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Exploratory Factor Analysis of the Nova Multilingual Neuropsychological Battery (NMNB)

Annelly Bure-Reyes
Nova Southeastern University, annelly@hotmail.com

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By

Annelly Buré-Reyes, M.S.

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Approved:

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Defense Date

Charles J. Golden, Ph.D., Chairperson

Ed Simco, Ph.D.

Barry Schneider, Ph.D.

11/17/16
Date of Final Approval

Charles J. Golden, Ph.D., Chairperson

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Nova Southeastern University

ABSTRACT

This study examined the underlying factor structure of the Nova Multilingual Neuropsychological Battery (NMNB) and evaluated the influence of demographic variables such as language fluency and acculturation on test performance. The NMNB is a comprehensive test designed to measure cognitive abilities in Spanish/English bilinguals. The instrument was developed taking into consideration cultural and language variables believed to influence neuropsychological test performance and it includes a Spanish and an English version. It is comprised of tasks measuring abilities such as short and long term memory, executive functioning, motor skills, visuo-spatial abilities, arithmetic, and vocabulary.

The study included 139 participants (69 English monolinguals and 70 Spanish/English bilinguals). Forty-four participants from the bilingual group were tested in English and 26 were tested in Spanish. Participants were normal adults between 18 and 56 years of age who were primarily recruited from a university setting. They also completed a demographic questionnaire that included a measure of acculturation.

An exploratory factor analysis was used to test the hypothesis that the subtests from NMNB would load onto five factors including language, perceptual reasoning, memory, executive functioning and psychomotor abilities. Results from four different

retention models did not match the hypothesized factor structure, yet they allowed the identification of specific cognitive domains within the factors. These cognitive domains include memory, learning, executive functioning, perceptual reasoning, speed of processing, and language abilities. Verbal memory and learning were factors consistently identified across the retention methods.

The moderation effects of language fluency and level of acculturation on test performance were examined. It was hypothesized that language fluency, as defined by performance on the Categorical Fluency subtest, would moderate the performance on tasks measuring language abilities. It was also hypothesized that level of acculturation would moderate the performance on measures of executive functioning and perceptual reasoning abilities. These hypotheses were based on the alleged pattern of advantages and disadvantages observed in bilingual individuals according to current research studies. Results from regression analyses showed no moderation effects of language fluency and level of acculturation on test performance. Data from this study did not show the purported pattern of disadvantages of bilingualism on language abilities neither demonstrated advantages in areas such as executive functioning and working memory.

Overall, the findings did not support the hypotheses of the study. However, the results allowed the analyses of the utility of the instrument in the assessment of specific cognitive abilities as well as the need for developing appropriate measures for this population. Furthermore, the findings put into perspective the importance of formal and objective assessment of language abilities and level of acculturation. This study represents an attempt to fill in the gap regarding to the empirical knowledge about neuropsychological assessment of individuals of Hispanic backgrounds. As such, it adds to the scarce literature on this topic. Further examination of the psychometric properties of the NMNB is warranted. Future research should include a larger sample with Spanish monolinguals, older adults as well as individuals with different levels of educational attainment.

CHAPTER I

Statement of the Problem

The current demographic trends of the United States put into perspective the diversity within the country. Currently, there are 55 million of Hispanics in the United States, representing 17 percent of the nation's total population and making Hispanics the largest ethnic or racial minority group (U.S. Census Bureau, 2015). Such facts and figures put into perspective the intricacies associated with the development and interactions of those who form part of a cultural diverse society. Therefore, the evaluation of those mechanisms that influence the development of culturally diverse societies seems to be appropriate at this point.

The assessment of individuals from different linguistic and cultural backgrounds currently represents a challenge in the field of neuropsychology. A variety of measures have been developed for the quantitative assessment of different cognitive domains. However, it has been stated that clinical neuropsychology has progressed in areas such as the assessment of brain pathology and the establishment of clinical/anatomical correlations, yet the understanding of the role of culture and individual differences has not reached remarkable progress (Ardila, 1995). Some authors (Ardila, Roselli & Puente, 1994) have discussed that age, education, language and culture are variables that play a crucial role in neuropsychological test performance. Despite the knowledge and awareness of the relevance of these variables, the approach to the understanding of neuro-cognitive functioning continues to be decontextualized and independent from socio-environmental variables (Pérez-Arce, 1999).

Research studies addressing the impact of cultural variables continue to be scarce, despite the theories highlighting its importance (Puente & Agranovish, 2003). Echmendia (2004) pointed out that this lack of empirical work may be attributed to the fact that neuropsychology is a relatively recent field and its focus has been directed towards the growth in professional identity, the development of tests, the identification of brain-behavior relationships, and so forth. However, according to the author, some efforts to include cultural variables have been made, yet the discrepancy between the scientific and clinical knowledge regarding the specific influence of cultural variables and the demographic changes is still noticeable. Particularly, Echemendia (2004) highlighted the accelerated growth of the minority population in the United States and the lack of professionals prepared to work with this population.

The evaluation of Spanish/English bilinguals is a case of interest due to its implications. Some authors (Rivera, Arentoft, Germano et al., 2008) have stated that even though the impact of bilingualism on cognitive development is evident, there is no clear understanding of how to best conduct neuropsychological evaluations with bilingual individuals. In view of that, the authors highlighted the critical issues related to the evaluation of bilingual individuals. Specifically, they pointed out the importance of conducting appropriate assessment of levels of bilingualism and conducting evaluations in both languages when possible. Furthermore, they discussed the need of trained professionals that can address the demands of working with socio-linguistically diverse populations.

Gasquoine and Gonzalez (2012) discussed that individual variables such as bilingualism impact the identification of cognitive impairment, which is the main purpose of neuropsychological evaluations. However, according to the authors, the specific mechanisms through which bilingualism influence cognitive abilities remain unclear. Accordingly, it is imperative to address issues concerning aspects associated with the assessment of linguistically diverse individuals.

Chapter II

Review of the Literature

Neuropsychological Research with Hispanic Populations

Several authors have discussed the slow progress of the field of neuropsychology towards the study of individuals from minority backgrounds. Gasquoine (2001) argued that neuropsychological research with Hispanics have been primarily characterized by the study of Spanish speaking older adults with low education. Specifically, the author described that research efforts have been directed towards comparisons with the Anglo-American population. Furthermore, the author pointed out that many studies have methodological limitations including Type I errors and inappropriate statistical control of variables such as education and acculturation as well as inappropriate Spanish/English translations of test instruments.

Some studies have focused on neuropsychological assessment in clinical populations. Boone, Victor, Wen, Razani and Pontón (2007) evaluated the effects of ethnicity, language, and acculturation on neuropsychological test performance in a clinical population. The sample included patients from a public hospital and a mental health center who were referred for a neuropsychological evaluation. The tests included in the study measured language, attention, constructional ability, nonverbal processing speed, and executive skills. The authors conducted analysis comparing the performance of patients who spoke English as a first language or learned English at the same time as they learned other language with patients who spoke English as a second language. The primary findings of the study showed that patients who spoke English as a first language had higher scores in most the tests. The results also showed an association between acculturation and performance. The authors concluded that test performance differences are not only observed in normal populations; they are also observed in clinical populations. This may be an indication of the strong influence of other variables such as ethnicity and acculturation.

Other studies have focused on the performance of Spanish/English bilinguals on specific neuropsychological tests. Rosselli, Ardila, Santissi and colleagues (2001) evaluated the effects of bilingualism on the performance on the Stroop Test. An aspect of interest in this study is that the authors evaluated bilingual participants in both English and Spanish based on their language proficiency. The authors found that bilingual participants demonstrated slower performance than the monolingual group. Authors concluded that the findings suggest the influence of language interference in bilinguals.

Gasquoine, Croyle, Cavazos and Sandoval (2007) also examined the performance of Spanish/English participants on neuropsychological tests. The authors compared the performance of Spanish-dominant, balanced, and English-dominant bilinguals on Spanish and English tests. The results showed no significant differences in test scores between the Spanish and English administration in balanced bilinguals. Significant effect of language was observed in Spanish and/or English dominant bilinguals. The authors highlighted the difficulties comparing the Spanish and English test scores because of issues with the norms. They also described that the discrepancies increased Type I error rates even after they were corrected.

The empirical examination of the translation of neuropsychological tests was addressed by Siedlecki, Manly, Brickman and colleagues (2010). Particularly, the authors were interested in examining whether neuropsychological tests translated into Spanish measure the same cognitive constructs. The performance of Spanish and English speaking older adults on neuropsychological tests used in the diagnosis of dementia was evaluated. The analyses were conducted using a four-factor structural model that included memory, language, visual-spatial abilities and speed constructs. The analyses indicated that the data from both language groups are consistent with the constructs measured.

Gasquoine and Gonzalez (2012) discussed the implications of developing separate norms in English and Spanish. Mainly, these authors indicated that norms developed for monolingual speakers in either English or Spanish may not be useful when evaluating bilinguals. According to them, the use of monolingual norms may be inadequate due to the particular effect of bilingualism on cognition.

Bender, Cole, Aponte-Samalot, Cruz-Laureano et al. (2009) argued that despite the need for appropriate measures for the growing and changing population of this country, "few assessment measures have been developed for, adapted to, or normalized with historically underrepresented populations" (p.217). Mungas, Reed, Marshall and Gonzalez (2000) stated that the few standardized tests that are available have many limitations and may underestimate or overestimate cognitive functioning. Evidently, the scarce number of tests with appropriate norms and that are culturally fair represents a major problem in the field of clinical neuropsychology (Bender et al., 2009; Ponton, Gonzalez, Hernandez, Herrera et al., 2000).

Few measures for Spanish speakers have been developed outside the United States. Ostrosky-Solís, Ardila and Roselli (1999) reported the development, standardization and reliability assessment of the NEUROPSI. The author described the test as a brief, reliable and objective instrument developed for the use with Spanish-speaking adults. The authors discussed that the test assess different cognitive domains including orientation, attention/concentration, language, memory, visuo-motor, executive function, reading, writing, and calculation. Furthermore, the standardization sample included 883 volunteers from different areas of Mexico with ages ranging from 16 to 85 years and education ranging from zero to 24 years. One of the major findings from this study was that level of education had a significant effect on most of the measures.

Ostrosky-Solís and colleagues (2007) also reported the development, standardization and the reliability of the test NEUROPSI: ATTENTION AND MEMORY. The authors indicated that the instrument assess domains including orientation, attention and concentration, executive functions, working memory, immediate verbal memory, delayed verbal memory, immediate visual memory, and delayed visual memory. Similar to the previously described measure, this instrument was standardized with a sample of 521 participants from Mexico with ages ranging from 6 to 85 years and education ranging from zero to 22 years. The analyses conducted in this study allowed the examination of the factor structure of the instrument as well as the examination of the effects of age, education and the interaction of these variables on performance. The authors identified six factors within the instrument and found effects of education on some of the areas evaluated, particularly in verbal fluency. They discussed that they only found a few significant age and education interactions.

The Bilingual Experience

Several research studies have been conducted with the purpose to evaluate different aspects related to the acquisition and use of two languages. Rivera, Arentoft, Germano and colleagues (2008) indicated that research on bilingualism has emphasized on the differences between monolinguals and bilinguals. The authors described that the focus has been directed towards the cognitive mechanisms related to frequency of language use and competition or interference between languages. Furthermore, they explained that these cognitive mechanisms are important aspects in the examination of the effects of bilingualism on neuropsychological test performance.

Gasquoine and Gonzalez (2012) stated that there is a debate regarding the effects of bilingualism on cognition. Other authors (Stafford, 2011) highlighted that some research studies have concluded that bilingualism has a favorable effect on executive attention for the performance on non-verbal tasks, whereas other studies have indicated the presence of disadvantages in the performance on language-dependent tasks. It has been argued that although the cognitive disadvantages of bilingualism are associated with language proficiency and verbal domains, there are advantages associated with the executive control of attention (Bialystok, 2009 & Rivera, Arentoft, Germano et al, 2008). It has also been discussed that the influence of bilingualism on linguistic and cognition can be observed across the lifespan (Bialystok, 2009). Specifically, Bialystok (2007) discussed the hypothesis that suggests that bilingualism enhances the development of executive control during childhood, which leads to cognitive control advantages in adulthood, and therefore it protects bilingual older adults from decline in cognitive control.

Bialystok (2009) described the specific factors associated with the disadvantages of bilingualism in language proficiency and verbal fluency. The author explained that research studies on this topic suggest that bilingual children have a smaller vocabulary in each language than monolinguals. The author also indicated that the same pattern is observed in adults, but not necessarily in vocabulary size, rather the pattern is observed in access to vocabulary. Regarding the pattern of performance on verbal tasks, Gasquoine and Gonzalez (2012) discussed that some research studies have claimed that bilingual individuals exhibit advantages in language skills when their performance is similar to monolinguals. On the other hand, the author discussed that the bilingual experience may enhance executive control functioning, particularly, those related to inhibition, cognitive flexibility and working memory.

