFPT), the second measure of IADLs, significant correlations were found between the EFPT and visuospatial/constructional skills, language, delayed memory, and executive functions (i.e., concept formation and problem solving, and flexibility of thinking). Hierarchical multiple regressions demonstrated that only language significantly predicted UPSA total scores and no cognitive domains and executive functions significantly predicted EFPT total scores. These results have several implications. For example, cognitive domains and executive functions are important in predicting a stroke survivors' level of functioning, and not as individual predictors but rather as a set of cognitive abilities. Limitations of this study and future research directions are discussed.

APPROVAL PAGE

The faculty listed below, appointed by the Dean of the College of Arts and Sciences have examined a dissertation titled "Predictors of Performance-based Measures of Instrumental Activities of Daily Living in Stroke Survivors" presented by Denisse Tiznado, candidate for the Doctor of Philosophy degree, and certify that in their opinion it is worthy of acceptance.

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CHAPTER 1

STATEMENT OF THE PROBLEM

Each year in the United States 795,000 people experience a new or recurrent stroke (Lloyd-Jones et al., 2010), and stroke is a leading cause of disability in adulthood. Mortality rates in stroke survivors have declined by 18.4% from 1996 to 2006 (Lloyd-Jones et al., 2010), and both life expectancy after a stroke and the number of stroke survivors has been increasing (Hannerz & Nielsen, 2001). These numbers indicate that living with disability following stroke is becoming an increasingly large public health problem (Mendis, 2013).

People who experience a stroke tend to suffer from a number of disabilities, including impaired physical mobility, balance, gait speed, upper extremity function, cognition, and functional ability (Mayo et al., 1999). The World Health Organization has proposed the International Classification of Functioning, Disability and Health (WHO ICF) framework for understanding disability. This framework emphasizes the importance of activities (tasks and actions by an individual) and participation (involvement in a life situation) for maximizing quality of life. Using this model to characterize disability following stroke requires a focus on functional ability. In order to improve functional ability in stroke survivors, it is important to understand the cognitive predictors of activities and participation. This understanding will provide important information about the design and targets of interventions and about the deficits that stroke survivors experience in their everyday functioning.

Overview

In order to design cognitive interventions that target functional capacity for stroke survivors, an evaluation of predictors of daily functioning is necessary. Functional ability has been defined as the ability to perform both basic (e.g., bathing) and complex (e.g., paying bills) daily living tasks. However, the current literature on predictors of daily functioning has mainly explored this relationship focusing on basic tasks and little is known about the predictors of complex everyday living tasks. Additionally, a limitation of the current literature is the use of self-report measures, which as described in the following sections, can lead to an under or overestimation of daily functioning abilities.

The goal of the study proposed here is to explore cognitive and executive function predictors of everyday functioning using performance-based measures in stroke survivors. To provide context for this study, the present review will focus first on predictors of functional abilities utilizing self/proxy reports. Then, cognitive predictors of both Activities of Daily Living (ADLs) and Instrumental Activities of Daily Living (IADLs) will be reviewed. This review emphasizes inconsistencies in the current literature and possible explanations for these inconsistencies. A review of the limitations of self/proxy report is then presented. Following this, performance-based measures are reviewed and current studies examining predictors of performance-based functioning in stroke survivors are presented. Lastly, the limitations of the current literature are summarized and evaluated.

Background And Significance

Predictors of Functional Abilities (Utilizing Self/Proxy Reports)

Functional ability in stroke survivors, as measured by self- or proxy-report is associated with a number of different factors. In a review of predictors of Activities of Daily Living (ADLs; basic everyday tasks such as eating, bathing, dressing, toileting, and transferring) in the early post-stroke phase, Veerbeek, Kwakkel, Wegen, Ket, and Heymans (2011) found strong evidence for the following factors: age (Reid et al., 2010; Weimar et al., 2006; Weimar, Ziegler, König, & Diener, 2002; Johnston et al., 2007), arm paresis (Reid et al., 2010; Weimar et al., 2002), and initial neurological status (Weimar et al., 2006; Weimar et al., 2002; Johnston et al., 2007). Predictors with moderate supporting evidence included being able to walk without any assistance, pre-stroke independence (Counsell, Dennis, McDowall, & Warlow, 2002), and history of previous strokes (Woldag et al., 2006). Lastly, predictors with insufficient or no evidence included stroke volume (Johnston et al., 2007), pre-stroke mobility (Colantonio, Kasl, Ostfeld, & Berkman, 1996), and education levels (Schiemanck, Kwakkel, Post, Kappelle, & Prevo, 2006).

In contrast to basic ADLs, Instrumental Activities of Daily Living (IADLs) refer to activities that are more complex, such as handling personal finances, taking medications, shopping, using the telephone and meal preparation (Wiener, Hanley, Clark, & Van Nostrand, 1990). Several studies have investigated the role of clinical factors as predictors of complex Instrumental Activities of Daily Living (IADLs). For example, Mercier, Audet, Hébert, Rochette, and Dubois (2001) studied the predictive significance of motor, cognitive and perceptual difficulties on IADLs and found that all of these factors significantly predicted functional autonomy in stroke survivors. Additionally, other predictors of daily activities and social roles have included age, comorbidities, motor coordination, upper extremity ability, affect (Desrosiers, 2006) and the additive effects of multiple predictors: strength of the paretic upper limb, age, gender and report of basic ADLs performance (Cioncoloni et al., 2013).

These findings indicate that many different factors relate to daily functioning in stroke survivors. In addition, a growing literature suggests cognition is an important predictor to consider. These predictors are considered next.

Cognitive Predictors of Functional Ability

Difficulties in functional ability, recovery status, and recovery improvements have been found to be associated with a number of different cognitive domains. Additionally, the cognitive impairments experienced after stroke have been found to persist long after the stroke. Patel, Coshall, Rudd, and Wolfe, (2003) examined the prognosis and natural recovery of cognitive impairments at four different time points (i.e., 3 months, 1 year, 2 years and 3 years post stroke) and found that cognitive impairment remained highly prevalent 3 years after the individual's stroke. Additionally, better cognitive recovery was associated with less disability and fewer difficulties performing IADLs. These findings suggest that cognitive functioning is an important factor to consider in the recovery of stroke survivors.

The association between a stroke survivor's cognitive functioning and ADLs/IADLs has been examined in a number of different studies. Brown, Mapleston, Nairn, and Molloy (2013), assessed the relationship between stroke survivors' cognitive and perceptual abilities and clinicians' report of ADLs and found that several domains of cognition were correlated with reported ADL abilities when assessed individually. These domains included orientation, comprehension, constructional ability (e.g., drawing and building or assembling), and repetition of short phrases and sentences. However, when these domains were assessed simultaneously as predictors of ADLs, only comprehension and repetition were found to be significant. In another study by Mercier and colleagues (2001), cognitive factors, including language, memory, and problem-solving abilities, explained 37% of the variance in a self-report measure of both ADLs and IADLs. Perceptual factors including tasks of visual discrimination, cancellation, spatial relation, and constructional abilities (e.g., drawing and building or assembling), explained a total of 47% of the variance. Similar findings were reported in a study by Larson, Kirschner, Bode, Heinemann, and Goodman (2005) where significant cognitive predictors of self-reported IADLs included language, delayed memory and visuospatial/constructional abilities. However, tasks of attention and immediate memory were not significant predictors of IADLs in stroke survivors, indicating inconsistencies with other studies.

The mixed findings with regard to which cognitive components best predict functional ability could be due to many factors. For example, some studies examined both immediate and delayed memory, whereas other studies did not differentiate between these two. Additionally, some studies use only total scores to represent ADL and IADL abilities. This is problematic because different cognitive abilities may correlate with different tasks of daily function. Only a limited number of studies have assessed the relationship between different cognitive components and specific ADL and IADL tasks. In one such study, Stephens and colleagues (2005) examined the correlation between a number of different cognitive domains and multiple ADL tasks. The authors divided the different ADL tasks into three groups: basic, intermediate and complex ADLs. Basic tasks were related to attentional impairments, intermediate tasks to executive functions, and complex tasks to global cognition. However, memory impairments were not associated with any of the three ADL components. It is difficult to understand why this relationship was not observed because the authors did not include the methodological details of how memory was assessed in their study. As mentioned above, previous studies have found differences between immediate and delayed memory and their association with ADLs/IADLs.

Executive functions have also been found to be important predictors of functional capacity. Executive functions have been defined as "…capacities that enable a person to engage successfully in independent, purposive, self-directed, and self-serving behavior" (Lezak, Howieson, Bigler, & Tranel, 2012, p. 37). In a study by Pohjasvaara and colleagues (2002), executive functions (i.e., cognitive flexibility and switching, visual attention, selective attention and processing speed) were assessed and participants with executive dysfunctions reported significantly more difficulties in performing both ADLs and IADLs, compared to participants without executive dysfunctions. In another study by Ballard and colleagues (2003), impairments in processing speed, working memory and attention were found in stroke survivors, suggesting executive dysfunctions occur in this population. However, no relationship between impairments in executive functions and performance of ADLs/IADLs was assessed. Additionally, in a study by McDowd, Filion, Pohl, Richards, and Stiers (2003), difficulties with both divided and switching attention were found to relate to reported problems on daily functioning in stroke survivors. These studies suggest that executive functions are important in predicting performance in daily functioning.

Other studies have found brief measures of global cognitive status (e.g., Mini Mental Status Examination [MMSE], Abbreviated Mental Test [AMT]) that assess domains such as orientation, memory and attention to be related to reported performance of ADLs in stroke survivors (Saxena, Ng, Koh, Yong, & Fong, 2007). However, not all studies have found this relationship (Paker, Buğdaycı, Tekdöş, Kaya, & Dere, 2010). It is possible that the inconsistency found is a function of the insensitivity of these measures (e.g., MMSE), which may lead to possible underestimation of cognitive deficits in stroke survivors (Pendlebury, Cuthbertson, Welch, Mehta, & Rothwell, 2010; Toglia, Fitzgerald, O'Dell, Mastrogiovanni, & Lin, 2011).

These studies suggest that ADLs and IADLs are influenced by a number of different cognitive domains such as memory, attention, language and executive functions. However, inconsistencies within this literature exist. Table 1 provides a summary of the literature on cognitive predictors of ADLs/IADLs.

Table 1

Summary of Correlational Findings

		Memory	Attention	Executive Functions	Visuospatial	Language	Global Cognition
ADLs	Yes	|	||	|||	||	||	||
	No	|					|
IADLs	Yes	||	||	|||	||	||	|
	No	|	|				

Note: Each tally mark represents one study. Yes = study found significant correlations. No = study did not find evidence for the relationship.

It is difficult to reconcile these inconsistencies because of the array of different methods used to assess both cognitive and daily functioning, with some studies assessing different ADL and IADL tasks, not differentiating between basic and complex ADLs, and differences in the use of self-report or caregiver reports. There is evidence to suggest that these factors make a difference in the pattern of results. For example, Bennett and colleagues (2002), found that decline in IADLs was associated with decreased performance on attentional and memory tasks, whereas decline in basic ADLs was associated with performance on perceptual and spatial tasks, suggesting cognitive correlates differ based on the complexity of daily living tasks and indicating this is an informative approach to take. As noted above, to date only one study (Stephens et al., 2005) has attempted to take this approach.

As noted by these studies, cognitive functioning plays an important role in predicting self/proxy report of performance in everyday functioning and thus warrants attention. However, there are a number of limitations with using self and proxy reports to assess daily functioning.

Limitations of Self/Proxy Reports

Although the above studies are important in understanding functional deficits in stroke survivors, these studies have relied on self-report and proxy reports to assess everyday functioning, which have been found to have questionable validity. For example, a number of studies have assessed ADLs and functional outcomes using the Barthel Index (BI), the Rankin Scale and/or the Modified Rankin Scale (mRs). The BI is a measure completed by the clinician that assesses participants in two different domains, mobility and self-care. The Rankin Scale and the mRs, also completed by the clinician, rates the individual’s global disability on a 5-point scale, ranging from no symptoms at all to severe disability. These measures are cost-effective and quick to administer, but do not capture the range of ability an individual may have. Specifically, the BI only assesses an individual’s abilities in the following areas: feeding, bathing, grooming, dressing, bowels, toilet use, transfer, mobility and stairs. Additionally, clinicians’ ratings can only report on a limited range of behaviors due to lack of direct observation in real-world settings. Further, the BI has been found to suffer from floor and ceiling effects, posing a threat to the ability of the BI to discriminate between stroke survivors with severe or minor functional difficulties. As a result, the BI lacks sufficient sensitivity to examine stroke survivors' ADLs over the longer-term (Quinn, Langhorne, & Stott, 2011).

Other studies have examined daily functioning via self-report or caregiver report. However, a problem with self-report measures is the possibility that the person's cognitive functioning or other factors such as communication problems, may pose a threat to the validity and accuracy of their responses. On the other hand, there are advantages of assessing daily-living functioning via proxy reports. For instance, stroke survivors who suffer from communication difficulties such as aphasia, or motor impairments, may have difficulties performing self-report measures. However, assessing daily-living functioning with proxy reports can also be problematic. In a study by Dassel and Schmitt (2008), educational background and executive function levels of Alzheimer's patients' caregivers significantly predicted discrepancies between caregiver's report of the patient's functioning and direct assessment of patient's ADLs. These results suggest caregivers are not always accurate judges of their care recipient's abilities (Dassel & Schmitt, 2008). In another study by Argüelles, Loewenstein, Eisdorfer, and Argüelles (2001), a significant overestimation of disability was found between caregivers' report and Alzheimer patients' actual functional performance, and this overestimation was related to caregivers' self-reported symptoms of depression. Although self-report measures are cost-effective and provide a voice for the person, they may not represent an accurate evaluation of the person's level of real-world functioning. Due to these potential biases, self and proxy reports of levels of daily functioning have the potential to reflect an overestimation or underestimation of stroke survivors' current functional abilities.

A more accurate method to assess daily functioning in stroke survivors is via performance-based measures, which have been found to be valid assessments of daily functioning in a number of different populations (T. L Patterson & Mausbach, 2010).

Performance-Based Measures of Functional Abilities

Performance-based measures are assessments that require the individual to perform a variety of everyday tasks such as writing checks, cooking meals, preparing a grocery list, or managing medications, under standardized, simulated conditions. Extensive research on performance-based measures has been conducted in people with schizophrenia, bipolar disorder, dementia, and healthy older adults. In a review of performance-based assessments of functional living skills, it was found that most measures reviewed demonstrated good internal validity, test-retest reliability, and concurrent validity (Moore, Palmer, Patterson, & Jeste, 2007). In these studies, predictive validity was assessed by examining the value of performance-based measures for predicting other measures such as the capacity to live independently, institutionalization, post-hospital living situation, pharmacy refill records, or employment status. Concurrent validity was assessed by examining the relationship between performance-based measures and self/proxy report questionnaires of daily functioning, other performance-based measures, and/or cognitive and neuropsychological assessments. The Moore et al. review presents a fair evaluation of both the weaknesses and strengths of performance-based measures as it assessed multiple components of validity and reliability for the individual instruments. Some weaknesses of performance-based measures reported by the authors include the lack of large standardization/normative samples in the majority of these measures, and the difficulty of assessing concurrent validity in some of these measures. Strengths of performance-based measures, as reported by the authors, include the assessment of multiple functional capacity domains, adequate psychometric data for many of the instruments evaluated in the review, and actual observation of performance (Moore et al., 2007).

Although performance-based measures have been found to be more reliable and valid than self or proxy report measures (Mausbach, Moore, Bowie, Cardenas, & Patterson, 2009), only a limited number of studies have examined predictors of daily functioning utilizing performance-based measures in stroke survivors. In a study by Higginson, Johnson-Greene, and Langrall (2010), the relationship between cognitive functioning and the Hopkins Telephone Task (HTT) was assessed. This task asks participants to call a person (the examiner provides them with a name) by locating the name and phone number using a telephone book. Performance on the HTT was found to be significantly correlated with scores on measures of global cognition, visual and auditory attention, immediate memory, executive function, visuoperceptual function, and visual confrontation naming (e.g., ease and accuracy of word retrieval). The strongest correlations were found between the HTT and scores on measures of auditory attention, executive function, and visuoperceptual function, with the latter significantly predicting scores on the HTT. Further, manual motor function was also related to scores on the HTT whereas symptoms of depression were not. This study provides some initial assessment of the relationship between executive functions, cognitive domains and performance-based measures of IADLs.

Other studies have attempted to investigate a variety of everyday functioning tasks in stroke survivors. In a study by Baum and colleagues (2008), the relationship between the

Executive Function Performance Test (EFPT) (i.e., an assessment of IADLs) and executive functions was examined. EFPT total scores were found to be related to complex measures of working memory, verbal fluency, and attention. However, no relationship was found between EFPT total scores and more basic measures of working memory and attention, suggesting that only better performance on higher-order cognitions relates to better performance on the EFPT. Although this information is important in understanding what executive function domains are significant in predicting performance of the EFPT total scores, the authors do not provide information regarding the association between executive functions and each subscale of the EFPT (cooking, paying bills, managing medication and using the telephone). As noted in the review above, differences may exist in the cognitive correlates for different IADLs tasks.

A similar pattern of results was found in a different study utilizing a different performance-based measure of IADLs. Sadek, Stricker, Adair, and Haaland (2011), investigated the relationship between the Functional Impact Assessment (FIA) and the Neuropsychological Assessment Battery (NAB; assesses attention, language, memory, spatial, and executive functions) in stroke survivors. The FIA is a performance-based measure of everyday functioning with subtests assessing finances, communication, shopping, cooking, and medication management. FIA total scores were significantly correlated with all the domains of the NAB (i.e., attention, language, memory, spatial, and executive functions). However, when all the domains were evaluated simultaneously in a regression, only the spatial domain was a significant predictor of FIA total scores, and the other cognitive domains did not predict unique variance above visuospatial abilities. Interestingly, this domain was also found to be the only significant predictor of performance in the Hopkins

Telephone Task. This pattern of results suggests that visuospatial abilities play an important role in the performance of IADLs.

Similar to the EFPT findings, FIA total scores were related to executive functions. Both the EFPT and FIA studies assessed a variety of measures as predictors. However, neither study examined all the relevant factors. For example, in contrast to the EFPT study, Sadek and colleagues (2011) did not consider different executive functions and instead used only a global score. However, the FIA study did examine the relationship between the FIA total scores and measures of memory performance, in contrast to the EFPT study which only focused on executive functions. For a summary of this literature on cognitive correlates of performance-based IADLs refer to Table 2.