Some authors (Carlson & Meltzoff, 2008; Stafford, 2011) also discussed the effects of bilingualism during childhood and adulthood. Carlson and Meltzoff (2008) discussed that several research studies primarily focus on the comparison of monolinguals and bilinguals. Specifically, the authors argued that the studies predominantly emphasize on the disadvantages of growing up with two languages. However, the authors conducted a close examination of the literature and they concluded that bilingual children might be at an advantage. They indicated that research studies suggest that bilingual children are more advanced in their ability to control attention than their monolingual peers. Stafford (2011) further explained that this advantage over cognitive control seen in children continues into adulthood, particularly in nonverbal domains. The author also discussed that research studies suggest that bilingual individuals have more difficulties on verbal tasks such as word retrieval, semantic fluency and syntactic memory.

Gasquoine and Gonzalez (2012) examined the alleged pattern of disadvantages and advantages of the performance of bilingual individuals on intelligence testing. The authors indicated that in tests such as the Wechsler Intelligence for Children, 3rd edition the mean scores of Hispanic American individuals tend to be lower when compared to White non-Hispanics. The authors further described that a similar pattern of performance occurs when tests are administrated in both English and Spanish. They examined research studies with the Woodcock-Munoz Language Survey-Revised and noted that individuals who were tested in English and Spanish obtained lower scores when their scores were compared to the national mean scores.

Artiola i Fortuny and colleagues (2005) evaluated the influence of assessment tools on the results of evaluations of cognitive abilities in Spanish speakers. The authors indicated that the linguistic quality of the instruments, such as questionnaires, manuals, test instructions, test items and test protocols, use to evaluate cognitive abilities in Spanish-speaking individuals living in the United States is questionable. Furthermore, they stated that the use of such materials in research studies represent a threat to the validity of the results.

Assessment of Bilingualism

Several variables influence the study of bilingualism and its impact on cognitive processes and neuropsychological test performance. Rivera, Arentoft, Germano and colleagues (2008) discussed the critical issues of the evaluation in the neuropsychological evaluation of bilinguals. The authors highlighted that a main issue is establishing who is bilingual, that is, determining proficiency in both languages. Regarding this, they discussed the importance of accurate assessment of language proficiency. They indicated that language proficiency can be assessed employing subjective and objective measures. They further explained that the objective evaluation of language proficiency provides important information regarding whether an individual is English-dominant bilingual, dominant in a non-English language or balanced.

Gasquoine and Gonzalez (2012) stated that bilingualism is a multidimensional continuous construct. They indicated that the assessment of bilingualism should include the evaluation of proficiency and dominance. The authors defined proficiency as the rating in each language and dominance as the difference score between proficiency measures in two languages. They indicated that both proficiency and dominance vary across domains including expression, comprehension, reading, and writing skills and they are also influenced by variables such as age of second language acquisition and amount of second language exposure.

Purpose of the Study

The current study was designed to address issues related to the development of appropriate instruments for Spanish/English bilinguals and to evaluate the impact of demographic variables, such as language proficiency and acculturation, on neuropsychological test performance. Therefore, the objective of the study was to identify the underlying factor structure of the Nova Multilingual Neuropsychological Battery (NMNB). The goal was to evaluate which variables of the battery are correlated with one another and independent from the rest of the variables, that is, which variables of the NMNB are combined into factors. Another goal of the study was to examine the influence of demographic variables such as language fluency and acculturation on the performance of Spanish/English bilinguals and English monolinguals on subtests measuring language abilities and executive functioning skills.

The cumulative evidence regarding the challenges associated with the neuropsychological assessment of the Hispanic/Latino population highlights the need of addressing this issue. The field of clinical neuropsychology has been inefficient in addressing the range of factors that play a critical role in the assessment of brain-behavior relationships. The current study represents an attempt to fill in the gap in the assessment of neuropsychological functioning of Spanish/English bilinguals. Particularly, this study was designed with the goal to contribute to the development of cultural proficiency in neuropsychological evaluation of individuals from Hispanic/Latino backgrounds.

Overall, this study also has many important implications for the development of appropriate assessment instruments. A major issue in the field of clinical neuropsychology is the lack of measures sensitive to the influence of cultural variables. Echemendia and Harris (2004) evaluated the use of neuropsychological tests with the Hispanic/Latino population. The authors found that it is a common practice to conduct evaluations of monolingual Spanish speakers and Spanish/English bilinguals using the same tests used with English speaking individuals. The problem is not only the use of inappropriate tests; the problem also involves the use of inappropriate norms and the simple translation of tests. Pontón and Ardila (1999) explained that the assumptions underlying tests translation include the conception that a translated test will measure the same constructs than the original test. That is, it is assumed that the psychometric properties will also be translated.

Furthermore, Mungas, Reed, Marshall and Gonzalez (2000) discussed the lack of psychometric matching tests and the importance of appropriate test construction strategies. Specifically, the authors indicated that careful test construction strategies involve consistent reliability across different scales and at all ability levels. They explained this is important because the use of appropriate instruments allows the accurate identification of abilities that are intact from those that are impaired, and this is the goal of neuropsychological assessment.

The increasing evidence of the several issues in neuropsychological assessment of the Hispanic/Latino population it is a current challenge. This study is an attempt to address the issues through the examination of the effects of cultural factors on neuro-cognitive development and their manifestations on test performance. It is expected that this study will open the door for the beginning of new studies that can guide the discipline to move forward the accurate knowledge of individual differences. Ultimately, this will provide the tools that will help with better diagnosis, treatments, and interventions to better serve individuals from Hispanic/Latino backgrounds.

Hypotheses

Hypothesis one. It was hypothesized that an exploratory factor analysis would reveal that the NMNB subtests load onto five factors. These factors included language, perceptual reasoning, memory, executive functioning and psychomotor abilities.

Examination of the nature of the tasks demands of each of the NMNB subtests guided this hypothesis. This battery has been developed with the goal to measure the cognitive domains expected to emerge as factors. Based on the examination of the tasks demands and the cognitive domains of each subtest, it was expected that the following subtests would load onto the language factor: Categorical Fluency, Anomia, Speeded Repetition, Categorization, Spelling, Reading Comprehension and Vocabulary. The following subtests would load onto the perceptual reasoning factor: Serial Learning, Figural Rotation, Sequential Picture Analysis, Visual Spatial Puzzle and Angular Rotation. The following subtests would load onto the memory factor: Semantic Memory (free recall and recognition), Semantic Memory Delayed, Memory for Figures, Memory for Figures Delayed, Verbal Learning, Oral Word Recognition, Embedded Figures and Visual-Sensory Memory. The following subtests would load onto the executive functioning factor: Visual Memory Span, Inverse Order, Interference Task and Complex Figure. Finally, the following subtests will load onto the psychomotor abilities factor: Motor Coordination, Motor Component of Visual Scanning and Motor Writing.

Research studies (e.g., Pontón, Gonzalez, Hernandez et al., 2000; Siedlecki, Manly, Brickman et al., 2010) have found language, memory, visual-spatial ability, attention, and processing speed to be the cognitive factors across different instruments developed for Spanish/English bilingual populations. Pontón, Gonzalez, Hernandez and colleagues (2000) conducted an exploratory factor analysis and found distinctive factors for both the orthogonal and the oblique solutions using a .45 loading criterion. The authors concluded that this type of analyses support the evaluation of how tests and underlying constructs function across individuals who differ in their linguistic and cultural backgrounds.

Hypothesis two. It was hypothesized that language fluency, as defined by the performance of on the Categorical Fluency subtest, would moderate the relationship between language group and the performance on the subtests measuring language abilities.

It has been argued that variables such as bilingualism influence language abilities (Stafford, 2011). Current literature on this topic focuses on the alleged patterns of advantages and disadvantages produced by language abilities (Rivera, Arentoft, Germano et al., 2008). Bialystok (1999) argued that language processing in bilingual individuals involves mechanisms such as representation and selective attention. Even though bilingual individuals exhibit certain advantages in specific cognitive domains, it has been noted that those advantages are not usually observed in tasks demanding language abilities (Stafford, 2011). Particularly, it has been stated that bilinguals experience difficulties in verbal tasks involving word retrieval and semantic fluency (Stafford, 2011).

Kroll (2012) examined the impact of second language acquisition on cognitive functioning. The author explained that learning a second language after childhood can have mixed outcomes that produce changes in the native language and its influence on the second one. Accordingly, it may be more important to evaluate proficiency in the second language rather than age of acquisition. It has been argued that variables such as bilingualism influence language abilities (Stafford, 2011).

The influence of language proficiency may be manifested in different ways and its impact across cognitive domains may be different. Proficiency in both languages vary across skills including reading, writing, listening or speaking (Rivera, Arentoft, Germano et al., 2008). However, the literature on this topic has mainly focused on the relationship between this variable and verbal ability. For instance, Bialystok (1999) argued that language processing in bilingual individuals involves mechanisms such as representation and selective attention.

Gasquoine and Gonzalez (2012) stated that the specific mechanisms through which bilingualism affects performance on tasks demanding language abilities continue to be unclear. They explained that in the case of Spanish/English bilinguals, discrepancy on performance has been found in both languages and demographic explanations such as low socio-economic status or poor quality of education have been posited, yet research studies suggest that these variables are unlikely to affect performance. Furthermore, the authors discussed that other potential variables such as individual differences in acculturation, bilingualism and English language proficiency have been ignored.

Hypothesis three. It was hypothesized that levels of acculturation would moderate the relationship between language group and the performance on the subtests measuring executive functioning abilities and perceptual reasoning abilities.

Bilingualism appears to have a different effect on other cognitive domains such as perceptual reasoning, memory, executive functioning factor and psychomotor abilities. Rivera, Arentoft, Germano and colleagues (2008) explained that research studies on bilingualism focus on two main aspects: (1) reduced frequency language-specific use and (2) competition for selection within the language system. Research literature on the effect of bilingualism suggests that individuals who speak two languages possess enhanced cognitive abilities (Bialystok, 1999). Specifically, it has been argued that the advantages associated with bilingualism are observed in aspects related to executive control functioning, particularly, those related to inhibition, cognitive flexibility and working memory (Gonzalez, 2012).

It has been discussed that the development of skills such as learning, memory, literacy and spatial and problem solving can be influenced by variables such as culture (Kisser, Wendell, Spencer & Waldstein, 2012). Herrera, Ponton, Corona and colleagues (1998) examined the effects of acculturation on the performance of a neuropsychological screening battery that measures abilities such as language, memory, visuospatial, psychomotor, mental control and reasoning. The authors discussed that they found that acculturation was a significant moderator variable despite that some of the tasks were thought to be unaffected by variables such as education and culture. Arentoft, Byrd, Robbins, Monzones and colleagues (2012) discussed that high levels of acculturation are associated with better neuropsychological performance on tasks demanding abilities including executive functions, attention/working memory, verbal fluency, and processing speed.

CHAPTER III

Method

Participants

This study involved analysis of archival data from the Nova Multilingual Neuropsychological Battery (NMNB) Pilot Study. This study collected normative data from monolingual English and Spanish/English speaking participants. Participants of the study were normal adults between the ages of 18 and 60. Criteria for inclusion in the study were the absence of a history of neurological disorders, traumatic brain injuries, emotional disorders or substance abuse. The current study included a sample of 139 participants (92 females and 47 males). Sixty-nine participants were monolingual English speakers and 70 were Spanish/English bilinguals. From the Spanish/English bilingual group, 44 participants were tested in English and 26 were tested in Spanish. These individuals did not receive compensation for their participation in the study. The study was approved by the Institutional Review Board (IRB) and all participants signed an informed consent form. Descriptive statistics for age and education for the overall sample included in the study is presented in Table 1.

Table 1

Overall Means and Distribution for Age and Education (N = 139)

Variable	*M*	*SD*	Skewness	Kurtosis
Age	27.89	8.24	1.97	3.56
Education	17.27	1.97	-.49	.14

Table 2 depicts the descriptive statistics for the group of English monolingual participants.

Table 2

Monolingual Means and Distribution for Age and Education (n = 69)

Variable	*M*	*SD*	Skewness	Kurtosis
Age	26.28	6.92	2.93	9.66
Education	16.42	2.04	-.61	.58

Descriptive statistics for age and education for the Spanish/English bilingual sample is presented in Table 3.

Table 3

Bilingual Means and Distribution for Age and Education (n = 70)

Variable	*M*	*SD*	Skewness	Kurtosis
Age	29.49	9.13	1.45	1.43
Education	16.13	1.90	-.39	-.19

Measures

The measures of the study included a Demographics Questionnaire and the Nova Multilingual Neuropsychological Battery (NMNB).

Demographics Questionnaire (Demsky Y.I., Golden C.J., De Bruno V.G., Arias, A.J., Burns, W.J., 1996).

Participants of the NMNB pilot study answered a demographic form that included an acculturation questionnaire that measured language, culture, and socialization preferences. This questionnaire included 21 specific questions about these variables. Stack (2010) provided description of the development and scoring of these questions.

This author explained that the questions were developed based on other known measures (i.e. Stephenson Multigroup Scale and the Abbreviated Multidimensional Acculturation Scale). The author further described the questions were on a scale from 1 to 5. All the questions were added up and the higher the score attained was interpreted as the more acculturated to the U.S. American culture the person was (Stack, 2010). It is important to highlight that the author discussed that there are no validation studies for these questions as they were adapted from other measures. Additionally, information about educational level, years in the United States, and/or country of origin was obtained with this questionnaire.

The Nova Multilingual Neuropsychology Battery (Demsky, Golden, De Bruno, Arias & Burns, 1996).

The NMNB is a comprehensive battery designed to measure various cognitive domains in Spanish/English bilingual populations. The battery was developed using Alexander Luria's research and theoretical framework on culture and higher mental processes. The goal of this battery is to address the cultural variables that affect neuropsychological tests performance. The NMNB, for which there is an English and a Spanish version, is comprised of 39 subtests measuring several aspects of cognitive and intellectual functioning. Most the subtests of the battery are adaptations, not merely translations, from other widely used cognitive tests. The subtests in the battery include measures of short and long term memory, executive functioning, motor functioning, reading comprehension, visuo-spatial abilities, arithmetic, and vocabulary. The completion of the battery takes approximately three hours. All subtests can be administered via paper and pencil. Some of the subtests are available on a computer

PowerPoint program to facilitate the administration process. Figueroa (2010) presented the following description of all the subtests comprising the NMNB:

The NMNB Memory and Malingering Test. This is a computer test (PowerPoint) includes 30 pictures that participants are asked to remember. The pictures are presented for three seconds each. This test was used to determine if maximum effort was given by the participant at the beginning of the assessment. The pictures include a fly, a wrench, scissors, and a pen. Then, after each picture is individually presented, participants are shown 30 slides with two pictures each and they are asked to indicate which one they saw before.

I. Orientation. This subtest assesses the participants' mental status through questions regarding orientation to person, place, and time. Each correct answer is given a score of one point. Maximum score is 12.

II. Automatized Series. Participants are asked to state the days of the week, months of the year, count from 1 to 25, and recite the alphabet. The subtest also measures the participants' mental status. Maximum score is four.

III. Mental Tracking. Participants are asked to state the days of the week and months of the year backwards. This subtest also assists in determining mental status. Maximum score is two.

IV. Verbal Commands. This subtest requires participants to mimic performance of tasks such as sweeping, threading a needle, and putting in eye drops. Maximum score is 11.

V. Motor Coordination. The task requires that participants to perform a series of motor tasks as quickly and accurately as possible in 10 seconds. These tasks include tapping the table twice with their right hand and once with their left, and tapping the table with the fingers of their right hand consecutively. This subtest is a measure of motor coordination. The score is the total number of motor tasks completed for all 10 tasks.

VI. Motoric Component of Visual Scanning. This is a task of processing speed and visual scanning composed of two parts. First, participants are asked to trace a line as quickly as possible following a path identify with lines. During the second part of the task participants are asked to draw the same path on another page where the lines has been removed. The score is the total time to complete the tasks.

VII. Visual Scanning. For this subtest participants are asked to trace a line as quickly as possible between two different visual stimuli. This subtest measures visual scanning and processing speed. The score is the total time to complete the tasks.

VIII. Semantic Memory. During this subtest, the examiner reads a story to the participants, then they are asked to recall as much of the story as possible. This section of the subtest measures short-term verbal recall memory. After participants spontaneously recall the story, a series of multiple-choice questions are asked. This portion of the subtest measures short-term verbal recognition memory. The procedure is repeated for a second story. The total potential score for free recall is 89 and for the recognition question is 24.

IX. Visual Sensory Memory. This subtest, a measure of visual spatial scanning and speeded processing, is administered via the computer to reduce administration error. During this task, participants are presented with a picture of several figures for one second, and then the same picture with one of the figures missing for another second. Participants are then asked to identify which of the figures is missing and where was located on the page. A maximum total score is 14 (7 for figure and 7 for figure placement).

X. Visual Memory Span. Using a set of cards with holes distribute in different positions, the examiner puts a pencil through the holes following a specific sequence and then asks participants to reproduce the sequence. This subtest assesses for immediate visual spatial memory and attention/concentration. Maximum score obtainable is 14.

XI. Inverse Order. Similar to the previous task, using the set of cards with holes the examiner touches the holes following a specific sequence and then asks participants to reproduce the sequence in inverse order. This is a measure of attention/concentration, immediate visual spatial memory, and visual spatial manipulation. Total potential score is 14.

XII. Demsky-Golden Interference Test **(**Demsky, Golden, De Bruno, Arias & Burns, 1996). This is the interference task from the NMNB. This subtest is a measure of executive functioning, and is comprised of three separate tasks. The test is administered on the computer to reduce administration error and to allow the examiner to accurately monitor the participants' performance. During the first task, the participants are presented with the words "one," "two," or "three." Then they are asked to read the words down each column of 50 words as quickly and accurately as possible in 30 seconds. If the participants reach the end of the 50 words before the 30 seconds, they are prompted to start reading the words from the beginning. Next, participants are presented with another computer screen with 50 stimuli that includes the Arabic numbers 1, 2, or 3. Like the previous trial, participants are asked to read the numbers as quickly and accurately as possible in 30 seconds. Finally, the third stimulus includes a screen or page with the

Arabic numbers 1, 2, or 3 grouped in different ways. The purpose of the subtest is for the participants to indicate the number of digits they see. For example, 222, 3, 11 would be correctly answered three, one, two. Similar to the two previous tasks, participants must respond as quickly and accurately as possible in 30 seconds. The scores from the three trials are added up for a total score.

XIII. Semantic Memory Delayed. During this subtest, participants to recall the two stories read to them earlier. Similar to the Semantic Memory subtest, a multiple-choice recognition task is administered after the spontaneous recall of each of the stories. This is a measure of long-term verbal memory and recognition. The total potential score for free recall is 89 and for the recognition questions is 24.

XIV. Categorical Fluency. In this subtest participants are given a category (i.e. terrestrial animals, fruits, and colors) and then asked to name as many things as they can that fit into that specific category in 60 seconds. This subtest measures the participants' categorical fluency abilities. The total score is the sum of responses for each of the three categories.

XV. Verbal Learning. This subtest measures participants' short-term verbal memory skills. This subtest and the subsequent subtest, Oral Word Recognition, are administered together. During this subtest, the examiner reads a list of words and asks participants to recall as many as they can remember. The list of words is presented during four successive trials. Oral Word Recognition subtest is administered immediately after the first three learning trials. It involves presenting a new list and asking participants to identify which of the words were in the list they were asked to remember. Verbal Learning. Total possible score is 48.

XVI. Oral Word Recognition. This is a test of short-term verbal recognition memory. As previously described, following the list of words read for Verbal Learning, the examiner reads a list of words and asks the participants if it was one of the words from the list they were asked to remember. This is repeated a total of three times. Total potential score is 60.

XVII. Serial Learning. This subtest assesses the participants' visual spatial learning abilities. This subtest is also administered on the computer and utilized for this study to reduce administration error. During this task, participants are presented with a set of five colored figures one at a time, each for three seconds, and asked to examine each one of them. Then the same figures are presented in white and black and the participants' task is to point to color that corresponds to each figure using a color swatch. Participants receive feedback after each answer. Maximum potential score is 15 points.

XVIII. Memory for Figures. This test measures visual spatial recognition and scanning and is also available on the computer. This subtest involves presenting a picture of five figures for three seconds. Then, participants are presented with a page including several figures and asked to point to the figures they saw on the previous page. This procedure was conducted during three different trials. Total potential score is 15.

XIX. Figural Rotation. During this subtest of visual spatial manipulation, participants are presented a page containing rows with different figures. The participants are then asked to determine which of the rotated figures on the right side of the page is the same as the figure on the left side of the page. Total potential score is nine.

XX. Embedded Figures. Participants are presented with several pictures of objects embedded over one another, one at a time, for three seconds. Participants are asked to name all the objects in the picture. The subtest measures visual scanning and discrimination. Total potential score is 20.

XXI. Cancellation Task. This is a measure of visual scanning and processing speed. Participants are presented with a page that has several rows of different figures. Participants' task is to cross out all the triangles as quickly as possible in 30 seconds. The total score is the number of correct cancellations minus the total number of errors. Maximum potential score is 55.

XXII. Mazes. For this task of visual scanning and processing speed, participants are asked to complete several mazes as quickly as possible without making errors. The total score is the amount of time it takes to all the mazes. Total errors are also recorded.

XXIII. Verbal Learning Delayed. This is a measure of long-term verbal memory. Participants are asked to recall as many words as they can from the list they were asked to remember previously. Total potential score obtained is 12.

XXIV. Oral Word Recognition Delayed. During this subtest, the participants are asked to identify the words from the Verbal Learning subtest. This is measure of long-term verbal recognition. The maximum score that can be obtained is 20.

XXV. Anomia. For this task, participants are presented with a page containing a series of objects and they are asked to provide the name of the objects as well as the names of different parts of the objects. If participants are unable to name object, a phonemic cue is given. The correct answer without assistance receives a score of one point and any pictures that requires prompting receives a score of 0. Total potential score is 20.

XXVI. Phonetic Discrimination. During this subtest, the examiner reads aloud two similar sounding words and participants are asked to repeat the words and point the picture that corresponds to each word. This subtest is a measure of auditory phonetic discrimination. Total score is equal to the number of word pairs repeated accurately.

XXVII. Speeded Repetition. On this subtest, participants are asked to repeat word or phrases as many times as possible in 10 seconds. This subtest is a measure of articulation. Total score is equal to the total times that all the words and phrases accurately repeated.

XXVIII. Visual Spatial Puzzles. This subtest has two parts. The first part involves asking participants to look at a puzzle that has missing pieces and identify the space where the missing pieces belong. During the second part participants are provided with a puzzle and asked to put the pieces together as quickly as possible. This subtest is a measure of visual analysis, synthesis, and construction. Maximum score is 38. Total time to complete all of the puzzles is also recorded.

XXIX. Categorization. This subtest involves presenting a page with pictures of different objects and asking participant to point to the pictures belonging to a specific category. There are four different categories. Total potential score is 12.

XXX. Spelling. During this task of verbal knowledge, participants are asked to spell words presented orally by the examiner. Participants are asked to write down a series of letter, then spell words and sentences. Maximum potential score is 44.

XXXI. Motor Writing. On this subtest, the participants are asked to copy a text from a booklet. Participants are first asked to copy letters, then to copy words, and finally to copy groups of words and complete sentences. Maximum score that can be attained is 117.

XXXII. Reading Comprehension. This subtest requires asking participants to read five incomplete sentences to themselves and then provide a word that would complete the sentence. After that, the examiner reads two short passages and asks participants questions about the read passages. Total maximum score is seven points.

XXXIII. Sequential Picture Analysis. This is a test of logical/sequential reasoning. A group of pictures are presented to the participants, and then they are asked to organize the pictures in the correct order. Total potential score is six points.

XXXIV. Complex Figure. During this subtest, participants are asked to examine and try to remember a figure. Then, they are asked to identify the figure different parts of the figures. Total maximum score is five points.

XXXV. Angular Rotation. During this task of visual spatial ability, participants are presented a figure comprised of eight arrows labeled with different letters forming different angles. Then they are presented with different angles of the figure and asked to identify the letters corresponding to them. Maximum possible score is six points.

XXXVI. Memory for Figures Delayed. The delayed subtest of Memory for Figures is a test of long-term visual memory. It involves asking participants to point to the five figures the saw during the Memory for Figures subtest. Maximum score is five points.

XXXVII. Intellectual Analysis. This subtest is a measure of abstract reasoning. Participants are asked to describe the similarity or difference between two scenarios. During one of the items participants are asked to describe what seems absurd about a statement. The last three questions asked the participants to describe the difference between the same words when used in different contexts. The score for each item ranges from 0 to 2, with more complex or complete answers earning a score of 2. Total maximum score is 28.

XXXVIII. Mathematics. During this subtest, participants are asked to complete arithmetic problems. The first four equations are presented orally and participants are required to mentally solve the problems. Participants are allowed to use paper and pencil for the following problems. During the last part participants are presented a series of problems in 15 minutes. Maximum score is 18.