Table 2

Summary of Performance-based IADLs Findings

		Memory	Attention	Visuospatial	Language	Global Cognition	Executive Functions
HTT	Yes	|	|	|	|	|	|
EFPT	Yes				|	|	|
FIA	Yes	|	|	|	|		|

Note: HTT = Hopkins Telephone Task; EFPT= Executive Function Performance Test; FIA = Functional Impact Assessment.

These studies add to our knowledge and understanding of how and what cognitive domains relate to performance of IADLs. However, there are a limited number of studies that assess the association between cognitive predictors and performance of IADLs. Additionally, one of these studies only assessed one type of IADL, a telephone task.

Limitations of the Current Literature

Although these studies provide important knowledge about the association between cognitive functioning and daily functioning, this literature has limitations. First, a number of studies focus on basic ADLs and do not assess more complex IADLs. This is problematic because the relationship between cognitive domains and daily functioning has been found to differ for ADLs and IADLs, thus complicating the understanding of the relationship between cognition and functional capacity. For example, Bennett and colleagues (2002), found that self-reported performance on ADLs was related to tasks of spatial abilities and IADLs were related to tasks of attention and memory. Additionally, cognitive variables have been found to correlate with IADLs and not ADLs (McGuire, Ford, & Ajani, 2006). Although understanding predictors of basic ADLs is important in stroke rehabilitation, less is known about predictors of complex IADLs.

A second limitation of the current literature is the use of self-report to assess ADLs and IADLs. As presented above, there are a number of limitations in using self-report to assess the stroke survivor's current level of functioning. Therefore, studies that have used self-report methods may not present an accurate picture of the relationship between cognitive domains and daily functioning. For example, Cahn-Weiner, Boyle, and Malloy (2002) found differences in cognitive predictors based on performance of IADLs or caregiver reports of IADLs in a community dwelling older adult sample. This suggests that the relationship between cognitive factors and IADLs may differ based on the method used to assess daily functioning.

Lastly, a large number of studies assessed a limited number of cognitive domains. For example, as mentioned above, some studies only assessed executive functions and did not assess other factors that have been found to relate to daily functioning (e.g., constructional abilities, memory) and other studies have used summary scores, limiting the range of cognitive domains examined. Additionally, a number of studies utilized measures such as the Mini Mental State Examination (MMSE) to assess cognitive functioning which have been found to underestimate cognitive deficits in stroke survivors (Toglia et al., 2011; Pendlebury et al., 2010) and although these measures provide information about important cognitive domains, they do not assess other important aspects of cognition. Assessing a variety of cognitive domains is important because it can provide information to help deliver a more complete approach to rehabilitation programs for stroke survivors. For this reason, the present study examined the relationship between functional capacity and a number of different cognitive and executive functions.

Purpose of the Present Study and Hypotheses

Few studies in the literature have examined cognitive predictors of performance-based measures of complex Instrumental Activities of Daily Living in stroke survivors. Instead, these relationships have been examined by utilizing self-and proxy report methods of assessing ADLs and IADLs. However, these methods can have limited validity as responses may be biased by possible reporter characteristics such as symptoms of depression and sub-optimal cognitive functioning. These factors can result in over- or under-reporting of functional levels, consequently threatening the validity of these instruments. Investigating cognitive predictors of different daily living tasks in stroke survivors is important, as rehabilitation professionals can use these predictors to tailor and design cognitive interventions to improve everyday functioning in this population. The present study was designed to provide this information, by investigating the relationship between cognitive variables and performance of IADLs in a sample of community-dwelling stroke survivors.

The first aim of this study was to examine the association between cognitive domains and two different standardized performance-based measures of IADLs (the UPSA and the EFPT; see below for task details). Specifically, it was hypothesized that executive functions (i.e., inhibition and flexibility, concept formation and problem solving, abstract thinking, deductive reasoning, and verbal abstraction), immediate and delayed memory, visuospatial/constructional abilities, language, and attention would be associated with performance of IADLs.

The second aim of the current study was to assess for potential predictors and their unique contribution to total scores of both performance-based measures of IADLs. By investigating predictors of IADLs, the total variance explained by the different variables and their significance can be assessed. Specifically, it was hypothesized that executive functions and visuospatial/constructional abilities would be significant predictors of IADL performance.

Aim One: Investigating the Relationship between Performance of IADLs and Cognitive Functioning.

Although the relationship between cognitive functions and IADLs has been researched, the findings have been inconsistent. These inconsistencies could be due to a number of limitations such as using global scores vs. individualized scores for cognitive domains, focusing on a limited number of cognitive factors, and utilizing different methods to assess both ADLs and IADLs. Additionally, this literature has focused mainly on using self/proxy reports of ADLs/IADLs. To address these limitations, the present study will investigate the relationship between executive functions (i.e., inhibition and flexibility, concept-formation and problem-solving, abstract thinking, deductive thinking, and verbal abstraction) as measured by the Delis-Kaplan Executive Function System (D-KEFS); immediate and delayed memory, visuospatial/constructional, language, and attention, as measured by the Repeatable Battery for the Assessment of Neuropsychological Status

(RBANS); and performance of IADLs as measured by both the Executive Function Performance Test (EFPT) and the UCSD Performance-Based Skills Assessment (UPSA). Correlations were investigated using both EFPT and UPSA total scores.

In addition to the analysis that will assess this primary aim, additional exploratory analyses will examine the relationships between individual functional abilities and individual cognitive and executive functions. These analyses will only be exploratory as our study is not powered to conduct multiple tests and make inferences from these.

Two performance-based measures of IADLs were chosen for the current study for the purpose of contrasting cognitive correlates between the two measures. Having two IADL assessments will not only provide a more comprehensive understanding of the predictors and correlates of daily functioning, but will also provide insight to whether correlates are significant because similar constructs are being assessed (i.e., IADLs) or because of task-specific (i.e., UPSA vs. EFPT) methods used to assess IADLs.

The UPSA was selected for several reasons. The UPSA has been validated and tested in different populations such as older adults diagnosed with schizophrenia (Patterson, Goldman, McKibbin, Hughs, & Jeste, 2001), people with bipolar disorder (Depp et al., 2009), individuals with mild cognitive impairment (Goldberg et al., 2010) and Alzheimer's disease (Goldberg et al., 2010). A study conducted by Harvey, Velligan, and Bellack (2007), assessed the reliability of different performance-based measures and found very high test-retest and inter-rater reliability data for the UPSA in people diagnosed with schizophrenia. The UPSA has also been found to have good predictive validity in people diagnosed with schizophrenia. In a study by Mausbach and colleagues (2008), an UPSA total score of 75 or above significantly predicted independent living in a large sample of people diagnosed with schizophrenia or schizoaffective disorder. Additionally, the UPSA was also found to be related to degree of independence in the community defined by living situation (Twamley et al., 2002) and greater community responsibilities such as doing volunteer work, household chores, or taking care of children (Cardenas et al., 2008). As the UPSA has been well validated in a number of different populations and because we wanted to extend the use of the UPSA to a stroke population, it was selected as one of the performance-based measures of IADLs.

The EFPT was selected as one of the performance-based measures for several reasons. The EFPT has been validated and tested in different populations such as stroke survivors (Baum et al., 2008), people with schizophrenia (Katz, Tadmor, Felzen, & Hartman-Maeir, 2007), people with multiple sclerosis (Goverover et al., 2005), and homeless people with substance use disorders (Raphael-Greenfield, 2012). The EFPT has been found to have good construct and criterion validity in stroke survivors (Baum et al., 2008) and has been found to relate to executive function deficits at the acute stage of stroke (Wolf, Stift, Connor, & Baum, 2010). Additionally, performance on the EFPT has been found to relate to employment status, engagement in case management services, and engagement in hobbies, in a sample of homeless individuals with substance use disorders (Raphael-Greenfield, 2012). Because the EFPT has been validated in different populations including stroke survivors, it was selected as one of the performance-based measures of IADLs.

> **H1:** Significant correlations were predicted between executive functions (i.e., inhibition and flexibility, concept-formation and problem-solving, abstract thinking, deductive thinking, and verbal abstraction), immediate and delayed memory, visuospatial/constructional abilities, language, attention, and UPSA/EFPT total scores. Correlations between the UPSA and cognitive domains were expected to be positive as higher scores in the UPSA represent better functional performance. Lastly, negative correlations were expected between the EFPT and cognitive domains as lower scores on the EFPT represent better functional performance.

Additionally, correlations between individual UPSA/EFPT tasks (e.g., communication, planning and organizing) and cognitive and executive functions were examined in an exploratory analysis. Because this analysis is exploratory, no predictions were formulated.

Aim Two: Investigating the Cognitive Predictors of Performance of IADLs.

After investigating the relationship between cognitive functions and performance of IADLs, the next step was to determine how well executive and cognitive functions predict performance of IADLs, using a hierarchical regression. This analysis also allowed for the assessment of the total variance explained by each block and provided information as to what variables are better in predicting IADLs. The model was designed based on the significant correlations observed in the analysis from aim one. Additionally, as suggested by the literature, it was hypothesized that executive functions and visuospatial/constructional abilities would be stronger predictors of performance of IADLs than attention, language, immediate and delayed memory. Two hierarchical multiple regressions were conducted: the first one including UPSA total scores as the outcome and the second including EFPT total scores as the outcome.

H2: Executive functions and visuospatial/constructional abilities will be significant predictors of both UPSA and EFPT total scores, over and above age, symptoms of depression, side of stroke, and stroke severity. Specifically, executive functions will explain an additional amount of variance over and above age, symptoms of depression, side of stroke, stroke severity, and cognitive variables (e.g., immediate and delayed memory).

CHAPTER 2

METHODOLOGY

Recruitment and Data Collection

Fifty-two stroke survivors were recruited to participate in this study. Participants were recruited from the American Stroke Foundation, a local organization providing post-rehabilitation services to adults living with a stroke, and the Landon Center on Aging at the University of Kansas Medical Center, where a database of stroke survivors willing to participate in research studies is maintained. Participants who were recruited from the American Stroke Foundation were recruited via the program director. The program director provided the research assistants with a list of stroke survivors who met eligibility criteria. Research assistants would then approach the stroke survivor, described the study, and inquire about interest in participation. Thirty participants were approached at the American Stroke Foundation and out of these, 3 did not meet eligibility criteria and 1 declined participation. Participants who were recruited from the University of Kansas Medical Center – Landon Center were recruited via a research associate who is in charge of coordinating a database of stroke survivors who are willing to participate in research studies. The research associate provided the research assistants with names and contact information of stroke survivors who met eligibility criteria. Fifty-seven possible participants were contacted and 26 agreed to participate in the study. Reasons for declining participation included traveling difficulties, scheduling conflicts, and not interested in the study.

Stroke survivors (both male and female) were enrolled if they were at least 6 months post-stroke, living in the community, and willing and able to sign an informed consent. Exclusion criteria include severe difficulties with motor function that would prevent task performance, and an inability to communicate with the experimenter, as measured by the NIH Stroke Scale. The assessment for stroke survivors took place at the American Stroke Foundation Mission Kansas Center, The Landon Center on Aging, or at the SilverRoo lab at UMKC. Stroke survivors participated in two sessions, one week apart, and the assessments were counterbalanced to decrease practice effects. Participants were randomized to receive either the UCSD Performance-based Skills Assessment (UPSA)/Delis-Kaplan Executive Function System (D-KEFS) during session one or the Executive Function Performance Test (EFPT)/The Repeatable Battery for the Assessment of Neuropsychological Status (RBANS). Stroke survivors were offered a 40-dollar honorarium for their participation.

Measures

Control Variables

Demographic Information

Demographic information was collected using a self-report demographic questionnaire. Information collected included age, education level, gender, income level, marital status, living situation, ethnicity, and employment status. Participants were also asked to report time since stroke, number of strokes, side of stroke, length of time in the hospital, length of time in a rehabilitation program after the stroke, medical and psychiatric history.

Beck Depression Inventory (BDI-II)

Symptoms of depression were measured using the Beck Depression Inventory-II (BDI-II). The BDI-II is comprised of 21 items, rated on a 4-point scale; total score could range from 0 to 63. Scores of 0 to 13 indicate no to minimal depressive symptoms, 14 to 19 indicate mild depressive symptoms, 20-28 indicate moderate depressive symptoms, and 29-63 indicate severe depressive symptoms. The BDI-II takes approximately 5-10 minutes to administer. The BDI-II has been found to have good validity and reliability in stroke survivors (Aben, Verhey, Lousberg, Lodder, & Honig, 2002).

NIH Stroke Scale (NIHSS)

Chronic stroke severity was measured using our own modification of the NIH Stroke Scale (NIHSS) (Brott et al., 1989). The NIHSS is a brief measure that assesses a stroke patient's neurological status in three different domains. These domains include: (a) Movement; (b) Sensation; and (c) Perception. The NIHSS has been found to have good validity and reliability (D'Olhaberriague, Litvan, Mitsias, & Mansbach, 1996), and is typically administered shortly after stroke to asses stroke severity. However, in the absence of severity measures for chronic stroke, we applied the measure in the present context. For practical reasons, items that required the participants to lay down on the floor were eliminated. For the remaining items, performance was scored according to the guidelines for the measure. Typically the total score is compared to a series of cut-off scores in order to assess severity as mild, moderate, or severe. However, because we had eliminated some items, scores for this measure were converted to percentage scores with higher scores representing more severe symptoms of stroke.

Outcome Variables

UCSD Performance-Based Skills Assessment (UPSA)

The UPSA (Patterson et al., 2001) involves role-play tasks similar in complexity to situations that an older community-dwelling person is likely to encounter. It assesses the person's ability to perform everyday living tasks in the following domains: (a) Finance; (b) Communications; (c) Organization/Planning; (d) Transportation; and (e) Household Management. The finance domain provides participants with simulated bills and real coins.

The first task asks participants to count out specific amounts (e.g., $12.49, $6.73, $1.02) and to make change from ten dollars. For the second part of this domain participants are given a utility bill and are asked to provide information included in the bill (e.g., check is written to utility company, how much to pay, when to pay). This subtest takes about five minutes to complete.

In the communication domain participants are provided with a disconnected telephone and are asked to dial the number they would call if they had an emergency (correct response is 9-1-1). An additional task is to role-play a call to "information", asking for a number and dialing the number from memory. The final communication task asks participants to read a letter they received from their doctor about an appointment, and then to call the hospital and leave a voice mail requesting to reschedule their appointment. Participants are scored on the quality of their message. In addition, participants are also asked to recall information from the letter, such as how they were to prepare for their medical appointment (e.g., fast for a blood draw) and what two items they were to take to their appointment (e.g., insurance card and list of medications). This subtest takes approximately five minutes to complete.

The organization/planning domain asks participants to read a "newspaper article" describing the opening of a new Water Theme Park. They are then asked to recall important information from the article, and to generate a list of seven objects they should take to the waterpark (e.g., sunscreen, swimsuit, sandals, towel, sunglasses). This subtest takes approximately five minutes to complete.

In the transportation domain participants are provided with three bus schedules and are asked about the cost of the bus ticket, the telephone number they could dial to obtain more information on bus schedules, and to point to the different trolley stations. They are also asked to point to the correct bus schedule to get to a particular location and where they would get off the bus to transfer to a different bus. The last task asks participants to use the information from the bus schedule to answer questions about when to catch a bus in order to arrive early to an appointment. These tasks take approximately five minutes to complete.

The household management domain provides participants with a recipe for rice pudding along with an incomplete shopping list. Participants are then presented with 29 items that can be found in their pantry (e.g., potato chips, rice, crackers, jelly, toothpaste) and are asked to write a shopping list based on the missing and necessary items they need to buy to cook rice pudding. This task takes about five minutes to complete.

Administration of the UPSA requires approximately 30 minutes to complete. Participants receive scores for each of the 5 subscales (range = 0-20), which are summed to create a summary score ranging from 0 to 100. For example, there are 4 items for the household management task. If a participant misses one item (i.e., does not include a cooking item in their shopping list) their total raw score is 3. The raw score is divided by the total number of items (i.e., ¾ = .75) and then multiplied by 20 (i.e., .75*20 = 15). Higher scores represent better performance on the UPSA.

Executive Function Performance Test (EFPT)

The Executive Function Performance Test (EFPT) (Baum et al., 2008) assesses executive function by requiring role-playing of everyday living tasks including (a) Simple Cooking; (b) Telephone use; (c) Medication Management; and (d) Bill Payment. All of the materials required to accomplish the tasks in the EFPT are found in a clear box provided by the examiner, and participants are required to search for the necessary materials to accomplish each specific task.

The cooking subtest provides participants with an oatmeal recipe and requires participants to prepare oatmeal by following the instructions. The telephone use subtest requires participants to look up the number for a grocery store in a telephone book, and call the grocery store to ask if they deliver groceries. For the medication management subtest participants are asked to find their prescribed medication among two pill bottles (one bottle without their name, one has their name on the label), to follow the instructions on the pill bottle and to take their medicine. They are also asked when they need to take their medication, what they are supposed to take with it, and what do they need to be careful about with this medication. And finally, the bill payment task requires participants to find their bills, check the amount of money in their check register, pay their bills and balance their checkbook. The EFPT takes approximately 45 minutes to complete.

Prior to performing each task, participants are asked how familiar they are and how much assistance they will need to perform each task. In contrast to the UPSA, participants are scored depending on the level of cuing needed to complete each task. Additionally, within each task (e.g., Simple Cooking, Telephone Use) participants are scored on how much assistance they needed to perform these 5 executive functions: initiation (e.g., moves to table), organization (e.g., gathers tools), sequencing (e.g., executes the steps in the proper order), judgment/safety (e.g., avoids dangerous situations), and completion (e.g., terminates the task). The scores represent the levels of cuing needed for each of the executive functions: independent (score of 0), verbal guidance (score of 1), gestural guidance (score of 2), verbal direct instruction (score of 3), physical assistance (score of 4), and do for participant (score of 5). This scoring method provides the examiner with an understanding of the assistance that the participant needs to complete the task and it also prevents the participant from failing at completing the subtest. Participants receive scores for each task (range = 0-25), and a total score (range= 0 to 100). For example, if a participant was completing the Simple Cooking task and they did not need any assistance for initiation (score of 0), needed verbal guidance organizing the cooking materials (e.g., needed a prompt to ask if any other items were needed to cook the oatmeal; score of 1), needed verbal direct instruction in following the sequence of cooking steps (e.g., received instructions to turn the heat down; score of 3), needed verbal direct instruction in judgement and safety (e.g., received instructions to turn off the burner; score of 3), and did not require any assistance in completing the task, then their total Simple Cooking score would be 7 (range of 0-25). This score is the sum of the 5 different executive functions assessed within each task (i.e., initiation, organization, sequencing, judgment/safety, and completion). Higher scores on the EFPT indicate the need for more assistance performing the tasks.

Repeatable Battery for the Assessment of Neuropsychological Status (RBANS)

Cognitive functioning was measured using the Repeatable Battery for the Assessment of Neuropsychological Status (RBANS). The RBANS assesses multiple areas of cognitive functioning including Immediate Memory, Visuospatial/Constructional, Language, Delayed Memory and Attention, using tasks as described below. Raw scores were converted into index scores corrected for age.

<u>Immediate Memory Index.</u> This index consists of two subtests: 1) List Learning which consists of immediate recall of a 10-item list of words over four learning trials; and 2)

Story Memory which consists of a 12-item story, read aloud for immediate recall over two trials.

Visuospatial/Constructional Index. This index consists of two subtests: 1) Figure Copy which consists of copying a geometric figure comprised of 10 parts; and 2) Line Orientation which consists of 10 items in which the participant was presented with two target lines arranged at various angles and asked to identify the matching lines from an array of 13 lines spanning 180 degrees.

Language Index. This index consists of the following two subtests: 1) Picture Naming which consists of 10 drawings which the participant was asked to name; and 2) Semantic Fluency which consists of asking the participants to name as many words as they can from a provided semantic category within 60 seconds.

Attention Index. This index consists of two subtests: 1) Digit Span consisting of a digits forward task which consisted in reading a string of digits and asked the participant to repeat the digits in the same order with strings increasing from 2 to 9 digits; and 2) Coding which consists of a task where participants are presented with a page filled with rows of boxes with a number from 1 to 9 above each box and a blank space below the number. At the top of the page there is a key that contains both numbers and symbols, with each number having a unique symbol. Using the key, the participant is asked to fill in the number that corresponds to each symbol. The participant is given 90 seconds to complete as many boxes as possible.

Delayed Memory Index. This index consists of 4 subtests including 1) List Recall (free recall from the List Learning Task); 2) List Recognition (yes/no recognition testing memory of the words from the List Learning Task); 3) Story Recall (free recall of the story from the story memory test); and 4) Figure Recall (free recall of the figure from the Figure Copy subtest).

The sequence of subtests in the RBANS is the following: List Learning, Story Memory, Figure Copy, Line Orientation, Picture Naming, Semantic Fluency, Digit Span, Coding, List Recall, List Recognition, Story Recall, and Figure Recall. The RBANS has been found to have good construct and predictive validity of cognitive disability and self-reported performance of IADLs in a stroke sample (Larson et al., 2005) and found to be sensitive to cognitive deficits in acute stroke (Wilde, 2006).

Delis-Kaplan Executive Function System (D-KEFS)

Executive function was measured using tests from the Delis-Kaplan Executive Function System (D-KEFS), which has been normed for adults up to age 89. The D-KEFS measures selected for this study included:

Color Word Interference Test. This subtest includes four conditions. The first condition involves naming of color patches, and the second condition involves the reading of words printed in black ink. The third condition consists of an interference task where the participants were asked to name the ink colors the words were printed in and not to read the word. The last and fourth condition consists of switching back and forth between naming the ink colors and reading the words. This subtest assesses inhibition and cognitive flexibility. The seconds to complete condition 4 (inhibition/switching) were converted to scaled scores corrected for age and these were used in the present study.

Sorting Test. This subtest consists of sorting cards that display different stimuli. Participants were asked to sort the different cards into two groups utilizing different sorting rules and concepts. This subtest assesses concept-formation and problem-solving skills.

Confirmed correct sorts raw scores, a measure of correct sorts, were converted to scaled scores corrected for age.

Twenty Questions Test. For this subtest, participants were presented with a stimulus page depicting pictures of 30 objects. The participant was asked to ask the fewest number of yes/no questions to identify the target item. This subtest assesses abstract thinking. Total weighted achievement raw scores, a measure of the identification of the target item and number of questions asked, were converted to scaled scores corrected for age.

Word Context Test. For this subtest, participants were asked to guess the meaning of made-up words based on clues given in sentences. For each made-up word, participants were shown 5 sentences that served as clues to help the participant decode the meaning of the word. This subtest assesses deductive reasoning, integration of different information, hypothesis testing and flexibility of thinking. Total consecutive correct raw scores, a measure of the sum of correct response that the participant provides for all of the clue sentences, were converted to scaled scores corrected for age.

Proverb Test. For this subtest, participants were presented with 8 different proverbs and were asked to interpret the meaning of each proverb. This subtest consists of two different conditions: spontaneous explanation and multiple choice. Verbal abstraction is assessed by this subtest. Total achievement raw scores, a measure of the accuracy of the description of the proverb, were converted to scaled scores corrected for age.

Analysis

The IBM Statistical Package for Social Sciences (IBM SPSS; Version 21.0) was used for the analysis of the data. To test hypothesis one, Pearson correlations were conducted to examine the relationship between the UPSA total scores, EFPT total scores, and the following measures: D-KEFS: Color Word Interference, Sorting Test, Twenty Questions, Word Context, and Proverb Test; RBANS: Immediate Memory, Visuospatial/Constructional, Language, Attention and Delayed Memory; and BDI-II total scores.

> **H1:** Significant correlations will be found between executive functions (i.e., inhibition and flexibility, concept-formation and problem-solving, abstract thinking, deductive thinking, and verbal abstraction), delayed memory, immediate memory, visuospatial/constructional, language, attention, and UPSA/EFPT total scores. Correlations between the UPSA and cognitive domains were expected to be positive as higher scores in the UPSA represent better functional performance. Lastly, negative correlations were expected between the EFPT and cognitive domains as lower scores on the EFPT represent better functional performance.

For this hypothesis to be supported, positive significant correlations were expected between executive functions, delayed memory, immediate memory, attention, visuospatial/constructional, language and total UPSA scores. Additionally, these variables were also expected to have a significant correlation with total EFPT scores, however these correlations were expected to be negative (higher scores in the EFPT indicate poorer performance in the tasks). In addition to this analysis, correlations between the UPSA tasks (i.e., Finance, Communication, Organization/Planning, Transportation, and Household Management), EFPT tasks (i.e., Simple Cooking, Telephone Use, Medication Management, and Bill Payment) and D-KEFS tests and RBANS Indices were calculated.

Regarding hypothesis two, the measures that correlated significantly from aim one were included in a hierarchical regression model to assess total variance explained and significance of single predictors. Data screening was conducted to assess for violation of multiple linear regression assumptions. These assumptions included linearity, independent errors, homoscedasticity, normal distribution of errors, and multicollinearity. Corrections were made if assumptions were violated. Two multiple hierarchical regressions were conducted, the first predicting UPSA total scores and the second predicting EFPT total scores.

> **H2:** Executive functions and visuospatial/constructional abilities will be significant predictors of both UPSA and EFPT total scores, over and above age, symptoms of depression, side of stroke, and stroke severity. Additionally, executive functions will explain a significant amount of variance over and above demographic and cognitive variables.

The cognitive factors and executive functions that significantly related to UPSA and EFPT total scores in aim one, were included in a hierarchical multiple regression. According to the literature described above, executive functions and visuospatial/constructional skills have been found to be significant predictors of daily functioning. Therefore, for hypothesis two to be supported, these factors were expected to be significant predictors of both UPSA and EFPT total scores, over and above age, symptoms of depression, side of stroke, and stroke severity. Additionally, executive functions were expected to explain a significant amount of variance on both UPSA and EFPT total scores, over and above demographic characteristics and other cognitive variables (e.g., immediate and delayed memory).

CHAPTER 3

RESULTS

Participant Characteristics

Participant demographics can be found in Table 3. Participants were 52 stroke survivors (*M* age= 62.10, *SD* = 9.05). More than half of the participants were male (59.6%) and identified as White (78.8%). The average years of education was 14.72 (*SD* = 2.76). Seventy-five percent of participants had experienced only one stroke and 44.2% had experienced an ischemic stroke. Sixty-two percent of stroke survivors reported experiencing the stroke on their right side of the brain. The majority of the stroke survivors were right handed (90.4%). The average number of years since stroke was 5.89 (*SD* = 5.30) and the average number of days in the hospital after their stroke was 24.32 (*SD* = 26.16). Thirty-nine percent of stroke survivors reported currently being part of a rehabilitation program such as the American Stroke Foundation or an exercise rehabilitation program.

Aim One

Hypothesis 1: Significant correlations would be found between executive functions (i.e., inhibition and flexibility, concept-formation and problem-solving, abstract thinking, deductive thinking, and verbal abstraction), immediate and delayed memory, visuospatial/constructional abilities, language, attention, and UPSA/EFPT total scores.

See Table 4 for the means and standard deviations of the UPSA, EFPT, RBANS indices, and D-KEFS tests used in these analysis. See Table 5 for the means and standard deviations of the UPSA and EFPT subscales. In addition Figure 1 shows the distribution of scores in the UPSA and EFPT (for Figure 1, scores on the EFPT were reversed to be equivalent to scores on the UPSA). The data were screened for normality. The D-KEFS Twenty Questions total weighted achievement score was negatively skewed as indicated by the critical ratio greater than |3.00| (i.e., 3.64). Therefore Spearman's correlations were conducted between Twenty Questions and UPSA and EFPT total scores. No transformations were performed on the data. Two participants were identified as outliers on the EFPT total scores and RBANS Delayed Memory Index. These two outliers' data were removed after statistical analysis of z-scores (Field, 2013, p. 179-180). No other assumptions were violated. However, due to the multiple correlations performed and to reduce the chances of committing a family wise error, Holm's Sequential Bonferroni procedure corrections were performed and correlations were interpreted as significant at corrected criterion values. To conduct a Holm's Sequential Bonferroni Procedure the multiple p-values obtained from the correlations' significance tests were ordered from the smallest to the largest. The test with the smallest p-value was tested first with a Bonferroni correction. The second smallest p-value was then tested with a Bonferroni correction involving one less test and so on for the remaining tests. This procedure was chosen because it is a less conservative procedure than the Bonferroni correction while still decreasing the chances of a committing a familywise error (Holm, 1979; Simes, 1986; Aickin & Gensler, 1996).

To test hypothesis 1 Pearson correlations were conducted to examine the relationship between UPSA and EFPT total scores, D-KEFS executive functions (i.e., Color Word Interference Test, Sorting Test, Word Context Test, and Proverb Test), and RBANS Indices (i.e., Delayed Memory, Immediate Memory, Visuospatial/Constructional, Language, and Attention). Additionally, Spearman's correlations were conducted between D-KEFS Twenty Questions Test and UPSA/EFPT total scores. Positive correlations were expected between UPSA total scores and cognitive and executive function variables, as higher scores in the UPSA represent better functional performance. Negative correlations were expected between

EFPT total scores and cognitive and executive function variables, as lower scores in the EFPT represent better functional performance.

As expected, positive significant correlations were found between UPSA total scores and RBANS Immediate Memory Index, $r(48) = .53$, $p' = .001$, Visuospatial/Constructional Index, $r(48) = .43$, $p' = .018$, Language Index, $r(48) = .70$, $p' < .001$, Delayed Memory Index, $r(48) = .57$, $p' < .001$, D-KEFS Sorting Test, $r(48) = .65$, $p' < .001$, Word Context Test, $r(47) = .57$, $p' < .001$, and Proverb Test, $r(48) = .51$, $p' = .002$. No significant correlations were found between UPSA total scores and RBANS Attention Index, D-KEFS Color Word Interference Test, and 20 Questions Test.

Negative significant correlations were found between EFPT total scores and RBANS Visuospatial/Constructional Index, $r(47) = -.47$, $p' = .008$, Language Index, $r(47) = -.45$, $p' = .013$, Delayed Memory, $r(47) = -.42$, $p' = .026$, D-KEFS Sorting Test, $r(47) = -.61$, $p' < .001$, and Word Context Test, $r(47) = -.41$, $p' = .032$. No significant correlations were found between EFPT total scores and RBANS Immediate Memory Index, Attention Index, D-KEFS Color Word Interference Test, 20 Questions Test, and Proverb Test. Further analysis examined r-to-z transformations to determine whether correlations between the UPSA and the RBANS indices and D-KEFS tests were significantly different from correlations between the EFPT and RBANS indices and D-KEFS tests. No significant differences were found between the UPSA and EFPT correlations. Corrected correlations are summarized in Table 6 and uncorrected correlations are summarized in Table 7. Additionally, scatterplots are presented in Appendix B.

Lastly, the correlations between the UPSA individual tasks (i.e., Finance, Communication, Organization/Planning, Transportation, and Household Management), EFPT individual tasks (i.e., Simple Cooking, Telephone Use, Medication Management, and Bill Payment), RBANS Indices, and D-KEFS tests were examined as an exploratory analysis. The results of this exploratory analysis are summarized in Table 8.

Aim Two

Hypothesis 2: Executive functions and visuospatial/constructional abilities will be significant predictors of both UPSA and EFPT total scores, over and above age, symptoms of depression, side of stroke, and stroke severity. Specifically, executive functions will explain an additional amount of variance over and above age, symptoms of depression, side of stroke, stroke severity, and cognitive variables (e.g., immediate and delayed memory).

The first model tested whether age, symptoms of depression, side of stroke, stroke severity, immediate and delayed memory, visuospatial/constructional skills, language, concept formation/problem solving (Sorting Test), flexibility of thinking (Word Context Test), and verbal abstraction (Proverb Test) would significantly predict UPSA total scores. The alpha level for the test of this model was set at .05. To achieve a power of .80 and a large effect size (f^2 = .35), a sample size of 45 is required to detect a significant model. The second model tested whether age, stroke severity, visuospatial/constructional skills, language, delayed memory, concept formation/problem solving (Sorting Test), and flexibility of thinking (Word Context Test), would significantly predict EFPT total scores. The alpha level for the test of this model was set at .05. To achieve a power of .80 and a large effect size (f^2 = .35), a sample size of 41 is required to detect a significant model. Power analysis was conducted by utilizing G*Power 3.1: Statistical Power Analyses (Faul, Erdfelder, Buchner, & Lang, 2009) to determine the number of participants needed to conduct two hierarchical multiple regressions.

Preliminary analysis suggested no violations of linearity and normality of the residuals. Investigation of casewise diagnostics suggested no extreme cases influenced the models. The assumptions of no multicollinearity was upheld by examining the VIF and tolerance statistics. The assumption of independent errors was met as examined via the Durbin Watson statistic.

Two hierarchical multiple regressions were conducted to test the hypothesis that cognitive and executive functions would predict both UPSA and EFPT total scores, over and above age, symptoms of depression, side of stroke, and stroke severity. Two models were conducted, one predicting UPSA total scores and the second model predicting EFPT total scores.

Predicting UPSA Total Scores

For the first model, age, stroke severity, side of stroke, and symptoms of depression were entered in step one. Immediate Memory, Visuospatial/Constructional, Language, and Delayed Memory Indices were entered in step two. Lastly, concept formation/problem solving (Sorting Test), flexibility of thinking (Word Context Test), and verbal abstraction (Proverb Test) were entered in step three. The variables entered in this model were chosen because they were significantly related to UPSA total scores. In regards to the order of entry of the variables, age, stroke severity, side of stroke, and symptoms of depression were entered as control variables with the aim of understanding how much variance cognitive and executive functions explain in functional capacity over and above these control variables. Additionally, RBANS indices were entered before D-KEFS tests (i.e., executive functions) because executive functions have been found to be important predictors of daily functioning. Lezak and colleagues (2012, p. 37) stated "[As] long as the executive functions are intact, a person can sustain considerable cognitive loss and still continue to be independent, constructively self-serving, and productive."

In step 1, none of the control variables were significant predictors of UPSA total scores. In step 2, visuospatial/constructional skills, β=.22, *t*(48) = 2.03, *p* =.049, and language, β=.52, *t*(48) = 4.03, *p* <.001, were significant predictors of UPSA total scores. However, age, stroke severity, side of stroke, symptoms of depression, immediate memory, and delayed memory were not significant predictors. Significant R square change was found in step 2, Adjusted R^2 = .59, ΔR^2=.56, *F*(4,38) = 15.75, *p* <.001, suggesting the variables in step 2 explained unique variance over and above age, stroke severity, side of stroke, and symptoms of depression. In step 3, only language, β=.40, *t*(48) = 2.87, *p* =.007, was a significant predictor of UPSA total scores. Age, stroke severity, side of stroke, symptoms of depression, immediate memory, delayed memory, visuospatial/constructional, concept formation/problem solving (Sorting Test), flexibility of thinking (Word Context Test), and verbal abstraction (Proverb Test), were not significant predictors of UPSA total scores. No significant R square change was found in step 3. The overall regression including age, stroke severity, side of stroke, symptoms of depression, immediate memory, delayed memory, visuospatial/constructional skills, language, concept formation/problem solving (Sorting Test), flexibility of thinking (Word Context Test), and verbal abstraction (Proverb Test), was statistically significant, Adjusted R^2= .62, *F*(11,35) = 7.76, *p* < .001. Results of this regression are presented in Table 9.

Predicting EFPT Total Scores

For the second model, age, stroke severity, side of stroke, and symptoms of depression were entered in step one, visuospatial/constructional skills, language, and delayed memory were entered in step two. Lastly, concept formation/problem solving (Sorting Test), and flexibility of thinking (Word Context Test), were entered in step 3. The variables entered in this model were chosen because they were significantly related to EFPT total scores. The same rationale for the order of entry used in the first model was applied to this second model.

In step 1, stroke severity was a significant predictor of EFPT total scores, β=.38, $t(48) = 2.48$, $p = .017$, however age, side of stroke, and symptoms of depression were not significant. In step 2, visuospatial/constructional skills, β= -.41, $t(47) = -3.00$, $p = .005$, was a significant predictor of EFPT total scores. However, stroke severity was no longer significant. Age, side of stroke, symptoms of depression, delayed memory, and language were also not significant predictors. A significant R square change in step 2 indicated that the variables in step 2 explained unique variance in stroke survivors EFPT performance, Adjusted $R^2 = .35$, $\Delta R^2 = .30$, $F(3,38) = 6.95$, $p = .001$, over and above age, stroke severity, side of stroke, and symptoms of depression. In step 3, age, stroke severity, side of stroke, symptoms of depression, visuospatial/constructional skills, language, delayed memory, concept formation/problem solving (Sorting Test), and flexibility of thinking (Word Context Test) were not significant predictors of EFPT total scores. No significant R square change was found in step 3. The overall regression including age, stroke severity, side of stroke, symptoms of depression, visuospatial/constructional skills, language, delayed memory, concept formation/problem solving (Sorting Test), and flexibility of thinking (Word Context Test) was statistically significant, Adjusted $R^2 = .38$, $F(9,36) = 4.08$, $p = .001$. Results of this regression are presented in Table 10.