XXXIX. Vocabulary. For this subtest of verbal ability, participants are asked to provide the definition of words. The words became progressively more difficult and are scored from 0 points to 2 points. Total possible score is 40.

Procedure

The following were the steps employed to assess participants of the NMNB pilot study. At the entrance of the study, participants completed the demographic and acculturation questionnaire. This questionnaire was used to gather information about age, gender, marital status, level of education, country of origin, language preference, proficiency, and acculturation. The completion of this form took approximately 10 minutes. Following that, the Spanish/English bilinguals were assigned to complete the Nova Multilingual Neuropsychological Battery (NMNB) either in English or Spanish based on their preference.

CHAPTER IV

Results

Preliminary Analysis

The mean, standard deviation, skewness and kurtosis of all the subtests included in the study for the overall sample are presented in Table 4. Data were examined for accuracy of data entry and the presence of outliers. No outliers were found. The distribution of the subtest Anomia was found to be positively skewed with 70% of the participants obtaining the maximum possible score. The distributions of the subtests Phonemic Discrimination- Pronunciation, Phonemic Discrimination- Concept, Reading Comprehension, Angular Rotation and Motor Writing were found to be negatively skewed with the distribution primarily grouped towards higher scores. Ninety-six percent of the participants obtained the highest possible scores on Phonemic Discrimination-Pronunciation. Ninety-three percent of the participants obtained the highest possible score on the subtest Phonemic Discrimination- Concept. During the Reading Comprehension subset, 88% of participants obtained the highest scores. Ninety-three percent of the scores of the Angular Rotation fell in the higher end. Similarly, 87% of participants obtained the highest possible scores during the Motor Writing subtest. This pattern of distribution indicated little variability in performance across participants. This suggests that all participants may have obtained the higher scores due to the simplicity of the tasks, in contrast to the rest of the subtests, which varied in terms of the demands and difficulty levels.

Table 4

Descriptive Statistics of the Performance of All Participants

	M	*SD*	Skewness	Kurtosis
Categorical Fluency	54.76	11.86	-0.10	0.54
Anomia	20.26	5.61	6.26	41.22
Phonemic Discrimination- Pronunciation	18.96	0.24	-6.08	40.27
Phonemic Discrimination- Concept	18.90	0.39	-4.03	15.97
Speeded Repetition	164.84	39.21	0.87	2.02
Categorization	11.50	0.61	-1.00	1.03
Spelling	41.65	2.45	-1.30	2.22
Reading Comprehension	6.86	0.40	-3.09	9.41
Vocabulary	30.22	7.71	1.05	3.44
Serial Learning	13.32	1.82	-1.47	3.86
Figural Rotation	7.42	1.72	-0.95	0.10
Sequential Picture Analysis	5.46	1.02	-1.40	1.91
Visual Spatial Puzzle- Correct	35.65	3.34	-2.39	7.15
Visual Spatial Puzzle- Time	177.13	65.34	0.81	1.08
Angular Rotation	5.91	0.46	-5.61	39.96
Semantic Memory Immediate Recall	47.20	11.84	0.51	0.37
Semantic Memory Immediate Recognition	21.13	2.14	-0.46	-0.30
Semantic Memory Delayed Recall	50.34	11.11	-0.03	-0.59
Semantic Memory Delayed Recognition	21.36	2.24	-0.77	0.57
Memory for Figures Immediate Recall	12.98	1.68	-1.07	1.55
Memory for Figures Delayed Recall	4.67	0.64	-1.91	4.01
Verbal Learning Immediate Recall	35.66	5.62	-0.37	-0.20
Oral Word Immediate Recognition	54.71	3.82	-0.91	1.03
Verbal Learning Delayed Recall	8.70	2.29	-0.52	-0.30
Oral Word Delayed Recognition	18.76	1.38	-1.02	0.41
Embedded Figure	15.19	2.90	-0.37	-0.68
Visual Sensory Memory	8.28	2.36	0.65	0.30
Visual Memory Span	10.02	1.81	0.13	0.65
Inverse Order	7.67	1.95	0.83	0.48
Interference	213.42	36.56	-0.04	-0.01
Complex Figure	3.12	1.29	-0.21	-0.72
Motor Coordination	143.84	38.56	0.19	0.67
Motor Component of Visual Scanning	16.82	9.21	1.56	3.24
Motor Writing	116.81	0.55	-2.99	8.57

Note. *M* = mean; *SD* = Standard Deviation; N=139

The distributions of the subtests mentioned above exceeded the acceptable values of skewness and kurtosis, which indicate that these subtests were not normally distributed. Therefore, the data from these subtests were removed from subsequent analyses.

Samples with significant departure from normality can affect the robustness of parametric tests that assume normal distributions. Consequently, this can affect the inferences about the population. On the other hand, minor violations to the assumption of normality may have little impact on the analyses. All other subtests did not exhibit significant deviation from a normal distribution.

The mean, standard deviation, skewness and kurtosis for the monolingual participants are presented in Table 5. The pattern of distribution was similar to what was observed in the overall sample. The distribution of the subtest Anomia was found to be positively skewed with 71% of the participants obtaining the maximum possible score. The distributions of the subtests Phonemic Discrimination- Pronunciation, Phonemic Discrimination- Concept, Visual Spatial Puzzle- Correct, Angular Rotation and Motor Writing were found to be negatively skewed with the distribution primarily grouped towards higher scores. Ninety-six percent of the participants obtained the highest possible scores on the subtests Phonemic Discrimination- Pronunciation and Phonemic Discrimination- Concept. During the Visual Spatial Puzzle- Correct, 42% of the participants obtained the highest scores. Ninety percent of the scores of the Angular Rotation fell in the higher end. Also, 88% of participants obtained the highest possible scores during the Motor Writing subtest.

Table 5

Descriptive Statistics of the Performance of Monolingual Participants

	M	*SD*	Skewness	Kurtosis
Categorical Fluency	58.23	11.55	0.11	0.91
Anomia	21.21	7.72	4.60	20.42
Phonemic Discrimination- Pronunciation	18.96	0.21	-4.58	19.52
Phonemic Discrimination- Concept	18.94	0.29	-5.51	32.13
Speeded Repetition	164.09	35.47	0.53	-0.09
Categorization	11.56	0.56	-0.80	-0.41
Spelling	42.30	1.79	-0.68	-0.72
Reading Comprehension	6.90	0.30	-2.70	5.44
Vocabulary	32.59	8.62	1.09	3.11
Serial Learning	13.35	1.97	-1.91	6.10
Figural Rotation	7.64	1.48	-1.01	0.46
Sequential Picture Analysis	5.51	0.98	-1.08	2.00
Visual Spatial Puzzle- Correct	36.12	2.93	-3.02	12.80
Visual Spatial Puzzle- Time	171.75	58.56	0.39	-0.48
Angular Rotation	5.83	0.62	-4.51	23.24
Semantic Memory Immediate Recall	48.43	11.84	0.76	0.29
Semantic Memory Immediate Recognition	21.12	2.14	-0.46	-0.30
Semantic Memory Delayed Recall	50.87	11.98	-0.04	-0.68
Semantic Memory Delayed Recognition	21.61	2.30	-0.79	0.88
Memory for Figures Immediate Recall	12.78	1.81	-1.15	1.96
Memory for Figures Delayed Recall	4.62	0.64	-1.84	3.56
Verbal Learning Immediate Recall	36.49	5.85	-0.44	-0.24
Oral Word Immediate Recognition	54.51	3.72	-1.04	1.91
Verbal Learning Delayed Recall	8.72	2.52	-0.57	-0.44
Oral Word Delayed Recognition	18.90	1.43	-1.48	1.91
Embedded Figure	15.62	2.60	-0.63	-0.14
Visual Sensory Memory	8.59	2.33	0.77	0.26
Visual Memory Span	10.29	1.85	0.31	.034
Inverse Order	7.74	1.98	0.88	0.25
Interference	213.64	36.17	0.03	0.04
Complex Figure	3.04	1.17	-0.20	-0.45
Motor Coordination	149.07	43.66	-0.18	0.56
Motor Component of Visual Scanning	16.04	8.99	2.00	6.27
Motor Writing	116.87	0.38	-3.03	9.35

Note. *M* = mean; *SD* = Standard Deviation; n=69

Scores on these subtests exceeded the acceptable values of skewness and kurtosis, which indicates that these subtests were not normally distributed. This suggests the performance of the monolingual participants on these subtests was similar this group and the scores tended to cluster around the mean.

The mean, standard deviation, skewness and kurtosis for the bilingual sample are presented in Table 6. The distributions of the subtests Anomia, Phonemic Discrimination-Pronunciation, Phonemic Discrimination- Concept, Reading Comprehension, Angular Rotation and Motor Writing were negatively skewed with the distribution grouped towards higher scores. Sixty-eight percent of the Spanish/English bilingual participants obtained the highest scores during the Anomia subtest. Ninety-seven percent of participants obtained the highest scores during the Phonemic Discrimination-Pronunciation, while the 90% obtained the highest scores during Phonemic Discrimination- Concept. During the Reading Comprehension subset, 87% of participants obtained the highest scores. Ninety-six percent of the scores of the Angular Rotation subtest fell in the higher end. Correspondingly, 86% of participants obtained the highest possible scores during the Motor Writing subtest.

Again, the pattern of the distribution was similar to the overall sample and the monolingual sample as well, yet some variations across the subtests were observed. The distributions of the subtests Reading Comprehension and Motor Writing did not exceed the acceptable kurtosis, suggesting that the scores of the Spanish/English bilingual participants on these subtests were more spread around the mean, therefore they are less likely to affect the results of the other analyses.

Table 6

Descriptive Statistics of the Performance of Bilingual Participants

	M	*SD*	Skewness	Kurtosis
Categorical Fluency	51.33	11.23	-0.41	-0.17
Anomia	19.33	1.52	-4.05	20.94
Phonemic Discrimination- Pronunciation	18.96	0.27	-6.66	46.07
Phonemic Discrimination- Concept	18.86	0.46	-3.31	10.29
Speeded Repetition	165.59	42.82	1.033	2.87
Categorization	11.44	0.65	-1.08	1.54
Spelling	41.00	2.83	-1.13	1.30
Reading Comprehension	6.83	0.48	-2.88	7.65
Vocabulary	27.89	5.87	0.02	-0.41
Serial Learning	13.29	1.68	-0.79	-0.08
Figural Rotation	7.21	1.90	-0.80	-0.38
Sequential Picture Analysis	5.41	1.06	-1.67	1.87
Visual Spatial Puzzle- Correct	35.19	3.66	-2.01	4.78
Visual Spatial Puzzle- Time	182.43	71.42	0.97	1.45
Angular Rotation	5.99	0.21	-1.45	21.74
Semantic Memory Immediate Recall	45.99	11.80	0.30	0.39
Semantic Memory Immediate Recog.	21.14	2.16	-0.47	-0.25
Semantic Memory Delayed Recall	49.81	10.24	-0.09	-0.54
Semantic Memory Delayed Recognition	21.11	2.16	-0.84	0.38
Memory for Figures Immediate Recall	13.17	1.53	-0.85	0.27
Memory for Figures Delayed Recall	4.71	0.64	-2.05	5.00
Verbal Learning Immediate Recall	34.84	5.29	-0.41	-0.05
Oral Word Immediate Recognition	54.90	3.93	-0.84	0.48
Verbal Learning Delayed Recall	8.67	2.05	-0.45	-0.20
Oral Word Delayed Recognition	18.63	1.33	-0.57	-0.88
Embedded Figure	14.76	3.13	-0.11	-0.92
Visual Sensory Memory	7.97	2.36	0.60	0.39
Visual Memory Span	9.76	1.75	-0.12	0.93
Inverse Order	7.60	1.94	0.80	0.83
Interference	213.20	37.21	-0.01	0.03
Complex Figure	3.20	1.40	-0.27	-0.91
Motor Coordination	138.69	32.27	0.68	0.87
Motor Component of Visual Scanning	17.60	9.42	1.22	1.31
Motor Writing	116.74	0.67	-2.56	5.52

Note. *M* = mean; *SD* = Standard Deviation; n=70

Primarily, it was determined that the distribution of scores for Anomia, Phonemic Discrimination- Pronunciation, Phonemic Discrimination- Concept, Reading Comprehension, Angular Rotation, and Motor Writing exceeded the acceptable values for skewness and kurtosis in the overall sample, which indicated the scores were not normally distributed. A similar pattern of distribution was observed in the scores of the monolingual participants and the bilingual participants, however the subtests Reading Comprehension and Motor Writing did not show departure from normality. No outliers or data entry errors were identified, which suggests the pattern of scores was a result of the tasks demands and performance. The subtests Anomia, Phonemic Discrimination-Pronunciation and Phonemic Discrimination- Concept were the subtests with the greater departure from normal distribution across participants in the different groups. The Phonemic Discrimination subtest is one the simplest tasks of the battery. Credit for correct pronunciation usually occurred in conjunction with credit for understanding the concept. Anomia is a confrontational naming task in which participants were asked to provide the names of simple objects. It appears that the nature of these tasks and their demands allowed that most participants obtained the maximum possible scores, which led to a skewed distribution of scores. Therefore, to avoid the possible impact of a distribution of scores exceeding acceptable values of distribution, the scores from the subtests Anomia, Phonemic Discrimination- Pronunciation, Phonemic Discrimination-Concept, Reading Comprehension, Angular Rotation, and Motor Writing were not included in the statistical analyses of the study.