CHAPTER 4

DISCUSSION

The purpose of the present study was to investigate the relationship between cognitive and executive functions and performance-based measures of daily functioning. In order to improve functional ability in stroke survivors, it is important to understand the cognitive predictors of activities and participation. This understanding will provide important information about the design and targets of interventions and about the deficits that stroke survivors experience in their everyday functioning. Previous research has investigated these relationships but the vast majority of research has been conducted utilizing self-report of ADLs and IADLs and only a small number of studies have utilized performance-based measures. Therefore, this study investigated these relationships utilizing two different performance-based measures of daily functioning. Lastly, cognitive and executive functions that significantly correlated with these measures were assessed for their unique contribution to performance of IADLs.

Aim One: Summary of Findings

For hypothesis one, the correlations among D-KEFS executive functions (i.e., inhabitation and flexibility, concept formation and problem-solving, abstract thinking, deductive thinking, and verbal abstraction), RBANS Indices (i.e., immediate and delayed memory, visuospatial/constructional abilities, language, and attention) and UPSA and EFPT total scores, were investigated. The results yielded significant correlations indicating that better performance on the UPSA/EFPT was associated with better cognitive and executive function performance. Significant correlations were found between UPSA total scores and RBANS Immediate Memory, Visuospatial/Constructional, Language, and Delayed Memory

Indices. Additionally, significant correlations were found between D-KEFS tasks of concept formation and problem solving (Sorting Test), flexibility of thinking and deductive reasoning (Word Context Test), and verbal abstraction (Proverb Test). However, no relationship was found between UPSA total scores and RBANS Attention Index, D-KEFS tasks of inhibition (Color Word Interference Test), and abstract thinking (Twenty Questions Test).

Regarding the EFPT, significant correlations were found between EFPT total scores and RBANS Visuospatial/Constructional, Language, and Delayed Memory Indices. Additionally, significant correlations were found between EFPT total scores and D-KEFS task of concept formation and problem solving (Sorting Test) and a task of flexibility of thinking and deductive thinking (Word Context Test). However, no relationship was found between EFPT total scores and RBANS Immediate Memory Index, Attention Index, D-KEFS task of inhibition (Color Word Interference Test), abstract thinking (Twenty Questions Test), and verbal abstraction (Proverb Test). Further analysis examined the r-to-z transformations to determine whether correlations between the UPSA and cognitive and executive functions were significantly different from correlations between the EFPT and cognitive and executive functions. No significant differences were found between the UPSA and EFPT correlations meaning that the cognitive domains correlated are similar for both performance tasks.

Aim One: Interpretation of Findings

Although there is a limited number of studies in the stroke literature that investigate the relationship between cognitive and executive functions and performance-based assessments of IADLs, the studies that have investigated these relationships have found similar findings. One study that examined the relationship between a performance-based telephone task and cognitive predictors found that tasks of global cognition, visual and auditory attention, executive functions (i.e., deductive reasoning and problem solving), immediate memory, language, and visuoperceptual function, were significantly correlated to performance on the telephone task (Higginson, Johnson-Greene, & Langrall, 2010). In another study, the relationship between a performance-based measure of IADLs (i.e., finances, communication, shopping, cooking, and medication management) and neurocognitive factors was examined. The authors found that tasks of attention, language, memory, spatial, and executive functions were significantly related to performance of IADLs in stroke survivors (Sadek, Stricker, Adair, & Haaland, 2011).

Regarding the current findings, UPSA and EFPT total scores were significantly related to the same cognitive constructs except for attention. Specifically, stroke survivors who demonstrated better functional performance on the UPSA performed better on tasks of immediate and delayed memory. These results demonstrate that the ability to register, recall and recognize verbal and visual information both immediately and delayed, is assessed by both the UPSA and RBANS Immediate and Delayed Memory Indices. The UPSA requires one to dial a telephone number from memory, to remember items needed to attend a medical appointment, and to remember information from a news article about the opening of a new water theme park. In contrast, stroke survivors who demonstrated better functional performance on the EFPT performed better on tasks of delayed memory and not immediate memory. However, none of the tasks included in the EFPT make much demand on immediate memory, so this lack of a correlation is not surprising. These results demonstrate that the ability to recall verbal and visual information after a delay is related to performance on the EFPT. The EFPT tasks that may be related to delayed memory include remembering the set of cooking instructions after a period of time, and remembering which bills to pay and in what order.

Better functional performance on the UPSA and EFPT was also associated with better performance on the visuospatial/constructional tasks of the RBANS. This association demonstrates that visual recognition, visuoperception, and motor functioning are important in the performance of both the UPSA and EFPT. Specifically, the UPSA requires participants to point to different trolley stations in a bus map. Additionally, a bus schedule is presented and participants are asked to use the information to answer questions about when to catch a bus to arrive early to an appointment. The EFPT requires participants to locate the necessary materials to perform different tasks (e.g., cooking, telephone use) from a box of items, to cook oatmeal, to find the bills, calculator and check from the box of materials, and to find the prescription on the box and follow the instructions. Visuospatial and constructional skills are likely important in the performance of these tasks.

Stroke survivors who demonstrated better functional performance on the UPSA and the EFPT performed better on the RBANS Language Index. These results demonstrate that the ability to produce fluent speech and to accurately retrieve words is related to better performance on the UPSA and EFPT. Some the UPSA tasks that may involve these skills include naming important items needed to spend the day at a water theme park, calling the doctor's office and leaving a voicemail message, and calling information to request the phone number of an individual. Some of the EFPT tasks that may involve the ability to produce fluent speech include calling a grocery store and asking if they deliver groceries.

In regard to executive functions, better functional performance on the UPSA and the EFPT was associated with better performance on the D-KEFS Sorting Test (concept formation and problem solving) and the Word Context Test (flexibility of thinking and deductive reasoning). In addition, UPSA performance was associated with the Proverbs Test (verbal abstraction), but EFPT performance was not. These results demonstrate that concept formation and reasoning is important to functional performance. For example, the UPSA requires participants to count change after given a hypothetical situation, they are asked to think of items that are important to take to a water theme park, and are also asked to find the correct time of departure and arrivals for different hypothetical situations on a bus schedule. In regards to the EFPT, participants are asked to pretend to pay two different bills, balance the account and make a decision as to which bill is more important to pay. Also, participants are asked to pretend to take fake medication and to follow the directions on the pill bottles. Participants are also asked to follow the recipe and cook oatmeal on the stove. These tasks likely involve reasoning as participants have to reach a conclusion as to how to precede with the tasks they are asked to do. Also, participants may be required to elaborate a strategy plan when presented with the tasks instructions.

Surprisingly, the RBANS Attention Index was not significantly related to performance on the UPSA or the EFPT. These findings seems to contradict other research which suggests that better performance in tasks of attention relate to better functional performance (assessed via performance-based measures of IADLs) in stroke survivors (Baum et al., 2008; Higginson, Johnson-Greene, & Langrall, 2010; Sadek, Stricker, Adair, & Haaland, 2011). There are several potential reasons for these contradictory findings. First, the RBANS Attention Index is comprised of two different tasks, Digit Span Forward and Coding. In the study of the examination of the relationship of cognitive factors and the EFPT, the authors found that Digits Backward was significantly related to the EFPT but not Digits

Forward (Baum et al., 2008), suggesting the Digits Forward task may suffer from low sensitivity in stroke survivors. Additionally, the second study that investigated the relationship of the Functional Impact Assessment (FIA) with neurocognitive factors, measured attention with five different tasks (i.e., Digits Forward, Digits Backward, Dots, Letter and Symbol Cancellation, and Driving Scenes Tests) (Sadek et al., 2011). A number of these tasks not only measure attentional capacity and sustained attention, but also measured constructs such as working memory and processing speed. Furthermore, the last task of the attention module that was used by Sadek and colleagues (2011) consisted of a driving scenes test where participants are shown color drawings of a road scene from the perspective of sitting behind the steering wheel of the car. After a 30-s exposure, participants are then shown another similar picture, and are asked to point to and tell the examiner everything that is new or missing. The attention module used in the Sadek and colleagues study not only assessed a wide range of tasks, but the "real world" nature of the last task, could make this attention module more sensitive to attention difficulties than the RBANS Attention Index and highly correlated to performance-based measures of IADLs. Another possible explanation for the nonsignficant relationship between the Attention Index and the UPSA and EFPT is that in the present study Holm's Bonferroni Sequential corrections were conducted to decrease the probability of a Type 1 error. The relationship between attention and UPSA/EFPT scores was statistically significant before correcting alpha levels, and in the studies described above, the authors did not employ corrections for the multiple correlations conducted.

D-KEFS Color Word Interference Test (inhibition and cognitive flexibility) and the Twenty Questions Test (Abstract Thinking) were not related to scores on the UPSA or EFPT. There are several potential reasons for this pattern of results. While better performance on the

UPSA and EFPT may involve cognitive flexibility when utilizing the props to answer questions to different scenarios, it apparently does not depend heavily on inhibition and switching skills. Additionally, concept formation, reasoning and flexibility of thinking related to better performance on the UPSA and EFPT may be better accounted for by other D-KEFS tasks (e.g., Sorting, Word Context) and not the Twenty Questions Test. This raises the issues of the complexity of assessing cognitive constructs as the RBANS and DKEFS measures of cognitive and executive functioning appear to assess more than one construct. Lezak and colleagues (2012, p.21) stated “despite the seeming ease with which the classes of cognitive functions can be distinguished conceptually, more than merely independent, they are inextricably bound together.” For example, Delis, Kaplan, and Kramer (2001) describe the construct measured by the Twenty Questions Test as abstract thinking and Lezak and colleagues (2012, p. 628) describe this test as measuring a number of different constructs including “concept formation, hypothesis generating and testing, discriminating relevant from irrelevant information, logical judgment, maintaining conceptual direction, and short-term memory.” The complexity of these measures may complicate the interpretation regarding their relationship with measures of functional capacity.

Aim Two: Summary of Findings

For hypothesis two the predictive validity of cognitive and executive functions on UPSA and EFPT total scores was investigated. As hypothesized, visuospatial/constructional skills were significant predictors of UPSA total scores. Additionally, language was also a significant predictor. Surprisingly, when executive functions (i.e., Sorting, Word Context, and Proverb Test) were entered in the model, none were significant predictors and only language remained as a significant individual predictor of UPSA total scores. These results demonstrate that when controlling for other cognitive variables, language significantly predicts UPSA total scores in stroke survivors. However, the complete model explained a large amount of variance suggesting that cognitive and executive functions are important factors in the performance of daily living tasks.

With regard to the EFPT total scores, as hypothesized, visuospatial/constructional skills were significant predictors of EFPT total scores, when controlling for age, stroke severity, side of stroke, and symptoms of depression. However, when executive functions (i.e., Sorting and Word Context Test) were entered in the model, no significant predictors were found in the model. Similar to the findings with the UPSA, cognitive domains as a set and not as individual predictors explain performance on the EFPT.

Aim Two: Interpretation of Findings

There are several hypotheses that could explain the predicative ability of the Language Index and the lack of significance of executive functions and visuospatial/constructional skills at predicting UPSA total scores. First, RBANS Language Index is assessed by a confrontation naming task and semantic fluency. Although semantic fluency tasks assess for semantic memory, this task has also been thought to assess aspects of executive function. Specifically, category fluency assesses cognitive flexibility, self-regulation, and short-term memory (Lezak et al., 2012, p.37). The relationship between semantic fluency and a performance-based measure of IADLs was found to be significant in stroke survivors (Baum et al., 2008), suggesting that this ability of language and cognitive flexibility is important in the performance of daily living tasks. Additionally, further evaluation demonstrated a significant relationship between UPSA total scores and the

RBANS semantic fluency task, and no significant relationship between the RBANS naming task and UPSA total scores.

Surprisingly the Visuospatial/Constructional Index was not a significant predictor of UPSA and EFPT total scores. This pattern of results is contradictory to what others have found when examining the predictive validity of cognitive and executive functions. For example, Sadek et al. (2011) found that when all the cognitive domains (i.e., attention, language, memory, spatial, and executive functions) were evaluated simultaneously in a regression, only the spatial domain was a significant predictor of actual performance of IADLs and the other cognitive domains did not predict unique variance above spatial abilities. This domain was also found to be the only significant predictor of performance on a telephone task. There are several potential reasons for these contradictory findings. First, Sadek and colleagues (2011) assessed visuospatial skills with different tasks including a map reading task, which its external validity and "real-world" application may increase its sensitivity to functional difficulties in stroke survivors. Another possible explanation for the lack of significance of other individual tasks and indices is that these findings indicate that the UPSA and EFPT require multiple cognitive abilities and not single domains as unique predictors. Further, the large amount of variance (i.e., 60% for the UPSA and 38% for the EFPT) that the Immediate Memory Index, Visuospatial/Constructional Index, Language Index, Delayed Memory Index, Sorting Test, Word Context Test, and Proverb Test, explained as a set suggests that performance on the UPSA and EFPT is related to a number of cognitive domains and not individual domains as unique predictors. This explanation may also describe the pattern of results from the exploratory analysis conducted to investigate the relationship between individual IADL tasks and cognitive/executive functions. A number of

IADLs were related to more than one cognitive and executive function suggesting that the relationship between functional capacity and cognitive/executive functions may be better conceptualized as a set of predictors and not as individual cognitive domains.

Implications

The results of this study have several implications. First, cognitive and executive functions explained a large amount of variance demonstrating that cognitive functioning is important in the performance of everyday tasks in stroke survivors. Therefore, both the assessment and intervention of cognitive functioning is important in the functional recovery of stroke survivors. Specifically, assessing for multiple cognitive domains and executive functions is necessary to identify which domains are needed to target during rehabilitation. The results of this study demonstrate that the domains of memory, language, visuospatial/constructional abilities, cognitive flexibility, and verbal abstraction are important in the performance of IADLs. Additionally, targeting these domains may be important in the improvement of functional performance in stroke survivors. Second, the lack of significant differences, tested with r-to-z transformations, between cognitive/executive functions and the two performance-based measures of IADLs emphasizes the important role of cognitive functioning in daily functioning. Rehabilitation therapists and clinicians may benefit from assessing IADLs via performance-based measures as these methods seem to have similar relationships with cognitive domains and executive functions.

Limitations and Future Directions

This study has limitations that are important to mention. Although we had adequate power for the analyses we conducted, the sample size of stroke survivors is small, therefore limiting the types and number of analyses that could be conducted for this study. Future studies should assess the relationship between different cognitive/executive functions and functional ability by utilizing stronger statistical analysis such as Structural Equation Modeling (SEM). By conducting these types of analysis complex models could be tested including direct and indirect effects between cognitive/executive functions and functional capacity. Additionally, SEM also allows the incorporation of measurement models to more accurately model the cognitive and executive function constructs of interest.

Second, the present study was cross-sectional and not longitudinal. Although the cross-sectional nature of this study provides important information about the cognitive domains and executive functions that relate to functional capacity, it would be important to assess what cognitive factors and executive functions relate to changes in Instrumental Activities of Daily Living. Future studies should investigate these relationships by utilizing longitudinal methods.

Lastly, a large number of stroke survivors were involved in the services provided by the American Stroke Foundation. This could be problematic in the generalization of our findings because stroke survivors involved in the American Stroke Foundation engage in a number of classes such as balance, fitness, and stress management which have been found to increase functioning in stroke survivors (Werner & Kessler, 1996). Even so, excluding participants who had severe difficulties with motor function and an inability to communicate with the experimenter was necessary as the set of tasks used in this study did not allow for testing of a broader range of severity in stroke survivors. This is another limitation of the current study as the UPSA and the neuropsychological assessments used are limited in that they do not allow for testing of stroke survivors who experience severe communication and motor difficulties. Future studies should develop more specialized and sensitive instruments that can assess stroke survivors with a broader range of stroke disability. Also, future studies should assess stroke survivors who are not currently involved in post-rehabilitation activities.

Conclusion

In summary, the results from this study demonstrate that a number of cognitive domains and executive functions relate to performance of Instrumental Activities of Daily Living. A number of cognitive domains were highly correlated with functional performance, including immediate and delayed memory, language, visuospatial/constructional skills, concept formation, problem solving, cognitive flexibility and verbal abstraction. However, when assessing the individual cognitive domains for their ability to predict functional capacity in two different performance-based measures, only the RBANS Language subtest was a significant predictor and this result was only found in the UPSA and not the EFPT. These results demonstrate that cognitive domains and executive functions are important in predicting a stroke survivors' level of functioning and not as individual predictors, but rather as a set of cognitive abilities. The aim of the current study was to investigate the predictive validity of single cognitive and executive functions of functional ability. However, as evidenced by the pattern of findings from this study, this does not seem to be a useful approach as performance of IADLs was related to a constellation of cognitive domains and executive functions.

As has been noted, cognitive domains and executive functions play an important role in explaining functional capacity in stroke survivors. This has important implications in the design and implementation of post-stroke rehabilitation. Specifically, targeting cognitive difficulties in domains of memory, language, visuospatial/constructional, cognitive flexibility, and verbal abstraction may improve stroke survivors' functional performance.

APPENDIX A

Table 1

Summary of Correlational Findings

<table>
<tr><th></th><th></th><th>Memory</th><th>Attention</th><th>Executive Functions</th><th>Visuospatial</th><th>Language</th><th>Global Cognition</th></tr>
<tr><td rowspan="2">ADLs</td><td>Yes</td><td>|</td><td>||</td><td>|||</td><td>||</td><td>||</td><td>||</td></tr>
<tr><td>No</td><td>|</td><td></td><td></td><td></td><td></td><td>|</td></tr>
<tr><td rowspan="2">IADLs</td><td>Yes</td><td>||</td><td>||</td><td>|||</td><td>||</td><td>||</td><td>|</td></tr>
<tr><td>No</td><td>|</td><td>|</td><td></td><td></td><td></td><td></td></tr>
</table>

Note. Each tally mark represents one study. Yes = study found significant correlations. No = study did not find evidence for the relationship.

Table 2

Summary of Performance-based IADLs Findings

<table>
<tr><th></th><th></th><th>Memory</th><th>Attention</th><th>Visuospatial</th><th>Language</th><th>Global Cognition</th><th>Executive Functions</th></tr>
<tr><td>HTT</td><td>Yes</td><td>|</td><td>|</td><td>|</td><td>|</td><td>|</td><td>|</td></tr>
<tr><td>EFPT</td><td>Yes</td><td></td><td></td><td></td><td>|</td><td>|</td><td>|</td></tr>
<tr><td>FIA</td><td>Yes</td><td>|</td><td>|</td><td>|</td><td>|</td><td></td><td>|</td></tr>
</table>

Note. HTT = Hopkins Telephone Task; EFPT= Executive Function Performance Test; FIA = Functional Impact Assessment.

Table 3

Participant Demographics

Participant Characteristics	
Age at study enrollment, mean (SD)	62.10 (9.05)
Gender	
Male	31 (59.6%)
Female	21 (40.4%)
Years of Education, mean (SD)	14.72 (2.76)
Marital Status	
Never Married, n (%)	3 (5.8%)
Cohabitating, n (%)	2 (3.8%)
Divorced, n (%)	8 (15.4%)
Married, n (%)	38 (73.1%)
Civil Union, n (%)	1 (1.9%)
Ethnicity	
White, n (%)	41 (78.8%)
Black, n (%)	6 (11.5%)
Hispanic, n (%)	3 (5.8%)
Other, n (%)	2 (3.8%)
Handedness	
Left, n (%)	5 (9.6%)
Right, n (%)	47 (90.4%)
Experienced Multiple Stroke	
Yes, n (%)	13 (25.5%)
No, n (%)	38 (74.5%)
Type of Stroke	
Ischemic Stroke, n (%)	23 (44.2%)
Hemorrhagic Stroke, n (%)	11 (21.2%)
Transient Ischemic Attack, n (%)	6 (11.5%)
Don’t Know, n (%)	12 (23.1%)
Side of Stroke	
Left, n (%)	16 (30.8%)
Right, n (%)	32 (61.5%)
Both, n (%)	1 (1.9%)
Does not know, n (%)	3 (5.8%)
Years Since Stroke, mean (SD)	5.89 (5.30)
Stroke Severity, mean (SD)	9.84 (8.40)

Table 4

Summary of Means and Standard Deviations for Scores on the UPSA, EFPT, RBANS, and D-KEFS

	Mean	SD
UPSA Total Scores	77.17	11.12
EFPT Total Scores	8.69	5.87
RBANS Indices		
Immediate Memory Index	94.74	16.60
Visuospatial Index	87.08	15.68
Language Index	92.42	9.38
Attention Index	82.30	19.76
Delayed Memory Index	97.72	10.98
D-KEFS Tests		
Color Word Interference Test	7.67	3.44
Sorting Test	10.52	3.49
Twenty Questions Test	10.59	3.22
Word Context Test	8.55	3.31
Proverb Test	8.72	3.18

Note. RBANS normed indices have a mean of 100 and a standard deviation of 15; D-KEFS normed scaled scores have a mean of 10 and a standard deviation of 3.

Table 5

Summary of Means and Standard Deviations for Subscale Scores on the UPSA, EFPT, RBANS, and D-KEFS

	Mean	SD
UPSA		
Finance	16.72	3.82
Communication	14.57	3.05
Organization/Planning	15.69	3.36
Transportation	13.29	3.55
Household Management	16.90	3.76
EFPT		
Simple Cooking	2.60	2.19
Telephone Use	0.67	1.36
Medication Management	1.94	2.05
Bill Payment	3.59	2.55

Table 6

Summary of Correlations between Scores on the UPSA, EFPT, RBANS, and D-KEFS after Corrected Criterion Values

	UPSA	**EFPT**
RBANS Indices		
Immediate Memory Index	.527*	-.299
Visuospatial Index	.433*	-.473*
Language Index	.703*	-.452*
Attention Index	.353	-.367
Delayed Memory Index	.569*	-.420*
D-KEFS Tests		
Color Word Interference Test	.313	-.353
Sorting Test	.653*	-.612*
Twenty Questions Test	.259	-.299
Word Context Test	.570*	-.412*
Proverb Test	.514*	-.258

Table 7

Summary of Uncorrected Correlations between Scores on the UPSA, EFPT, RBANS, and D-KEFS

	1	2	3	4	5	6	7	8	9	10	11	12
1. UPSA Total Scores	--											
2. EFPT Total Scores	-.581**	--										
3. Immediate Memory Index	.527**	-.299*	--									
4. Visuospatial Index	.433**	-.473**	.063	--								
5. Language Index	.703**	-.452**	.504**	.314*	--							
6. Attention Index	.353*	-.367**	.420**	.066	.435**	--						
7. Delayed Memory Index	.569**	-.420**	.630**	.259	.568**	.282*	--					
8.Color Word Interference Test	.313*	-.353*	.315*	.068	.250	.553**	.290*	--				
9. Sorting Test	.653**	-.612**	.492**	.487**	.548**	.393**	.583**	.310*	--			
10. 20 Questions Test	.259	-.299*	.218	.268	.250	.222	.322*	.253	.233	--		
11. Word Context Test	.570**	-.412**	.423**	.495**	.477**	.357*	.226	.246	.380**	.224	--	
12. Proverb Test	.514**	-.258	.498**	.275	.392**	.249	.276	.408**	.430**	.308*	.508**	--

Table 8

Summary of Correlations between Subscale Scores on the UPSA, EFPT, RBANS, and D-KEFS

	UPSA					EFPT			
RBANS Indices	Finance	Communication	Organization	Transportation	Household	Cooking	Telephone	Medication	Bill
Immediate Memory	.32	.41*	.22	.36	36	-.37	-.10	-.02	-.29
Visuospatial/Constructional	.39	.02	.35	.33	.25	-.35	-.27	-.32	-.41*
Language	.57*	.43*	.41*	.44*	.38	-.32	-.35	-.19	-.41*
Attention	.41*	.36	-.16	.40*	.10	-.29	-.26	-.24	-.28
Delayed Memory	.39	.31	.40*	.36	.43*	-.42*	-.17	-.16	-.41*
D-KEFS Tests									
Color-Word Interference	.40*	.22	.17	.21	.25	-.26	-.20	-.06	-.34
Sorting	.59*	.38	.25	.54*	.30	-.55*	-.33	-.48*	-.41*
Twenty Questions	.09	.07	.25	.11	.17	-.33	-.17	-.03	-.30
Word Context	.39	.31	.34	.48*	.33	-.40*	-.17	-.12	-.37
Proverb	.48*	.49*	.10	.39	.18	-.33	-.26	-.19	-.03

Note. *High moderate to large effect size correlations (r>.40).

Table 9

Hierarchical Multiple Regression Analyses Predicting UPSA Total Scores from RBANS and D-KEFS

Predictor	***B***	***SE B***	***β***	***p***	**Adj. R^2**
Step 1					.02
Intercept	78.94				
Age (yrs)	.06	.20	.05	.758	
NIH Stroke Severity	-.30	.20	-.23	.141	
Side of Stroke	2.41	3.50	.11	.495	
Symptoms of Depression	-.26	.22	-.18	.24	
Step 2					0.59
Intercept	-3.35				
Age (yrs)	-.03	.13	-.02	.842	
NIH Stroke Severity	-.10	.13	-.08	.429	
Side of Stroke	2.95	2.46	.131	.238	
Symptoms of Depression	-.26	.15	-.18	.085	
Immediate Memory	.13	.09	.20	.132	
Delayed Memory	.03	.14	.03	.821	
Visuospatial/Constructional	.15	.07	.22	.049	
Language	.61	.15	.52	<.001	
Step 3					0.62
Intercept	10.63				
Age (yrs)	-.04	.13	-.03	.741	
NIH Stroke Severity	-.14	.13	-.11	.308	
Side of Stroke	2.78	2.39	.12	.252	
Symptoms of Depression	-.16	.15	-.11	.280	
Immediate Memory	.01	.10	.02	.921	
Delayed Memory	.12	.15	.12	.440	
Visuospatial/Constructional	.02	.09	.03	.821	
Language	.46	.16	.40	.007	
Sorting Test	.53	.44	.17	.235	
Word Context Text	.64	.43	.20	.149	
Proverb Test	.41	.42	.12	.331	

Table 10

Hierarchical Multiple Regression Analyses Predicting EFPT Total Scores from RBANS and D-KEFS

Predictor	***B***	***SE B***	***β***	***p***	**Adj.** R^2
Step 1					.06
Intercept	7.84				
Age (yrs)	-.03	.11	-.04	.810	
NIH Stroke Severity	.24	.10	.38	.017	
Side of Stroke	-2.03	1.81	-.18	.267	
Symptoms of Depression	.02	.11	.03	.87	
Step 2					.35
Intercept	36.43				
Age (yrs)	-.03	.09	-.04	.765	
NIH Stroke Severity	.16	.08	.24	.070	
Side of Stroke	-1.25	1.56	-.11	.427	
Symptoms of Depression	.02	.09	.03	.802	
Visuospatial/Constructional	-.14	.05	-.41	.005	
Language	-.10	.10	-.17	.326	
Delayed Memory	-.07	.08	-.14	.380	
Step 3					.38
Intercept	28.60				
Age (yrs)	-.03	.09	-.04	.770	
NIH Stroke Severity	.15	.08	.23	.092	
Side of Stroke	-1.33	1.53	-.12	.390	
Symptoms of Depression	-.02	.09	-.03	.832	
Visuospatial/Constructional	-.09	.05	-.24	.127	
Language	-.02	.11	-.03	.876	
Delayed Memory	-.04	.08	-.08	.645	
Sorting Test	-.47	.27	-.30	.093	
Word Context Test	-.25	.24	-.15	.320	

APPENDIX B

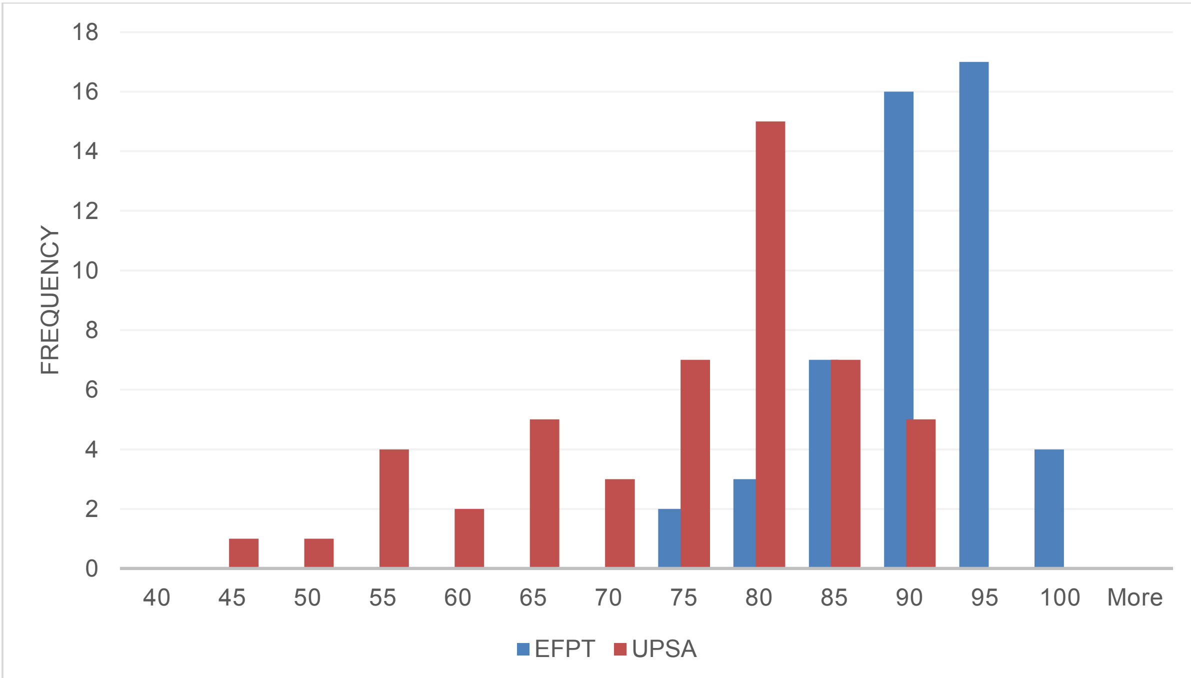

Figure 1. Frequency Histogram of UPSA and EFPT Total Scores. Scores on the EFPT were reversed to be equivalent to scores on the UPSA. Higher scores on both measures is equivalent to better functional performance.

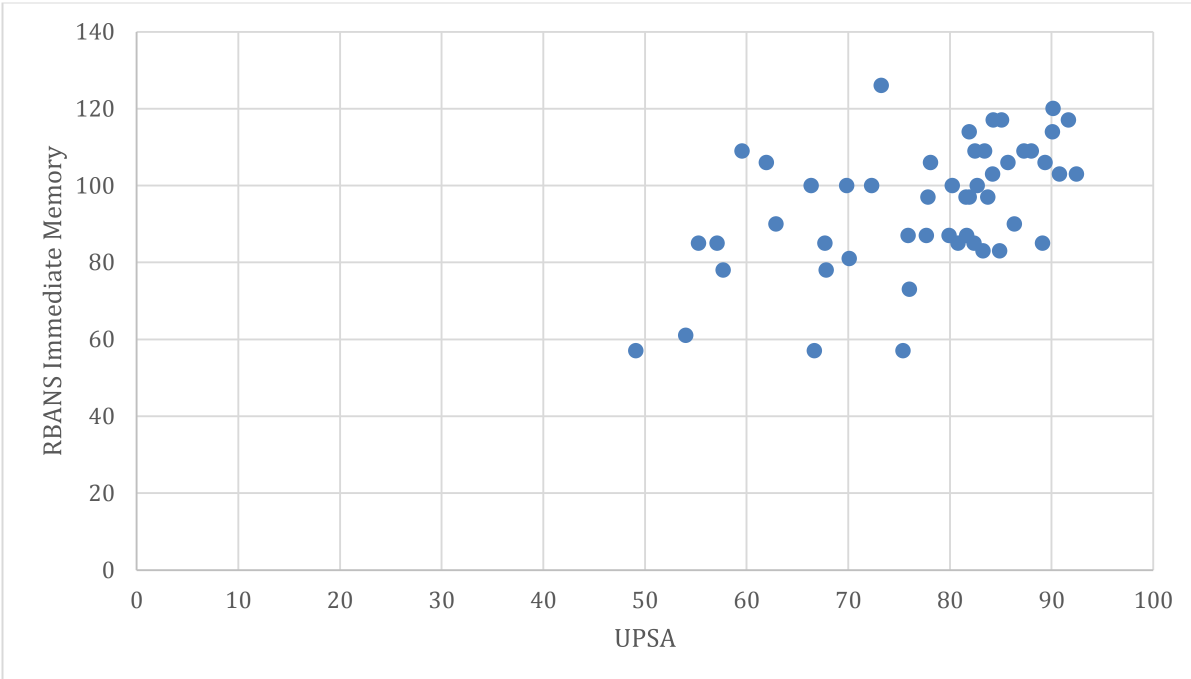

Figure 2. Scatterplot of UPSA total scores and RBANS Immediate Memory Index.

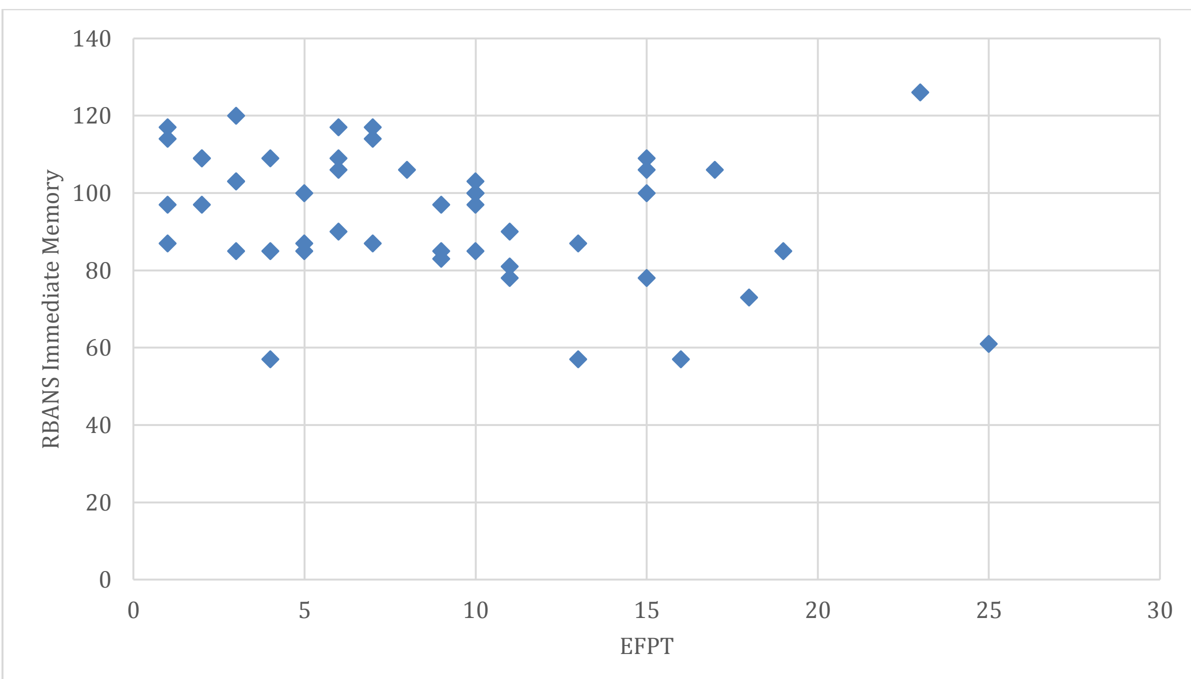

Figure 3. Scatterplot of EFPT total scores and RBANS Immediate Memory Index.