Pearson’s correlations for all the subtests included in the study are presented in Table 7 through Table 12. Cohen’s (1988) conventions were used to interpret the magnitude of the correlation coefficients. Table 7 illustrates the correlations for the five subtests considered to be part of the language factor. These subtests include Categorical

Fluency, Speeded Repetition, Categorization, Spelling, Reading, and Vocabulary. The Categorical Fluency subtest was found to be significantly correlated with the subtests

Table 7

Pearson's Correlation for the Language Subtests

Subtests	1	2	3	4	5
1. Categorical Fluency	-	.09	.07	.07	**.28**
2. Speeded Repetition	.09	-	02	.16	**.23**
3. Categorization	.07	.05	-	-.10	.04
4. Spelling	.07	.16	-.10	-	**.29**
5. Vocabulary	**.28**	**.23**	.04	**.29**	-
6. Serial Learning	.14	.00	-.13	.14	.06
7. Figural Rotation	.12	**.21**	.02	.06	.09
8. Sequential Picture Analysis	-.05	.06	-.04	.06	.01
9. Visual Spatial Puzzle- Correct	.01	.05	-.06	-.02	.01
10. Visual Spatial Puzzle- Time	-.17	-.14	.10	-.04	-.19
11. Semantic Memory Immediate Recall	.11	-.02	-.09	.18	**.25**
12. Semantic Memory Immediate Recognition	.08	.05	-.01	.13	**.27**
13. Semantic Memory Delayed Recall	.22	.06	-.08	.13	.18
14. Semantic Memory Delayed Recognition	.18	-.00	.02	.15	.21
15. Memory for Figures Immediate Recall	.14	**.27**	-.04	.07	.10
16. Memory for Figures Delayed Recall	.05	.08	-.09	.03	.04
17. Verbal Learning Immediate Recall	**.40**	.09	-.05	.14	**.27**
18. Oral Word Immediate Recognition	.18	.03	.12	.12	.05
19. Verbal Learning Delayed Recall	**.29**	.10	-.13	.10	.12
20. Oral Word Delayed Recognition	**.24**	.20	-.04	.06	.07
21. Embedded Figure	.10	.10	-.07	.18	.13
22. Visual Sensory Memory	.56	.01	-.18	.08	.10
23. Visual Memory Span	.02	.17	-.02	.11	.14
24. Inverse Order	.09	.22	-.04	.20	**.24**
25. Interference	.15	**.45**	.05	-.10	.20
26. Complex Figure	.06	.08	-.03	.16	.12
27. Motor Coordination	-.02	**.47**	-.04	.03	**.24**
28. Motor Component of Visual Scanning	**-.26**	-.02	-.06	.03	-.16

Note. Correlations significant at the 0.01are in boldface. N= 139

Vocabulary, Verbal Learning Immediate Recall, Verbal Learning Delayed Recall, Oral Word Delayed Recognition, and Motor Component of Visual Scanning. Although the correlations were significant, the effect size was overall small. The subtest Speeded Repetition was found to be significantly correlated with the subtests Vocabulary, Memory for Figures, Interference and Motor Coordination. The effect size of these correlations were medium to small. There was also a significant correlation between the subtest Vocabulary and the subtests Spelling, Semantic Memory Immediate Recall, Semantic Memory Immediate Recognition, Semantic Memory Delayed Recall, Verbal Learning Immediate Recall, Inverse Order, and Motor Coordination. Again, the effect size of these correlations was predominantly small.

Pearson’s correlation results for the five subtests that were part of the perceptual reasoning factor are presented in Table 8. These subtests include Serial Learning, Figural Rotation, Sequential Picture Analysis, Visual Spatial Puzzle Total Correct, and Visual Spatial Puzzle Total Time. Serial Learning was found to be significantly correlated with Semantic Memory Immediate Recall, Semantic Memory Delayed Recall, Semantic Memory Delayed Recognition, Memory for Figures Immediate Recall, Verbal Learning Delayed Recall, and Embedded Figures. The effect size of these correlations was small to medium.

There was a significant correlation between Figural Rotation and Visual Spatial Puzzle Total- Correct, Memory for Figures Immediate Recall, Visual Memory Span, and Inverse Order. These correlations were also small. The subtest Sequential Picture Analysis was negatively correlated with the subtest Inverse Order, which indicated that when participants obtained higher scores on Sequential Picture Analysis their scores on the subtest Inverse Order reduced. There was also a negative correlation between Visual Spatial Puzzle Total- Time and Visual Spatial Puzzle Total- Correct.

Table 8

Pearson's Correlations for the Perceptual Reasoning Subtests

Subtests	6	7	8	9	10
1. Categorical Fluency	.14	.12	-.05	.01	-.17
2. Speeded Repetition	.00	.21	.06	.05	-.14
3. Categorization	-.13	.02	.04	.06	.10
4. Spelling	.14	.06	.06	.06	-.02
5. Vocabulary	.07	.09	.01	.01	-.19
6. Serial Learning	-	.07	.05	-.06	-.11
7. Figural Rotation	.07	-	-.09	**.23**	-.20
8. Sequential Picture Analysis	.05	-.09	-	.08	-.10
9. Visual Spatial Puzzle- Correct	-.06	**.23**	.08	-	**-.37**
10. Visual Spatial Puzzle- Time	-.11	-.20	-.10	**-.37**	-
11. Semantic Memory Immediate Recall	.21	-.06	.09	.08	**.24**
12. Semantic Memory Immediate Recognition	**.23**	-.06	.01	.06	-.19
13. Semantic Memory Delayed Recall	.24	.01	.10	.05	-.21
14. Semantic Memory Delayed Recognition	**.32**	-.00	-.04	.04	-.17
15. Memory for Figures Immediate Recall	**.32**	**.23**	.06	.13	-.19
16. Memory for Figures Delayed Recall	.10	.03	-.07	.14	.05
17. Verbal Learning Immediate Recall	.17	.00	-.02	-.06	-.18
18. Oral Word Immediate Recognition	.10	.03	.00	.19	-.22
19. Verbal Learning Delayed Recall	.27	.04	.01	-.08	-.16
20. Oral Word Delayed Recognition	.19	.14	-.01	.05	-.13
21. Embedded Figure	**.29**	.17	.07	.21	-.12
22. Visual Sensory Memory	.14	.08	.10	.18	-.20
23. Visual Memory Span	-.04	**.23**	-.19	.17	-.16
24. Inverse Order	.54	**.25**	-.26	.04	-.19
25. Interference	.02	.15	.08	.13	-.17
26. Complex Figure	.10	.03	.00	-.01	-.05
27. Motor Coordination	-.10	.09	.01	.16	-.09
28. Motor Component of Visual Scanning	.04	-.04	.06	-.05	.14

Note. Correlations significant at the 0.01are in boldface. *N= 139*

This indicated that as participants took more time to complete the puzzles, there was a reduction on the number of puzzle pieces correctly placed.

Table 9 includes the Pearson's correlations calculated for six of the twelve subtests that were part of the memory factor of the NMNB. These subtests include Semantic Memory Immediate Recall, Semantic Memory Immediate Recognition, Semantic Memory Delayed Recall, Semantic Memory Delayed Recognition, Memory for Figures Immediate Recall and Memory for Figure Delayed Recall.

There was a negatively small correlation between Semantic Memory Immediate Recall and Visual Spatial Puzzle Total- Time. Semantic Memory Immediate Recall was significantly correlated with Semantic Memory Immediate Recognition, Semantic Memory Delayed Recall, Semantic Memory Delayed Recognition, Verbal Learning Immediate Recall, Embedded Figures, and Visual Sensory Memory. The effect size of these correlations was predominantly moderate to large.

The Semantic Memory Immediate Recognition subtest was significantly correlated with Semantic Memory Delayed Recall, Semantic Memory Delayed Recognition, Memory for Figures Immediate Recall, Verbal Learning Immediate Recognition, Oral Word Immediate Recall, Verbal Learning Delayed Recall, Oral Word Delayed Recognition, and Visual Sensory Memory. Medium to small correlations were found between the Semantic Memory Delayed Recall subtest and the subtests Semantic Memory Delayed Recognition, Verbal Learning Immediate Recall, Verbal Learning Delayed Recall, Embedded Figures, and Visual Sensory Memory.

It was also found that the Semantic Memory Delayed Recall subtest was significantly correlated with Semantic Memory Delayed Recognition, Verbal Learning

Table 9

Pearson's Correlations for the Memory Subtests

Subtests	11	12	13	14	15	16
1. Categorical Fluency	.11	.08	.22	.18	.14	.05
2. Speeded Repetition	-.02	.05	.06	-.00	**.27**	.08
3. Categorization	-.09	-.01	-.08	.02	-.04	-.09
4. Spelling	.18	.13	.13	.15	.07	.03
5. Vocabulary	**.25**	**.27**	**.30**	.21	.10	.04
6. Serial Learning	.21	**.23**	**.25**	**.32**	**.32**	.10
7. Figural Rotation	-.06	-.07	.01	-.00	**.23**	.03
8. Sequential Picture Analysis	.09	.01	.10	-.04	.06	-.07
9. Visual Spatial Puzzle- Correct	.08	.06	.53	.04	.13	.14
10. Visual Spatial Puzzle- Time	**-.25**	-.19	-.21	-.17	-.19	.05
11. Semantic Memory Immediate Recall	-	**.58**	**.74**	**.47**	.08	-.05
12. Semantic Memory Immediate Recognition	**.58**	-	**.54**	**.76**	**.22**	.03
13. Semantic Memory Delayed Recall	**.74**	**.54**	-	**.47**	**.31**	.17
14. Semantic Memory Delayed Recognition	**.47**	**.76**	**.47**	-	**.24**	.05
15. Memory for Figures Immediate Recall	.07	**.22**	**.31**	**.24**	-	**.42**
16. Memory for Figures Delayed Recall	-.05	.03	.17	.05	.42*	-
17. Verbal Learning Immediate Recall	**.30**	**.29**	**28**	**.32**	.21	.02
18. Oral Word Immediate Recognition	.22	**.31**	.14	**.37**	.13	.07
19. Verbal Learning Delayed Recall	**.25**	**.28**	**.31**	**.28**	**.31**	.13
20. Oral Word Delayed Recognition	.17	**.23**	.18	.21	.20	.05
21. Embedded Figure	**.28**	.19	**.29**	**.23**	**.31**	**.24**
22. Visual Sensory Memory	**.36**	**.24**	**.29**	**.27**	.14	.02
23. Visual Memory Span	-.07	.02	-.09	-.08	.09	.19
24. Inverse Order	-.12	.01	-.08	-.01	.10	.10
25. Interference	.01	.03	.06	.08	.20	.00
26. Complex Figure	.18	.19	.18	.14	**.24**	**.23**
27. Motor Coordination	-.03	-.03	.07	.01	.17	.03
28. Motor Component of Visual Scanning	.08	-.08	.04	-.15	-.06	.08

Note. Correlations significant at the 0.01are in boldface. *N= 139*

Immediate Recall, Verbal Learning Immediate Recall, Verbal Learning Delayed Recall, Embedded Figures, and Visual Sensory Memory.

Correlation analyses also revealed that the Semantic Memory Delayed Recognition subtest was significantly correlated with Memory for Figures Immediate Recall, Verbal Learning Immediate Recall, Oral Word Immediate Recognition, Verbal Learning Delayed Recall, Embedded Figures, and Visual Sensory Memory. These correlations were overall small.

The results showed there was a significant correlation between the Memory for Figures Immediate Recall subtest and Memory for Figures Delayed Recall, Verbal Learning Immediate Recall, Verbal Learning Delayed Recall, and Complex Figure. Finally, there was a significant correlation between the Memory for Figures Delayed Recall subtest and the subtests Embedded Figures and Complex Figure.