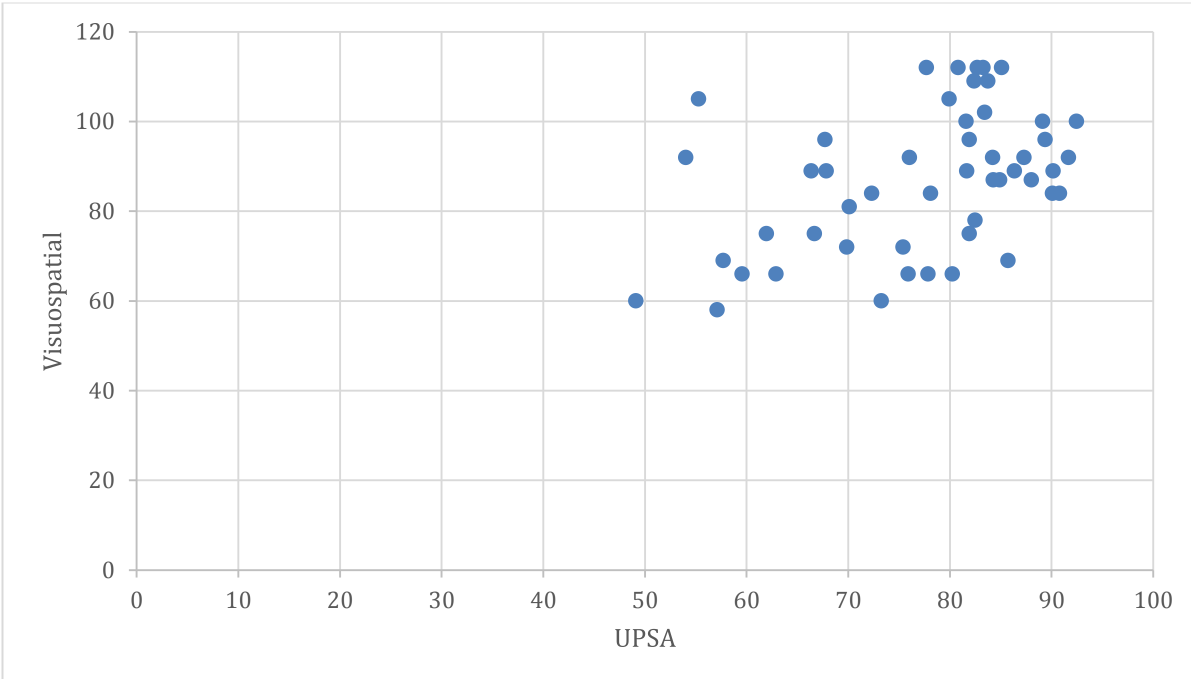

Figure 4. Scatterplot of UPSA total scores and RBANS Visuospatial/Constructional Index.

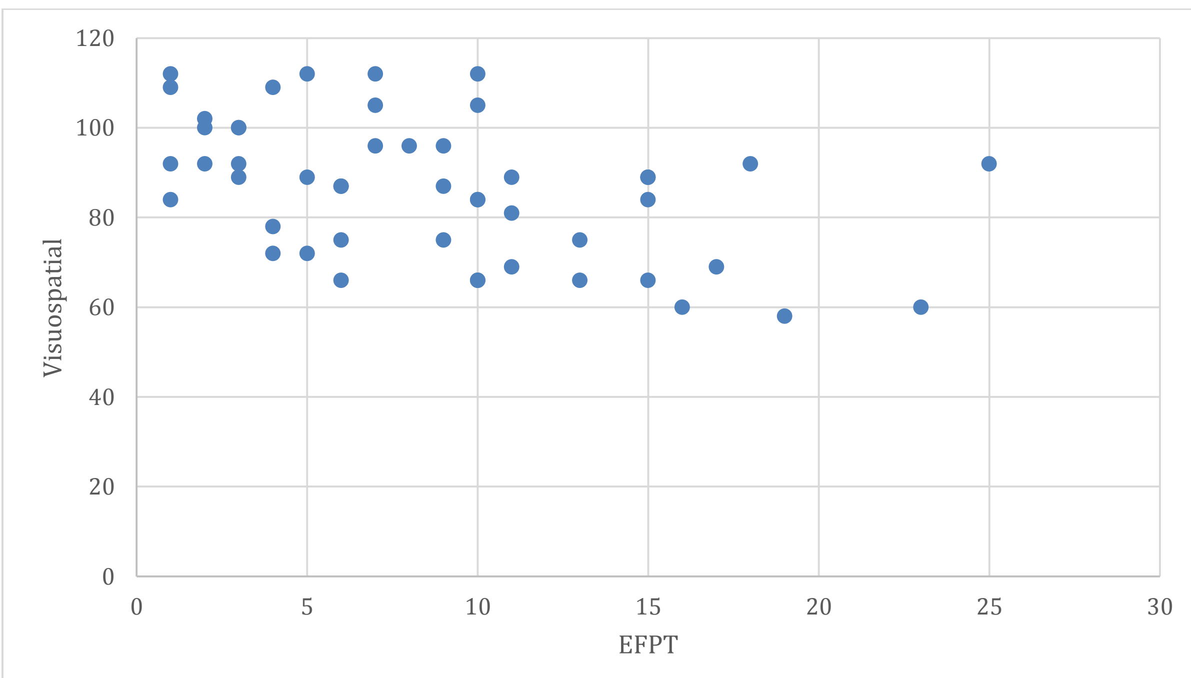

Figure 5. Scatterplot of EFPT total scores and RBANS Visuospatial/Constructional Index.

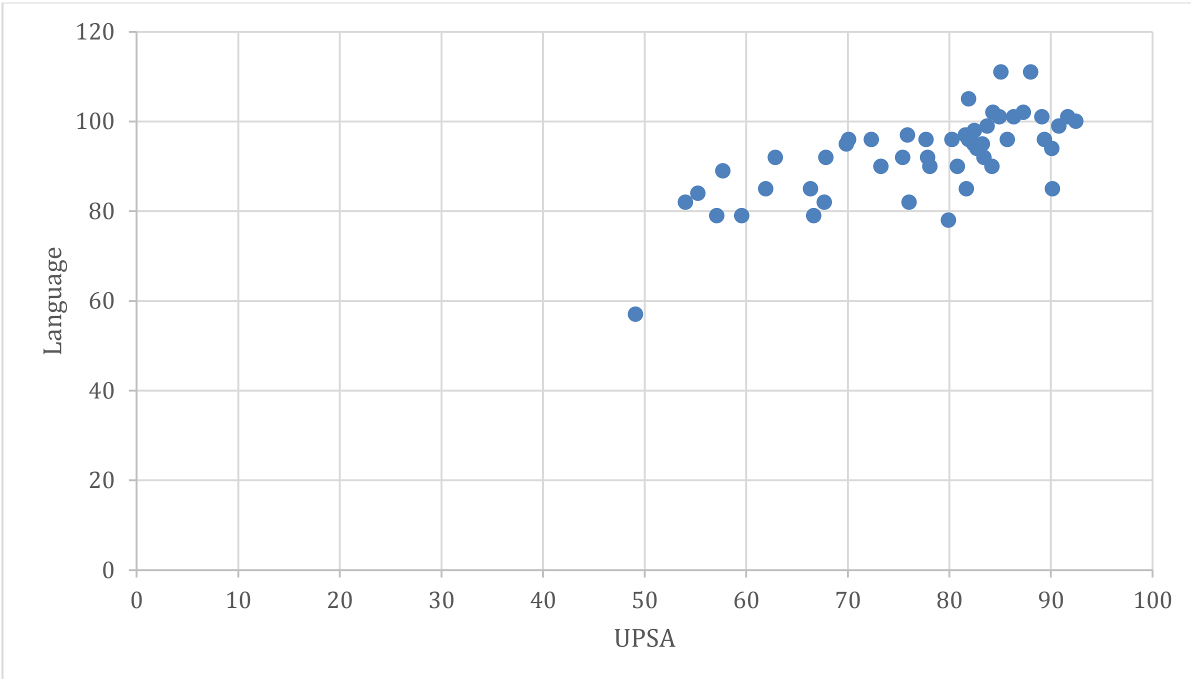

Figure 6. Scatterplot of UPSA total scores and RBANS Language Index.

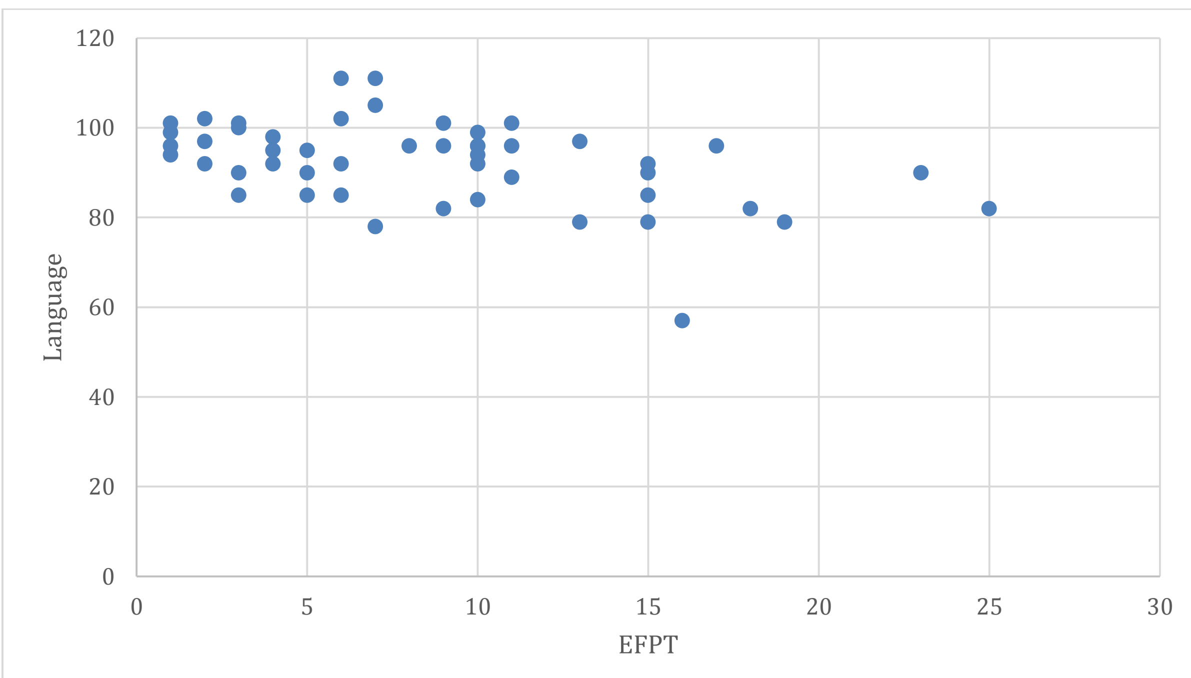

Figure 7. Scatterplot of EFPT total scores and RBANS Language Index.

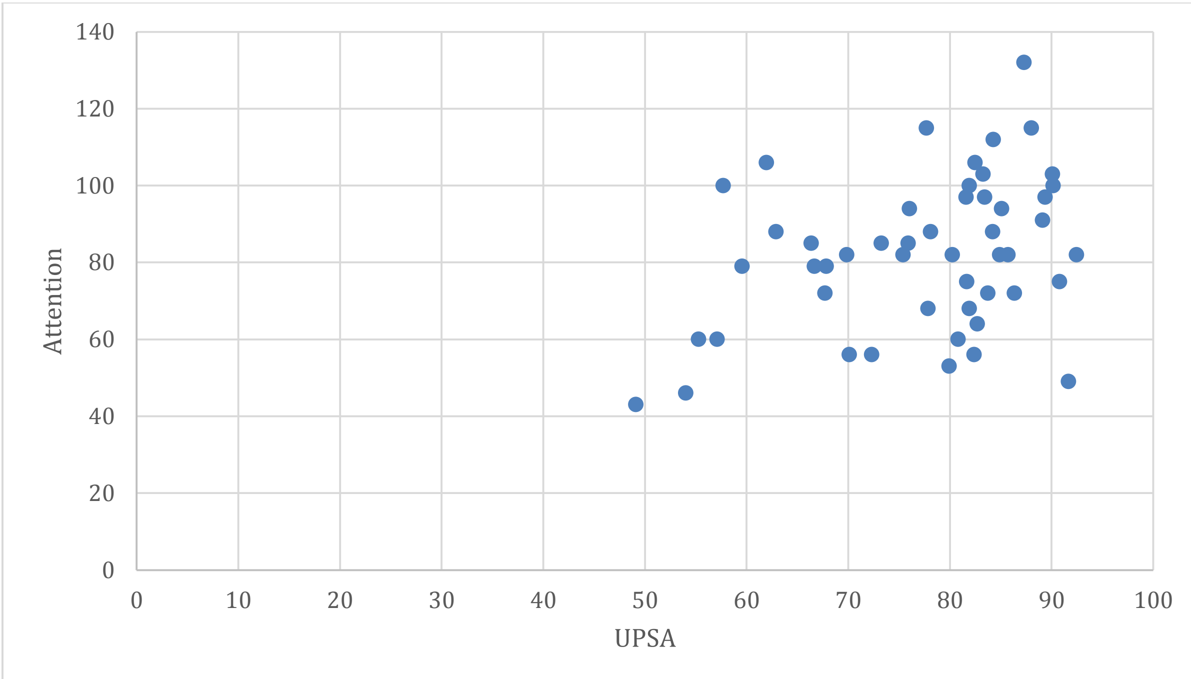

Figure 8. Scatterplot of UPSA total scores and RBANS Attention Index.

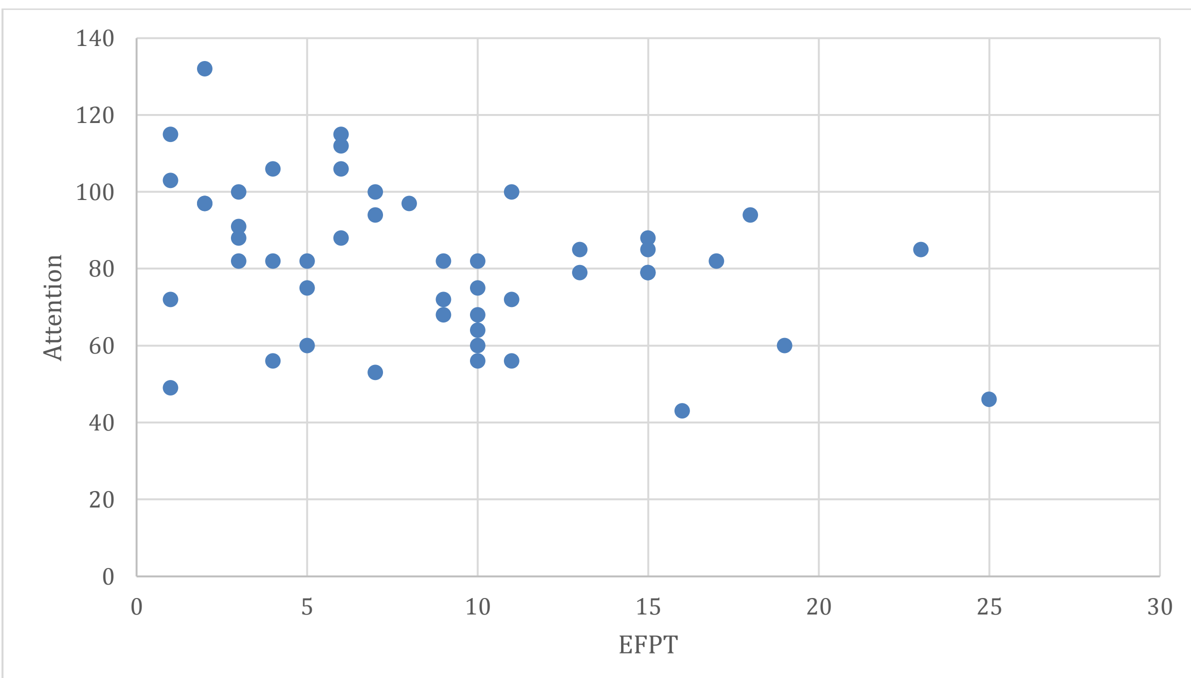

Figure 9. Scatterplot of EFPT total scores and RBANS Attention Index.

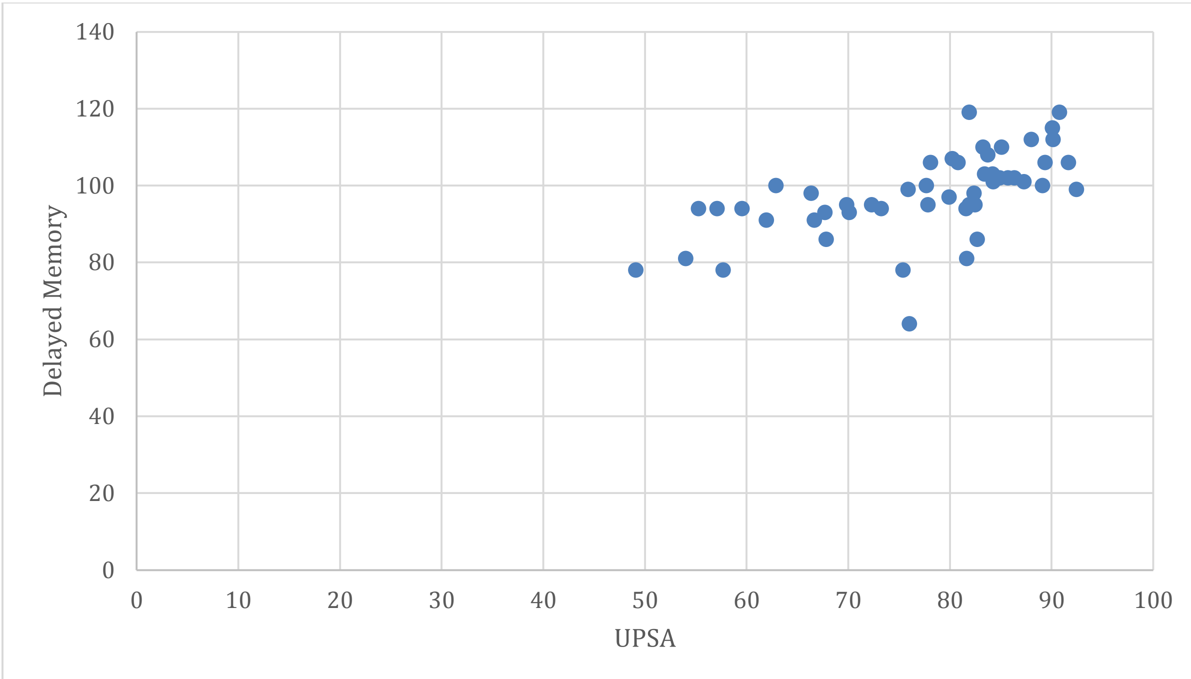

Figure 10. Scatterplot of UPSA total scores and RBANS Delayed Memory Index.

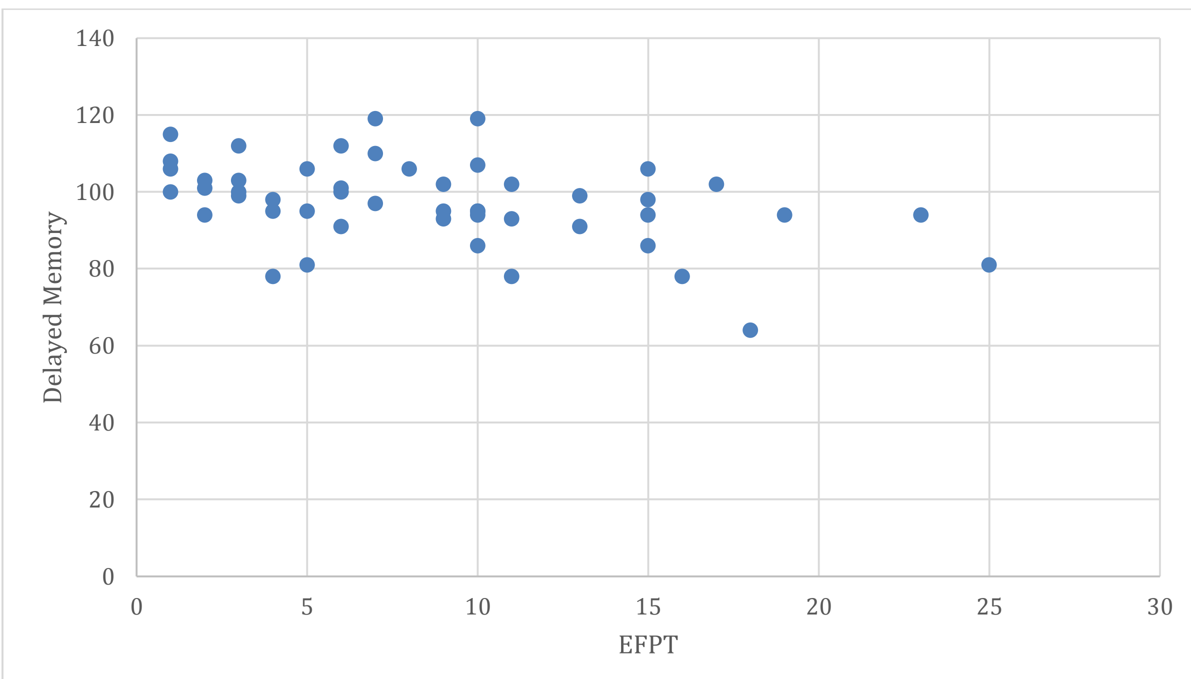

Figure 11. Scatterplot of EFPT total scores and RBANS Delayed Memory Index.

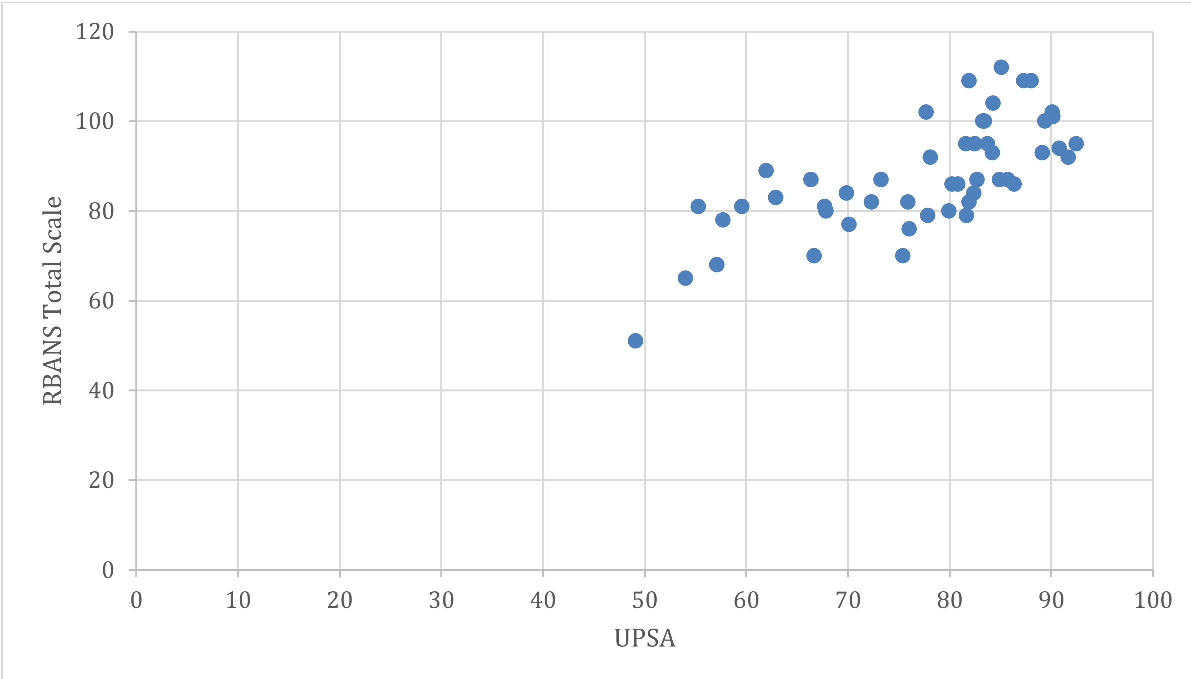

Figure 12. Scatterplot of UPSA total scores and RBANS Total Scale.

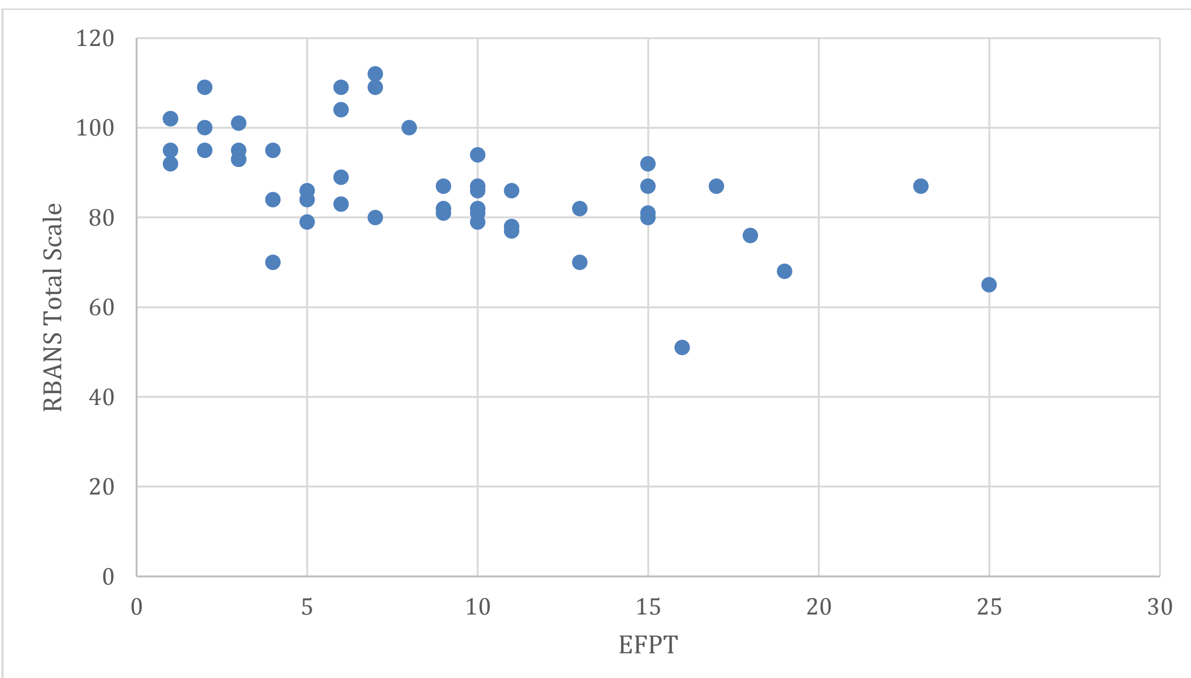

Figure 13. Scatterplot of EFPT total scores and RBANS Total Scale.

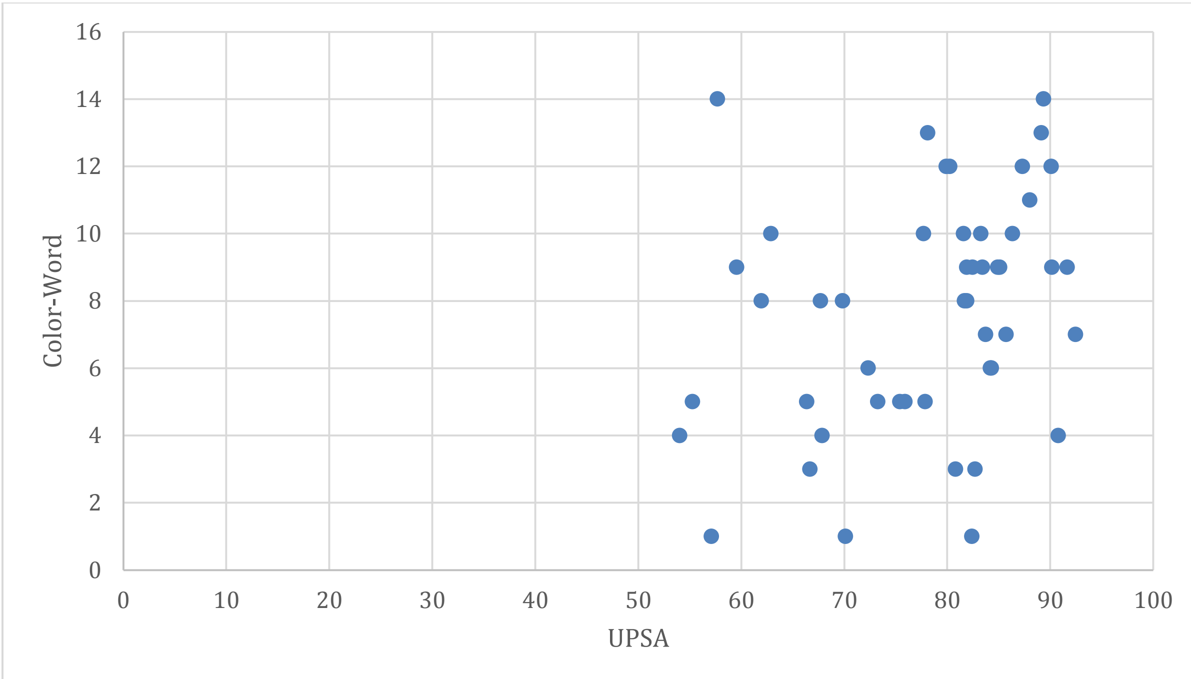

Figure 14. Scatterplot of UPSA total scores and D-KEFS Color-Word Interference Test.

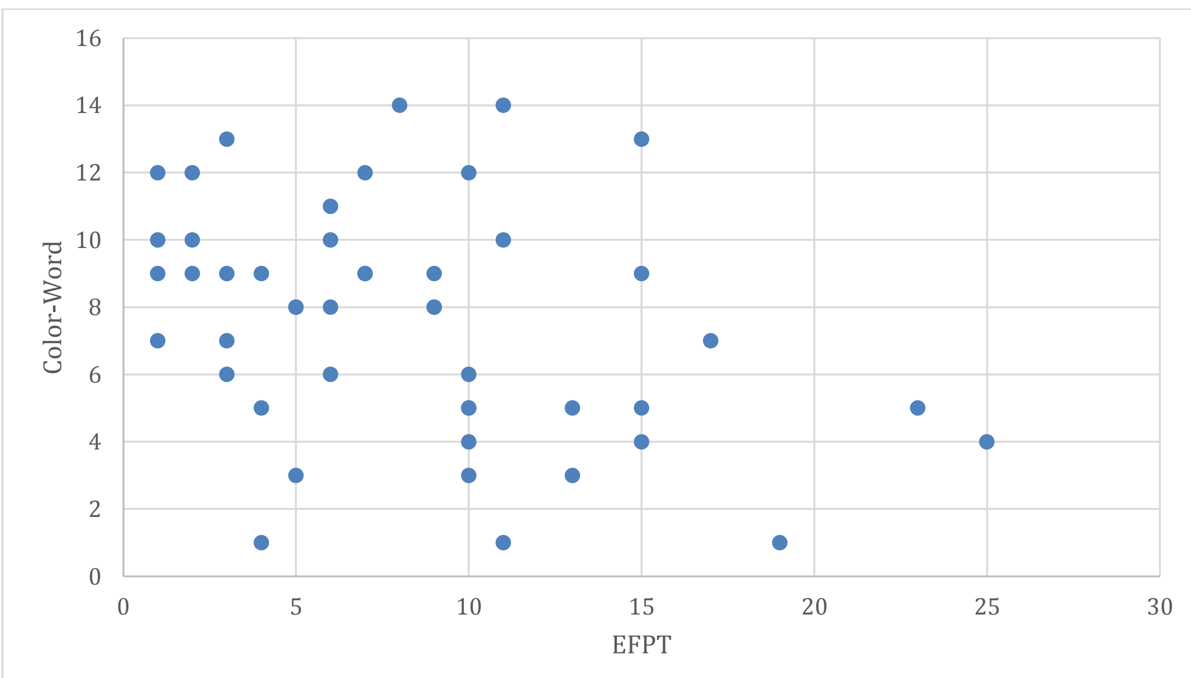

Figure 15. Scatterplot of EFPT total scores and D-KEFS Color-Word Interference Test.

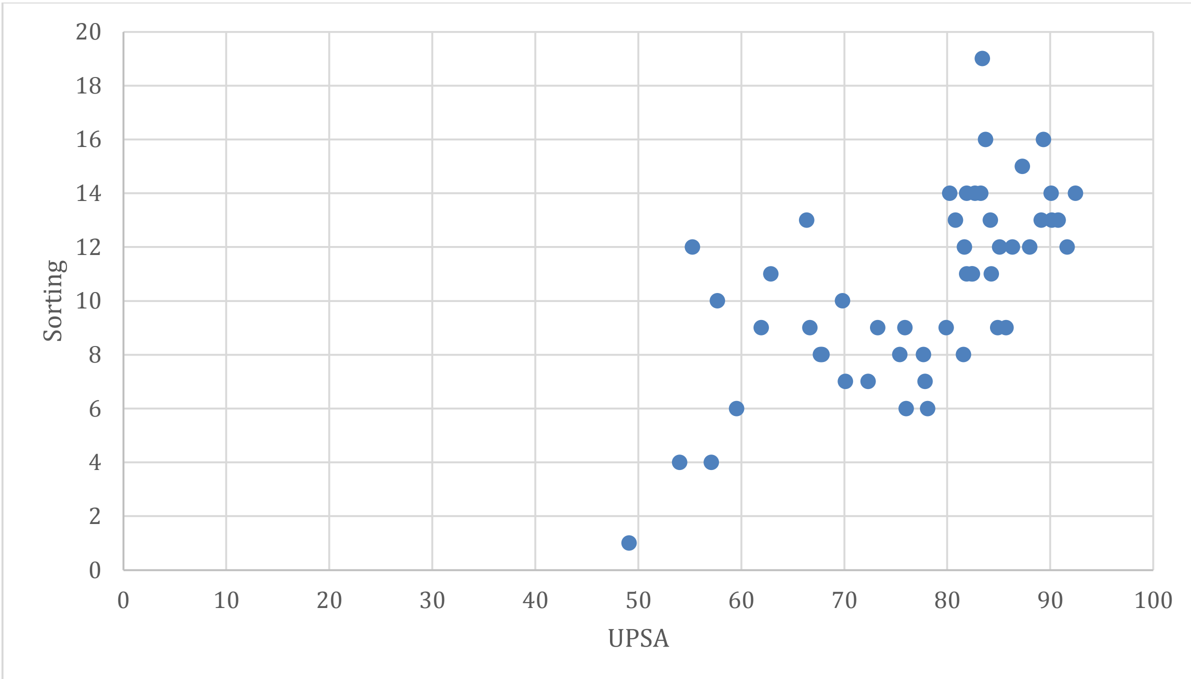

Figure 16. Scatterplot of UPSA total scores and D-KEFS Sorting Test.

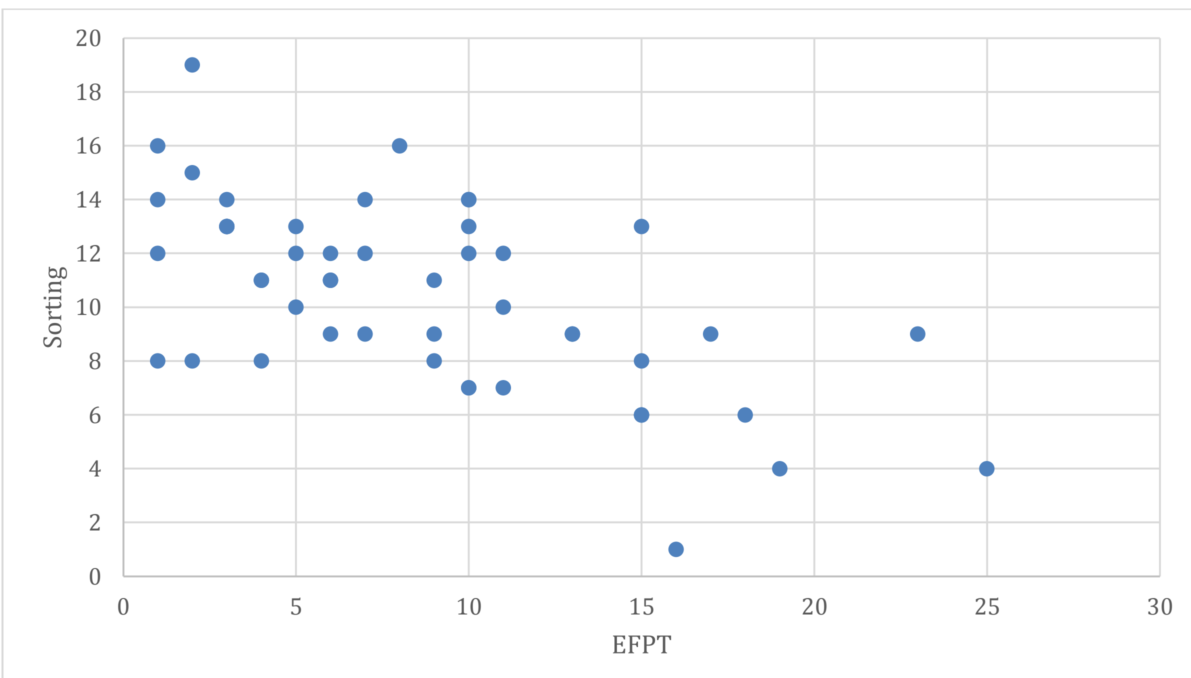

Figure 17. Scatterplot of EFPT total scores and D-KEFS Sorting Test.