Pearson's correlation results for the remaining six subtests that were considered part of the memory factor of the NMNB are presented in Table 10. These subtests include Verbal Learning Immediate Recall, Oral Word Immediate Recognition, Verbal Learning Delayed Recall, Oral Word Delayed Recognition, Embedded Figures, and Visual Sensory Memory. A significant correlation was also found between the Verbal Learning Delayed Recall and Oral Word Delayed Recognition. The effect size of the correlation between these two subtests was large. Verbal Learning Delayed Recall was also significantly correlated with the subtest Complex Figure. The Embedded Figures subtest was significantly correlated with Visual Sensory Memory.

Table 11 includes the Pearson's correlation results for the four subtests that were part of the executive functioning factor of the NMNB. These subtests include Visual Memory Span, Inverse Order, Interference, and Complex Figure. There was a significant relationship between the subtests Visual Sensory Memory and Inverse Order. The correlation between these subtests was large. The subtest Interference had a small correlation with the subtest Motor Coordination and was also negatively correlated with the subtest Motor Component of Visual Scanning.

Table 10

Pearson's Correlations for the Memory Subtests

Subtests	17	18	19	20	21	22
1. Categorical Fluency	**.40**	.18	**.29**	**.24**	.10	.06
2. Speeded Repetition	.09	.03	.10	.20	.10	.01
3. Categorization	-.05	.12	-.13	-.04	-.07	-.02
4. Spelling	.14	.12	.10	.06	.18	.09
5. Vocabulary	**.27**	.05	.12	.07	.13	.10
6. Serial Learning	.17	.10	**.27**	.19	**.29**	.14
7. Figural Rotation	.00	.03	.04	.14	.17	.08
8. Sequential Picture Analysis	-.02	.00	.01	-.01	.07	.10
9. Visual Spatial Puzzle- Correct	-.06	.19	-.08	.05	.21	.18
10. Visual Spatial Puzzle- Time	-.18	-.22	-.16	-.13	-.12	-.20
11. Semantic Memory Immediate Recall	**.30**	.21	**.25**	.17	**.28**	**.36**
12. Semantic Memory Immediate Recognition	**.29**	**.31**	**.27**	**.23**	.19	**.24**
13. Semantic Memory Delayed Recall	**.28**	.14	**.31**	.18	**.29**	**.29**
14. Semantic Memory Delayed Recognition	**.32**	**.37**	**.28**	.21	**.23**	**.28**
15. Memory for Figures Immediate Recall	.21	.13	**.31**	.20	**.31**	.14
16. Memory for Figures Delayed Recall	.02	.07	.13	.05	**.24**	.02
17. Verbal Learning Immediate Recall	-	**.40**	**.62**	**.54**	**.25**	.08
18. Oral Word Immediate Recognition	**.40**	-	**.45**	**.52**	.10	.00
19. Verbal Learning Delayed Recall	**.62**	**.45**	-	**.64**	.21	-.03
20. Oral Word Delayed Recognition	**.54**	**.52**	**.64**	-	.15	-.13
21. Embedded Figure	**.25**	.10	.21	.15	-	**.24**
22. Visual Sensory Memory	.08	.00	-.03	-.13	**.24**	-
23. Visual Memory Span	.04	.08	-.04	.05	.03	-.09
24. Inverse Order	.07	.08	-.03	-.02	.04	.07
25. Interference	**.30**	**.17**	.10	.18	.11	-.00
26. Complex Figure	.11	**.25**	**.25**	.15	.21	.12
27. Motor Coordination	.06	-.01	.07	.08	.09	.04
28. Motor Component of Visual Scanning	**-.22**	-.08	-.10	-.09	.01	.16

Note. Correlations significant at the 0.01are in boldface. *N= 139*

Table 11

Pearson's Correlations for the Executive Functioning Subtests

Subtests	23	24	25	26
1. Categorical Fluency	.02	.09	.15	.06
2. Speeded Repetition	.17	.22	**.45**	.08
3. Categorization	-.02	-.04	.05	-.02
4. Spelling	.11	.20	-.10	.16
5. Vocabulary	.14	**.24**	.20	.12
6. Serial Learning	-.04	.05	.02	.10
7. Figural Rotation	**.22**	**.25**	.15	.03
8. Sequential Picture Analysis	-.19	**-.26**	.08	.00
9. Visual Spatial Puzzle- Correct	.17	.04	.13	-.01
10. Visual Spatial Puzzle- Time	-.16	-.19	-.17	-.05
11. Semantic Memory Immediate Recall	-.07	-.12	.01	.18
12. Semantic Memory Immediate Recognition	.02	.01	.03	.19
13. Semantic Memory Delayed Recall	-.09	-.08	.06	.18
14. Semantic Memory Delayed Recognition	-.08	-.01	.08	.14
15. Memory for Figures Immediate Recall	.09	.10	.20	**.24**
16. Memory for Figures Delayed Recall	.19	.10	.00	**.23**
17. Verbal Learning Immediate Recall	.04	.07	**.30**	.11
18. Oral Word Immediate Recognition	.08	.08	.17	**.25**
19. Verbal Learning Delayed Recall	-.04	-.03	.10	**.25**
20. Oral Word Delayed Recognition	.05	-.02	.18	.15
21. Embedded Figure	.03	.04	.11	.21
22. Visual Sensory Memory	-.09	.07	-.00	.12
23. Visual Memory Span	-	**.56**	.13	.06
24. Inverse Order	**.56**	-	.12	.04
25. Interference	.13	.12	-	-.00
26. Complex Figure	.06	.04	-.00	-
27. Motor Coordination	.06	.14	**.29**	-.07
28. Motor Component of Visual Scanning	.00	-.06	**-.28**	.12

Note. Correlations significant at the 0.01are in boldface. *N= 139*

Pearson’s correlation results for the psychomotor subtests are presented in Table 12. Non-significant correlations were found among these subtests.

Table 12

Pearson’s Correlations for the Psychomotor Abilities Subtests

Subtests	27	28
1. Categorical Fluency	-.02	**-.26**
2. Speeded Repetition	**.47**	-.02
3. Categorization	-.04	-.06
4. Spelling	.03	.03
5. Vocabulary	**.23**	-.16
6. Serial Learning	-.10	.04
7. Figural Rotation	.09	-.04
8. Sequential Picture Analysis	.01	.06
9. Visual Spatial Puzzle- Correct	.16	-.05
10. Visual Spatial Puzzle- Time	-.09	.14
11. Semantic Memory Immediate Recall	-.03	.09
12. Semantic Memory Immediate Recognition	-.03	-.08
13. Semantic Memory Delayed Recall	.07	.04
14. Semantic Memory Delayed Recognition	.01	-.15
15. Memory for Figures Immediate Recall	.17	-.06
16. Memory for Figures Delayed Recall	.03	.08
17. Verbal Learning Immediate Recall	.06	**-.22**
18. Oral Word Immediate Recognition	-.01	-.08
19. Verbal Learning Delayed Recall	.07	-.10
20. Oral Word Delayed Recognition	.08	-.09
21. Embedded Figure	.09	.01
22. Visual Sensory Memory	.04	.12
23. Visual Memory Span	.06	.00
24. Inverse Order	.14	-.06
25. Interference	**.29**	**-.28**
26. Complex Figure	-.07	.12
27. Motor Coordination	-	**-.23**
28. Motor Component of Visual Scanning	**-.23**	-

Note. Correlations significant at the 0.01are in boldface. *N= 139*

Hypothesis One

Hypothesis one stated that an exploratory factor analysis would yield that the NMNB subtests load onto five factors. These factors included language, perceptual reasoning, memory, executive functioning and psychomotor abilities.

To test this hypothesis, a Principal Axis Factor (PAF) analysis with a Promax (oblique) rotation was conducted using the Statistical Package for the Social Sciences (SPSS). Promax (oblique) and Varimax (orthogonal) rotations were examined. Preliminary analyses indicated that the subtests Anomia, Phonemic Discrimination-Pronunciation, Phonemic Discrimination- Concept, Reading Comprehension, Angular Rotation, and Motor Writing were not normally distributed, thus these subtests were not included in the factor analyses. An examination of the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy suggested the sample was factorable (KMO = .702). The Test of Sphericity $\chi^2(378) = 1191.986$, $p < .001$ indicated the correlation matrix is not an identity matrix.

Model one. A PAF was first conducted retaining all factors with eigenvalues greater than 1.0. This is a default and common procedure when deciding how many factors retain for rotation. Based on this criterion, nine factors were retained. Table 13 depicts the factor loadings for the five of the nine factors retained using this method. Together they accounted for 63.81% of the variance. Subtests with a factor loading of .40 or greater were retained. Examination of the Varimax (orthogonal) showed that this retention method yielded a factor structure with lower loadings and some factors had cross-loadings. Although both Varimax and Promax rotations yielded similar factor structures the oblique rotation provided a more interpretable structure. Factor 1 accounted

Table 13

Factor Loadings for Exploratory Factor Analysis with Promax Rotation for Model One

Subtests	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Communalities
Categorical Fluency	.16	.11	-.08	.06	-.08	.29
Speeded Repetition	.06	.01	**.98**	.01	.01	.87
Categorization	-.02	-.11	.07	.00	.15	.06
Spelling	.03	.25	.03	.24	-.02	.17
Vocabulary	-.12	**.46**	.20	.23	-.01	.40
Serial Learning	.05	-.07	-.14	-.02	.16	.38
Figural Rotation	.02	-.14	.08	.20	-.06	.23
Sequential Picture Analysis	-.01	.13	.15	-.35	-.12	.16
Visual Spat. Puzzle- Correct	.00	.03	.00	-.02	-.04	.69
Visual Spat. Puzzle- Time	-.08	-.16	-.01	-.10	.03	.36
Semantic Mem. Imm. Rec.	.07	**.89**	-.06	-.09	.08	.82
Semantic Mem. Imm. Rec.	.05	.33	.04	.05	**.66**	.73
Semantic Memory Del. Rec.	-.03	**.73**	.03	-.15	.08	.67
Semantic Mem. Del. Rec.	-.02	.05	-.02	.00	**.85**	.88
Memory for Fig. Imm. Rec.	.02	-.11	.17	-.07	.10	.54
Memory for Fig. Del. Rec.	-.03	.02	-.05	.11	-.04	.70
Verbal Learning Imm. Rec.	**.55**	.18	-.03	.02	-.07	.64
Oral Word Imm. Recog.	**.68**	-.08	-.04	.10	.24	.55
Verbal Learning Del. Rec.	**.75**	.04	-.04	-.09	-.08	.71
Oral Word Del. Recog.	**.86**	-.10	.09	-.04	-.02	.67
Embedded Figure	.02	.17	-.00	-.04	-.03	.31
Visual Sensory Memory	-.24	.33	-.04	-.03	.08	.29
Visual Memory Span	.06	-.00	-.00	**.67**	-.04	.49
Inverse Order	-.09	-.04	-.01	**.83**	.02	.72
Interference	.09	-.07	**.47**	-.07	.03	.37
Complex Figure	.21	.15	-.01	.09	.03	.19
Motor Coordination	-.09	.05	**.55**	-.06	-.02	.34
Motor Comp of Vis. Scan.	.04	.18	-.07	.03	-.15	.47
Eigenvalue	5.00	2.70	2.20	1.92	1.72	
% of Total Variance	17.77	9.44	7.34	6.19	5.64	

Note. Factor loadings > .40 are in boldface.

for 17.77% of the variance and the subtests Oral Word Delayed Recognition, Verbal Learning Delayed Recall, Oral Word Immediate Recognition, and Verbal Learning Immediate Recall loaded onto this factor. This factor was associated with verbal learning. Factor 2 accounted for 9.44% of the variance with Semantic Memory Immediate Recall, Semantic Memory Delayed Recall and Vocabulary loading onto this factor. This factor was associated with verbal memory. Speeded Repetition, Motor Coordination and Interference loaded onto Factor 3 which accounted for 7.34% of the variance. This factor was associated with inhibitory control. Factor 4 accounted for 6.19% of the variance and the subtests Inverse Order and Visual Memory Span loaded onto this factor. This factor was associated with non-verbal working memory. Semantic Memory Delayed Recognition and Semantic Memory Immediate Recognition loaded onto Factor 5 with 5.64% of the variance. This factor was associated with verbal memory recognition.

The remaining factor loadings are presented in Table 14. Factor 6 accounted for 5.03% of the variance and included the subtests Visual Spatial Puzzle Total- Correct and Visual Spatial Puzzle Total-Time. This factor was associated with visual perception. Memory for Figures Delayed Recall was the only factor loading onto Factor 7 and accounted for 4.34% of the variance. This factor was associated with visual memory. Factor 8 accounted for 4.21% of the variance and the subtests Serial Learning and Memory for Figures Immediate Recall loaded onto this factor and it was associated with perceptual reasoning. Last, Factor 9 accounted for 3.85% of the variance and included the subtests Verbal Learning Immediate Recall, Motor Component of Visual Scanning and Categorical Fluency. This factor was associated with language functioning.

Table 14

Factor Loadings for Exploratory Factor Analysis with Promax Rotation for Model One

Subtests	Factor 6	Factor 7	Factor 8	Factor 9	Communalities
Categorical Fluency	-.02	.01	.10	**.41**	.29
Speeded Repetition	-.11	-.05	-.01	-.21	.87
Categorization	-.03	-.03	-.16	.08	.06
Spelling	-.11	-.06	.13	-.12	.17
Vocabulary	-.11	.02	-.10	.26	.40
Serial Learning	-.10	-.06	**.65**	-.04	.38
Figural Rotation	.23	-.06	.27	.01	.23
Seq. Pict. Anal.	.12	-.10	.10	-.09	.16
Vis. Spat. Puz. Total – Corr.	**.83**	.09	-.09	.01	.69
Vis. Spat. Puzzle Total- Time	**-.44**	.17	-.13	-.10	.36
Sem. Mem. Immediate Recall	.09	-.09	-.10	-.13	.82
Sem. Mem. Imm. Recogn.	-.03	.01	-.05	-.03	.73
Sem. Mem. Delayed. Recall	.01	.17	.02	.03	.67
Sem. Mem. Delayed Recogn.	-.05	-.03	.18	.12	.88
Mem Fig. Immediate Recall	.05	.37	**.44**	.06	.54
Mem. Fig. Delayed Recog.	.01	**.85**	-.03	-.01	.70
Verb. Learn. Imm. Recall	-.07	-.05	.05	.33	.64
Oral Word Immediate Recall	.20	-.01	-.16	-.07	.55
Verb. Learn. Delayed Recall	-.11	.06	.16	.06	.71
Oral Word Delayed Recogn.	.03	-.04	.00	-.05	.67
Embedded Figure	.15	.15	.35	-.01	.31
Visual Sensory Memory	.19	-.09	.27	-.09	.29
Visual Memory Span	.13	.14	-.14	-.06	.49
Inverse Order	-.01	-.04	.11	.03	.72
Interference	.12	-.03	-.06	.26	.37
Complex Figure	-.05	.20	.06	-.21	.19
Motor Coordination	.07	.04	-.13	.15	.34
Mot. Comp Vis. Scan.	-.06	.02	.12	**-.68**	.47
Eigenvalue	1.58	1.41	1.22	1.18	
% of Total Variance	5.03	4.34	4.21	3.85	

Note. Factor loadings > .40 are in boldface.

Model two. Based on the examination of the tasks demands and the cognitive domains of each subtest, it was expected that the following subtests would load onto the language factor: Categorical Fluency, Anomia, Phonemic Discrimination, Speeded Repetition, Categorization, Spelling, Reading Comprehension and Vocabulary. The following subtests would load onto the perceptual reasoning factor: Serial Learning, Figural Rotation, Sequential Picture Analysis, Visual Spatial Puzzle and Angular Rotation. The following subtests would load onto the memory factor: Semantic Memory (free recall and recognition), Semantic Memory Delayed, Memory for Figures, Memory for Figures Delayed, Verbal Learning, Oral Word Recognition, Embedded Figures and Visual-Sensory Memory. The following subtests would load onto the executive functioning factor: Visual Memory Span, Inverse Order, Interference Task and Complex Figure. Finally, the following subtests would load onto the psychomotor abilities factor: Motor Coordination, Motor Component of Visual Scanning and Motor Writing.

Based on the hypothesized a priori factor structure, five factors were retained using the PAF. Similar to the first retention model, an orthogonal rotation method yielded a factor structure with lower factor loadings and with some of the subtests loading onto more than one factor. Therefore, the oblique rotation was interpreted as it provided a more specific pattern of factor structure. Table 15 includes the factor loadings for model two. Together these five factors accounted for 46.38% of all the variable variances. Subtests with a factor loading of .40 or greater were retained. Five subtests loaded onto Factor 1, which accounted for 17.73% of the variance. These included Semantic Memory Immediate Recall, Semantic Memory Immediate Recognition, Semantic Memory Delayed Recall, Semantic Memory Delayed Recognition, and Visual Sensory Memory.

Table 15

Factor Loadings for Exploratory Factor Analysis with Promax Rotation for Model Two

Subtests	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Communalities
Categorical Fluency	.09	.34	.11	-.07	.07	.19
Speeded Repetition	-.08	.01	**.61**	.09	.00	.39
Categorization	-.02	.02	.04	-.17	.00	.03
Spelling	.22	.02	-.04	.08	.21	.11
Vocabulary	.36	.02	.27	-.14	.18	.28
Serial Learning	.20	.15	-.11	.28	-.00	.20
Figural Rotation	-.07	-.01	.23	.18	.21	.18
Sequential Picture Analysis	.08	-.11	.19	.07	-.36	.13
Visual Spat. Puzzle- Correct	.10	-.15	.27	.15	.03	.12
Visual Spat. Puzzle- Time	-.26	-.02	-.25	-.01	-.11	.20
Semantic Mem. Imm. Rec.	**.84**	-.03	-.07	-.03	-.11	.68
Sem. Mem. Imm. Recog.	**.74**	.12	-.10	-.07	.05	.59
Semantic Mem. Del. Rec.	**.70**	-.01	.06	.16	-.16	.61
Sem. Mem. Del. Recog.	**.65**	.18	-.07	-.05	.02	.53
Memory for Fig. Imm. Rec.	.01	.11	.26	**.57**	-.06	.49
Memory for Fig. Del. Rec.	-.12	.01	-.02	**.56**	.09	.30
Verbal Learning Imm. Rec.	.13	**.70**	.08	-.09	.02	.59
Oral Word Imm. Recogn.	.09	**.55**	-.07	.00	.11	.35
Verbal Learning Del. Rec.	-.06	**.82**	-.08	.20	-.09	.71
Oral Word Del. Recogn.	-.14	**.79**	.02	.09	-.03	.58
Embedded Figure	.21	.01	.12	**.40**	-.04	.30
Visual Sensory Memory	**.49**	-.29	.07	.14	-.03	.27
Visual Memory Span	-.08	.00	.02	.11	**.65**	.46
Inverse Order	.03	-.03	.04	.02	**.82**	.69
Interference	-.06	.16	**.64**	-.12	-.09	.42
Complex Figure	.10	.14	-.132	.33	.08	.18
Motor Coordination	-.04	-.07	**.64**	-.05	-.10	.35
Motor Comp of Vis. Scan.	.02	-.24	-.32	.32	.00	.22
Eigenvalue	4.97	2.64	2.06	1.73	1.58	
% of Total Variance	17.77	9.44	7.34	6.19	5.64	

Note. Factor loadings > .40 are in boldface.

This factor was associated with verbal memory. Four subtests loaded onto Factor 2 with 9.44% of the variance. These included Verbal Learning Delayed Recall, Oral Word Delayed Recognition, Verbal Learning Immediate Recall, and Oral Word Immediate Recognition. Factor 2 was associated with verbal learning. The following three subtests loaded onto Factor 3 with a variance of 7.34%: Interference, Motor Coordination, Speeded Repetition, and Motor Coordination of Visual Scanning. This factor was associated with Inhibitory Control. Memory for Figures Immediate Recall and Memory for Figures Delayed Recall loaded onto Factor 4, which was associated with visual memory. They had a variance of 6.19%. Three subtests loaded onto Factor 5 with a variance of 5.64%. These included Inverse Order, Visual Memory Span and Sequential Picture Analysis and they were associated with executive functioning. The factors retained in model two failed to match the hypothesized five factor structure.

Examination of the factor correlation matrix using a promax rotation method showed that the strength of the correlations among the five factors retained were predominantly small correlations ranging from -.01 to .40. Moderate correlations were found between Factor 1 and Factor 2 (.40) and between Factor 3 and Factor 5 (.34).

Model three. To further examine the factor structure, four factors were retained using the PAF. Although both Varimax and Promax roation methods yielded factors structures with consistent loadings, the Varimax (orthogonal) rotation yielded a more clear and interpretable factor structure without cross-loadings. Factor loadings for model three are presented in Table 16. This rotation method showed less subtests loading onto each the identified factors. Together these four factors accounted for 40.74% of all the variable variances. Four subtests loaded onto Factor 1, which accounted for 17.77%

Table 16

Factor Loadings for Exploratory Factor Analysis with Varimax Rotation for Model Three

Subtests	Factor 1	Factor 2	Factor 3	Factor 4	Communalities
Categorical Fluency	.37	.12	.18	-.02	.18
Speeded Repetition	.13	-.02	**.55**	.02	.32
Categorization	.00	-.04	.01	-.17	.03
Spelling	.06	.18	.14	.17	.08
Vocabulary	.15	.32	.39	-.05	.28
Serial Learning	.20	.23	-.02	.33	.20
Figural Rotation	.03	-.07	.39	.17	.19
Sequential Picture Analysis	-.02	.14	-.06	-.03	.02
Visual Spatial Puzzle- Correct	-.06	.10	.31	.12	.12
Visual Spatial Puzzle- Time	-.13	-.25	-.35	-.05	.21
Semantic Memory Imm. Recall	.16	**.80**	-.07	.11	.69
Semantic Memory Imm. Recog.	.27	**.69**	.02	.11	.55
Semantic Memory Del. Recall	.20	**.71**	.03	.24	.60
Semantic Memory Del. Recog.	.31	**.63**	.02	.11	.51
Memory for Figures Imm. Recall	.22	.12	.30	**.47**	.38
Memory for Figures Del. Recall	.03	-.06	.14	**.52**	.30
Verbal Learning Imm. Recall	**.72**	.21	.13	.01	.58
Oral Word Imm. Recognition	**.54**	.13	.06	.12	.32
Verbal Learning Delayed Recall	**.80**	.09	-.05	.26	.72
Oral Word Delayed Recognition	**.75**	-.01	.05	.14	.59
Embedded Figure	.13	.27	.18	.39	.27
Visual Sensory Memory	-.14	**.45**	.10	.18	.26
Visual Memory Span	-.03	-.16	**.45**	.19	.27
Inverse Order	-.03	-.10	**.52**	.15	.30
Interference	.27	.02	**.49**	-.17	.34
Complex Figure	.16	.13	.01	.38	.19
Motor Coordination	.07	.01	**.47**	-.13	.24
Motor Comp of Visual Scanning	-.27	-.00	-.25	.32	.24
Eigenvalue	4.97	2.64	2.06	1.73	
% of Total Variance	17.77	9.44	7.34	6.19	

Note. Factor loadings > .40 are in boldface.

of the variance. These included Verbal Learning Delayed Recognition, Oral Word Delayed Recognition, Verbal Learning Immediate Recall and Oral Word Immediate Recognition. This factor was associated with verbal learning. Four subtests loaded onto Factor 2 with 9.44% of the variance. These included Semantic Memory Immediate Recall, Semantic Memory Delayed Recall, Semantic Memory Immediate Recognition and Semantic Memory Delayed Recognition. Factor 2 was associated with verbal memory. The following five subtests loaded onto Factor 3 with a variance of 7.34%: Speeded Repetition, Inverse Order, Interference, Motor Coordination and Visual Memory Span. This factor was associated with control of cognitive interference. Memory for Figures Delayed Recall and Memory for Figures Immediate Recall loaded onto Factor 4 with a variance of 6.19%. This factor was associated with visual memory.