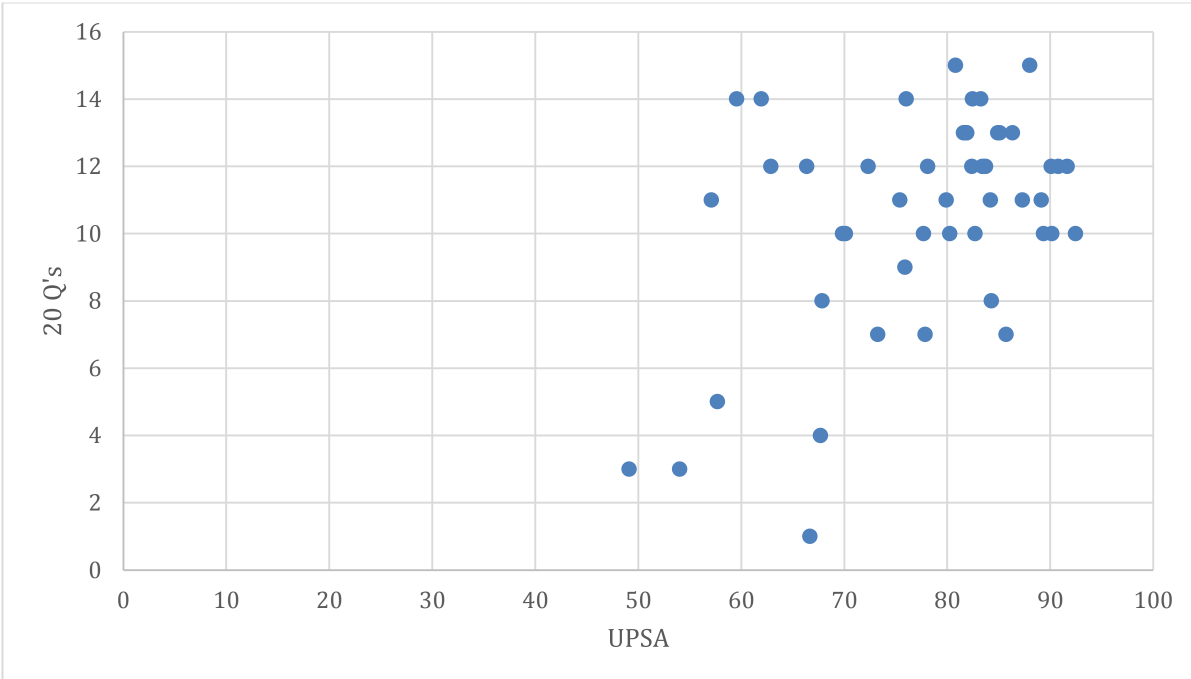

Figure 18. Scatterplot of UPSA total scores and D-KEFS Twenty Questions Test.

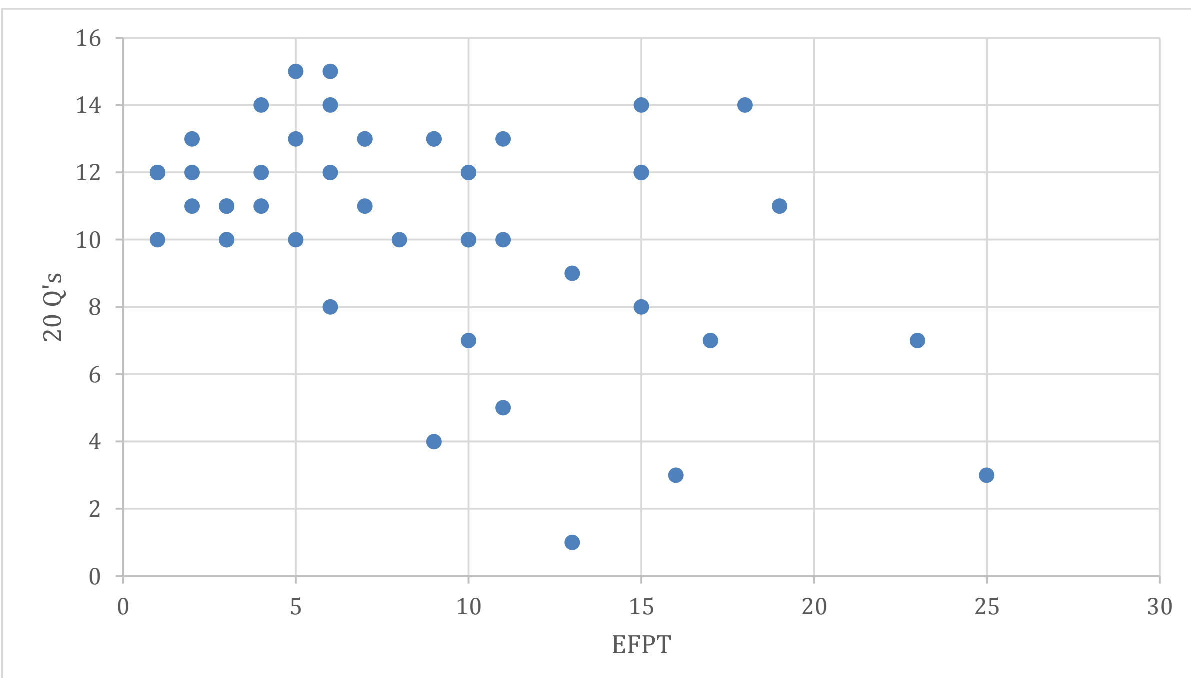

Figure 19. Scatterplot of EFPT total scores and D-KEFS Twenty Questions Test.

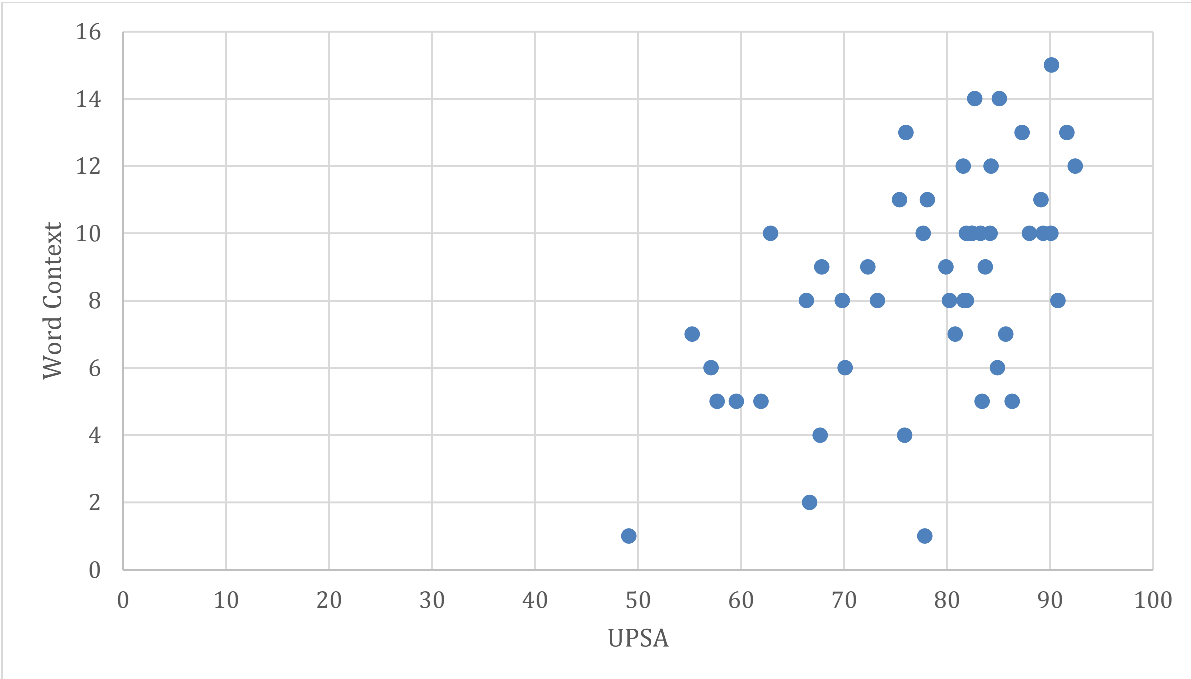

Figure 20. Scatterplot of UPSA total scores and D-KEFS Word Context Test.

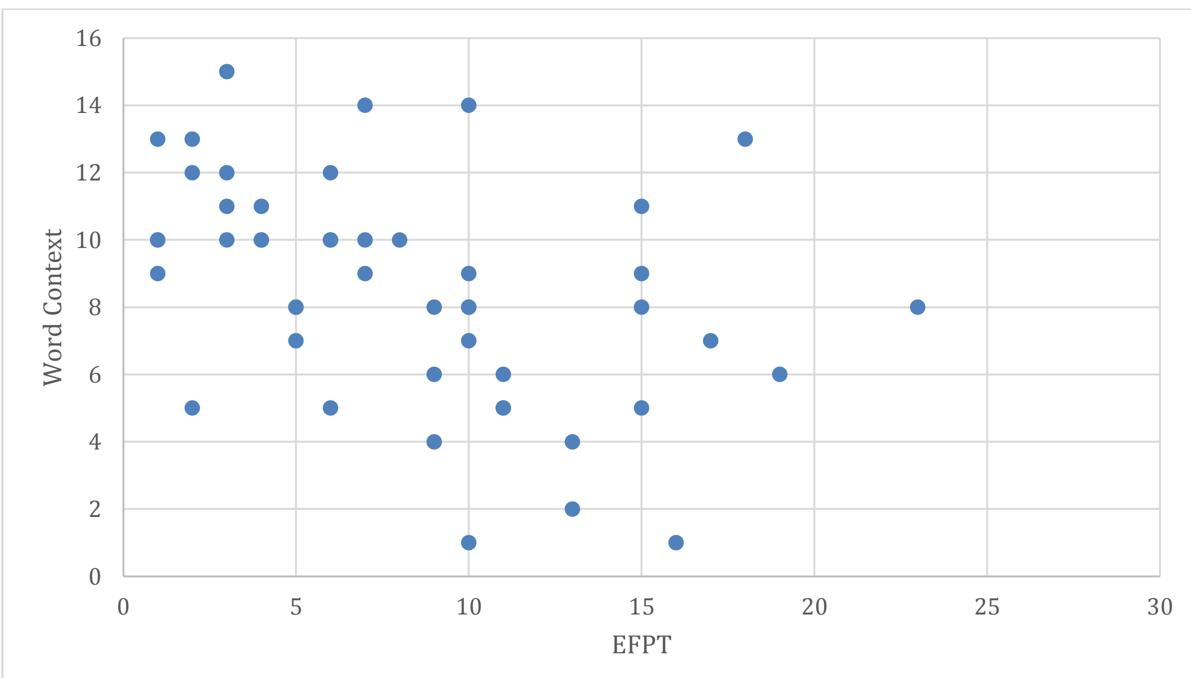

Figure 21. Scatterplot of EFPT total scores and D-KEFS Word Context Test.

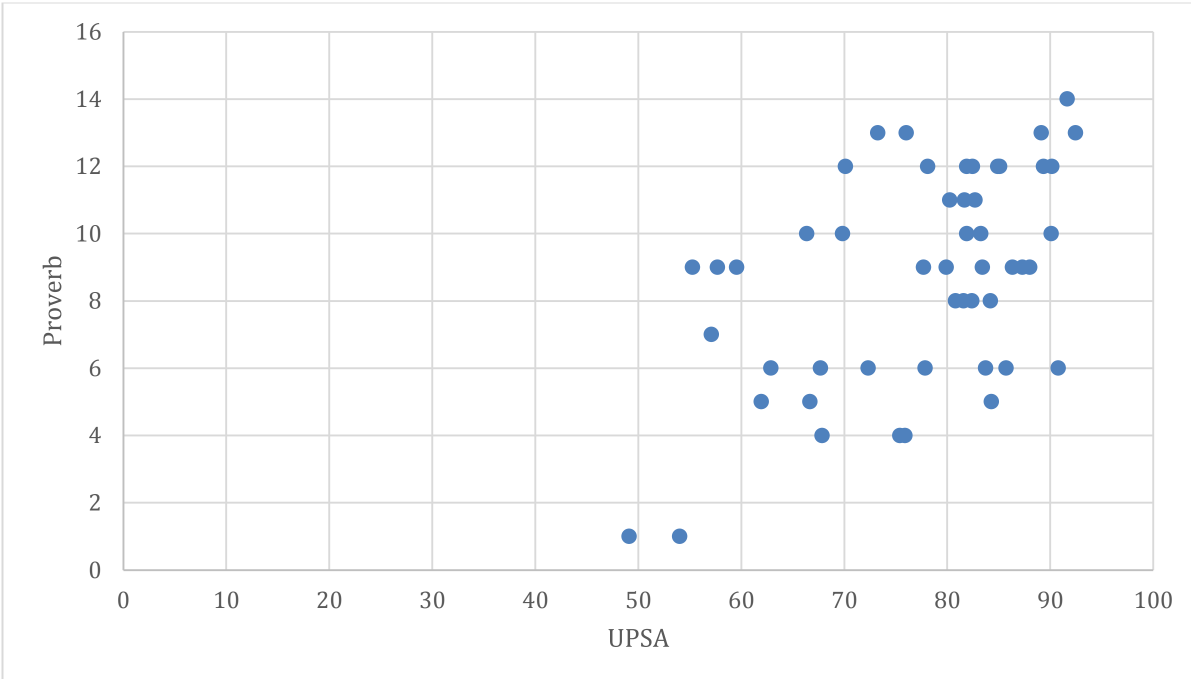

Figure 22. Scatterplot of UPSA total scores and D-KEFS Proverb Test.

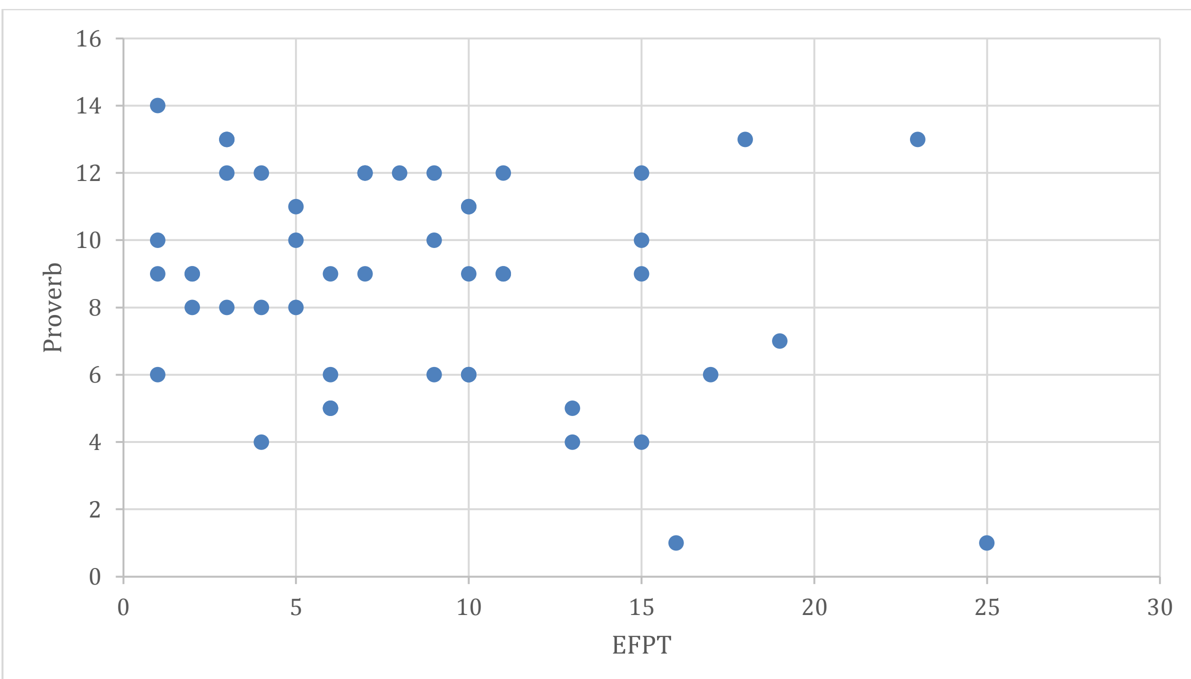

Figure 23. Scatterplot of EFPT total scores and D-KEFS Proverb Test.

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VITA

Denisse Tiznado was born on September 19, 1988, in San Diego, California. She attended elementary school in Mexico and returned with her family to Chula Vista, California where she attended local middle school and high school. Denisse graduated from Eastlake High School in 2006. She attended Southwestern Community College and then transferred to San Diego State University (SDSU) where she graduated, summa cum laude, in 2011. Her degree was a Bachelor of Arts degree in Psychology. She was a member of the McNair Scholars Program and the NIMH funded Career Opportunities in Research Scholars Program.

Denisse started her doctoral training in Clinical Health Psychology at the University of Missouri-Kansas City (UMKC) in the fall of 2011. She has been involved in research projects that investigate the relationship between cognitive and psychosocial variables and performance of Instrumental Activities of Daily Living in Stroke Survivors.

Denisse has completed and collaborated on multiple research projects that have been presented in national and international research conferences. She has received numerous fellowships during her doctoral training at UMKC including the Chancellor's Doctoral Fellowship, Chancellor's Minority Doctoral Fellowship, McNair Doctoral Fellowship, and the Women's Council Gerre Gene Strauss Award. She has authored and co-authored multiple peer-reviewed manuscripts published in the *The Journal of Nervous and Mental Disease*, *Schizophrenia Bulletin*, among other journals.

Denisse received clinical training at the Kansas City Care Health Clinic and the Leavenworth Veteran's Affairs Medical Center. She will complete an APA Accredited Psychology internship at the VA Long Beach Healthcare System in Long Beach, California.