Model four. To further examine the factor structure, three factors were retained using the PAF. Similar to the previous model, a Varimax (orthogonal) rotation yielded a more clear and interpretable factor structure without cross-loadings. Factor loadings for model three are presented in Table 17. Together these four factors accounted for 34.55% of the variance. Five subtests loaded onto Factor 1, which accounted for 17.77% of the variance. These included Semantic Memory Immediate Recall, Semantic Memory Delayed Recall, Semantic Memory Immediate Recognition, Semantic Memory Delayed Recognition, and Visual Sensory Memory. This factor was associated with verbal memory. Four subtests loaded onto Factor 2 with 9.44% of the variance. These included Verbal Learning Delayed Recall, Oral Word Delayed Recognition, Verbal Learning Immediate Recall and Oral Word Immediate Recognition. This factor was associated with verbal learning. The following seven subtests loaded onto Factor 3 with a variance

Table 17

Factor Loadings for Exploratory Factor Analysis with Varimax Rotation for Model Four

Subtests	Factor 1	Factor 2	Factor 3	Communalities
Categorical Fluency	.12	.37	.15	.17
Speeded Repetition	.01	.14	**.53**	.30
Categorization	-.10	.00	-.03	.01
Spelling	.23	.06	.16	.08
Vocabulary	.29	.14	.33	.21
Serial Learning	.34	.19	.02	.15
Figural Rotation	.01	.04	**.43**	.19
Sequential Picture Analysis	.12	-.02	-.09	.02
Visual Spatial Puzzle- Correct	.14	-.06	.31	.12
Visual Spatial Puzzle- Time	-.27	-.13	-.32	.19
Semantic Memory Immediate Recall	**.79**	.13	-.13	.65
Semantic Memory Immediate Recogn.	**.68**	.24	-.04	.53
Semantic Memory Delayed Recall	**.76**	.17	-.00	.60
Semantic Memory Delayed Recogn.	**.64**	.29	-.03	.49
Memory for Figures Immediate Recall	.29	.23	.35	.26
Memory for Figures Delayed Recall	.13	.05	.22	.06
Verbal Learning Immediate Recall	.23	**.71**	.09	.57
Oral Word Immediate Recognition	.18	**.54**	.06	.32
Verbal Learning Delayed Recall	.21	**.78**	-.02	.65
Oral Word Delayed Recognition	.06	**.76**	.06	.58
Embedded Figure	.39	.13	.22	.22
Visual Sensory Memory	**.49**	-.16	.09	.27
Visual Memory Span	-.07	-.01	**.51**	.26
Inverse Order	-.03	-.02	**.56**	.32
Interference	-.02	.27	**.41**	.24
Complex Figure	.25	.16	.07	.10
Motor Coordination	-.02	.07	**.41**	.18
Motor Comp of Visual Scanning	.09	-.25	-.16	.10
Eigenvalue	4.97	2.64	2.06	
% of Total Variance	17.77	9.44	7.34	

Note. Factor loadings > .40 are in boldface.

of 7.34%: Inverse Order, Speeded Repetition, Visual Memory Span, Figural Rotation, Motor Coordination, and Interference. This factor was associated with control of cognitive interference.

Hypothesis Two

It was hypothesized that language fluency, as defined by the performance on the Categorical Fluency subtest, would moderate the relationship between language group and the performance on the subtests measuring language abilities. These tests included Anomia, Speeded Repetition, Categorization, Spelling, Reading Comprehension, and Vocabulary.

To test this hypothesis four hierarchical regression models were set up. Preliminary analyses showed a skewed distribution of the scores of the subtests Anomia and Reading Comprehension, therefore these two subtests were not in the regression analyses. To test that language fluency moderates the relationship between the language group and the performance on the Speeded Repetition subtest, first, two variables were included in the model: language proficiency and language group. These variables did not account for a significant amount of variance on the Speeded Repetition subtest. $R^2 = .010$, $F(2, 136) = .71$, $p = .492$. Next, an interaction term between language proficiency and language group was created and added to the regression model, which revealed no significant interaction $\Delta R^2 = .046$, $\Delta F\ (1, 135) = 5.11$, $p = .025$.

The same procedure was conducted with the remaining subtests measuring verbal abilities. Table 18 depicts the results for the subtests Speeded Repetition and Categorization. The variance and interaction for the Categorization subtest were not significant $R^2 = .121$, $F(2, 136) = .81$, $p = .445$; $\Delta R^2 = .024$, $\Delta F\ (1, 135) = 1.62$, $p = .206$.

Language fluency did not moderate the relationship between language group and the performance on the Spelling subtest R^2 = .071, F(2, 136) = 5.23, p = .006; Δ R^2 = .108, ΔF (1, 135) = .06, p = .815.

Table 18

Hierarchical Multiple Regression Analysis for Speeded Repetition and Categorization (N=139)

	Speeded Repetition			Categorization		
Variable	*B*	*SE B*	*β*	*B*	*SE B*	*β*
Step 1						
Language	3.89	6.97	.05	-.11	.11	-.09
Categorical Fluency	.35	.30	.11	.00	.01	.04
Step 2						
Language x Categorical Fluency	1.31	.58	.96	.01	.01	.54

Results indicated that language proficiency and language group accounted for a significant amount of variance in Vocabulary R^2 = .132, F(2, 136) = 10.36, p <.001; however when the interaction term was added to the regression model, this interaction did not account for a significant proportion of the variance Δ R^2 = .133, ΔF (1, 135) = .06, p = .814. Results for the subtests Spelling and Vocabulary are presented in Table 19.

Results from the hierarchical multiple regression analyses indicated that language fluency was not a moderator of the relationship between language group and the performance on the subtests measuring language abilities; therefore, this hypothesis was not supported.

Table 19

Hierarchical Multiple Regression Analysis for Spelling and Vocabulary (N=139)

	Spelling			Vocabulary		
Variable	*B*	*SE B*	*β*	*B*	*SE B*	*β*
Step 1						
Language	-1.32	.42	-.27	-3.78	1.28	-.25
Categorical Fluency	-.00	.02	-.01	.13	.05	.21
Step 2						
Language x Categorical Fluency	.08	.04	.96	.03	.11	.09

Hypothesis Three

It was hypothesized that levels of acculturation would moderate the relationship between language group and the performance on the subtests measuring executive functioning abilities and perceptual reasoning abilities. The subtests measuring executive functioning abilities included Visual Memory Span, Inverse Order, Interference, and Complex Figure. The subtests measuring perceptual reasoning abilities included Serial Learning, Figural Rotation, Sequential Picture Analysis, Visual Spatial Puzzle Total Correct, Visual Spatial Puzzle Total Time, and Angular Rotation.

To test this hypothesis a total of nine hierarchical regression models were set up. The subtest Angular Rotation was not included in the analyses since preliminary analyses showed a skewed distribution of the scores. To test that acculturation moderates the relationship between language group and the performance on the Visual Memory Span subtest, a hierarchical multiple regression analysis was conducted. In the first step, two variables were included: acculturation and language group. These variables did not account for a significant amount of variance $R^2 = .023$, $F(2, 136) = .57$, $p = .212$. Next, an interaction term between language proficiency and language group was created and added to the regression model, which accounted for a no significant proportion of the variance, $\Delta R^2 = .025$, $\Delta F(1, 135) = .18$, $p = .670$.

The same procedure was conducted with the remaining measures of executive function and perceptual reasoning. Results of the multiple regression analysis for Visual Memory Span and Inverse Order are presented in Table 20. There was a no significant

Table 20

Hierarchical Multiple Regression Analysis for Visual Memory Span and Inverse Order (N=139)

	Visual Memory Span			Inverse Order		
Variable	*B*	*SE B*	*β*	*B*	*SE B*	*β*
Step 1						
Language	-.63	.42	-.17	-.36	.46	-.09
Acculturation	-.00	.01	-.04	-.01	.01	-.08
Step 2						
Language x Acculturation	.01	.02	.23	.01	.02	.20

variance and interaction for Inverse Order R^2 = .055, F(2, 136) = .34, p =.712; ΔR^2 = .006, ΔF (1, 135) = .13, p = .715.

A hierarchical multiple regression analysis was also conducted with the Interference subtest and the Complex Figure subtest. These results are presented in Table 21. Results were no significant for both Interference R^2 = .002, F(2, 136) = .14, p =.864; ΔR^2 = .002, ΔF (1, 135) = .01, p = .928; and Complex Figure R^2 = .004, F(2, 136) = .28, p =.757; ΔR^2 = .019, ΔF (1, 135) = 2.09, p = .150.

Table 21

Hierarchical Multiple Regression Analysis for Interference and Complex Figure (N=139)

	Interference			Complex Figure		
Variable	*B*	*SE B*	*β*	*B*	*SE B*	*β*
Step 1						
Language	2.69	8.55	.04	.20	.30	.08
Acculturation	.11	.21	.06	.00	.01	.03
Step 2						
Language x Acculturation	.04	.45	.05	.02	.02	.78

Results showed no significant variance and interaction for Serial Learning R^2 = .001, F(2, 136) = .07, p =.935; ΔR^2 = .006, ΔF (1, 135) = .64, p = .424; Figural Rotation R^2 = .102, F(2, 136) = 7.34, p =.001; ΔR^2 = .109, ΔF (1, 135) = .99, p= .322; and Sequential Picture Analysis R^2 = .009, F(2, 136) = .60, p =.551; ΔR^2 = .009, ΔF (1, 135) = .01, p = .870. Results from this analysis are depicted in Table 22.

Table 22

Hierarchical Multiple Regression Analysis for Serial Learning, Figural Rotation and Sequential Picture Analysis (N=139)

	Serial Learning			Figural Rotation			Sequential Picture Analysis		
Variable	*B*	*SE B*	*β*	*B*	*SE B*	*β*	*B*	*SE B*	*β*
Step 1									
Language	-.15	.43	-.04	.52	.38	.15	-.25	.24	-.12
Acculturation	-.00	.01	-.04	.03	.01	.40	-.01	.01	-.11
Step 2									
Language x Acculturation	-.02	.02	-.43	.02	.02	.51	.00	.01	.10

Table 23 presents the results for the remaining Perceptual Reasoning subtests. Non- significant results were found for Visual Spatial Puzzle Total Correct R^2 = .085, F(2, 136) = 6.35, p =.002; ΔR^2 = .095, ΔF (1, 135) = 1.47, p = .227 and Visual Spatial Puzzle Total Time R^2 = .007, F(2, 136) = .51, p =.602; ΔR^2 = .025, ΔF (1, 135) = 2.72, p = .101.

Results from the hierarchical multiple regression analysis indicated that level of acculturation was not a moderator of the relationship between language group and the performance on the subtests measuring executive functioning abilities and perceptual reasoning abilities, therefore this hypothesis was not supported.

Table 23

Hierarchical Multiple Regression Analysis for Visual Spatial Puzzle- Correct and Visual Spatial Puzzle-Time (N=139)

	Visual Spatial Puzzles-Total Correct			Visual Spatial Puzzles- Total Time		
Variable	*B*	*SE B*	*β*	*B*	*SE B*	*β*
Step 1						
Language	.67	.75	.10	7.43	14.25	.06
Acculturation	.06	.02	.35	-.12	.38	-.04
Step 2						
Language x Acculturation	.05	.04	.62	-1.31	.79	-.88

CHAPTER FIVE

Discussion

The current study was conducted with two main goals. First, the purpose of the study was to identify the underlying factor structure of the NMNB. Specifically, the goal was to examine which variables of the battery are correlated with one another and independent from the rest of the variables, that is, which variables of the NMNB are combined into meaningful and distinct factors. The second objective of the study was to examine the influence of demographic variables on the performance of English monolinguals and Spanish/English bilinguals. That is, to evaluate the performance of Spanish/English bilinguals and English monolinguals on subtests measuring language abilities, executive functioning and perceptual reasoning abilities by examining the influence of demographic variables such as language proficiency and acculturation. The current study was designed to address issues related to the development of appropriate instruments for Spanish/English bilingual individuals and to evaluate the impact of demographic variables on neuropsychological test performance.

Hypothesis One

Hypothesis one stated that an exploratory factor analysis of subtests of the NMNB would yield five factors. These hypothesized factors included language, perceptual reasoning, memory, executive functioning and psychomotor abilities. Four different factor retention models were employed. Results obtained from the four retention models did not support the hypothesized factor structure.

Model one. The first retention model employed consisted of retaining all factors with eigenvalues greater than one. This procedure yielded a total of nine factors comprised of subtests measuring a wide range of cognitive skills. Shared characteristics among the subtests loading onto each factor allowed the identification and description of each factor. Findings from this model showed a factor structure comprised of factors associated with verbal learning, verbal memory recognition, inhibitory control, visual memory, working memory, language, visual perception and perceptual reasoning.

The first factor from this model is comprised of four subtests. These include Oral Word Delayed Recognition (.86), Verbal Learning Delayed Recall (.75), Oral Word Immediate Recognition (.68), and Verbal Learning Immediate Recall (.55). Examination of the factor loadings indicated that all the subtests have strong correlations with the factor. All these subtests were administered together as part of a measure of verbal learning, thus this factor was identified as the verbal list learning factor. The subtests loading onto this factor include tasks measuring the rote memorization, learning and recognition of a list of 12 words presented over four successive learning trials. These abilities were measured during immediate and delayed trials. Particularly, the administration procedure of these tasks consisted of reading a list of words to the participants and then they were asked to recall as many words of the list they can remember. At the end of each spontaneous recall trial, participants were told how many words they correctly recalled. After this, a yes/no recognition trial was administered. The spontaneous recall included four trials, whereas the recognition included three trials. Twenty minutes later the same procedure was conducted, therefore four total scores were obtained. These scores included the total of the four immediate spontaneous recall trials (Verbal Learning Immediate Recall), the total of three yes/no immediate recognition trials (Oral Word Immediate Recognition), the total of the delayed spontaneous recall trial (Verbal Learning Delayed Recall), and the total of the yes/no delayed recognition trial (Oral Word Delayed Recognition). Overall, factor one is comprised of subtests measuring different aspects of the acquisition of verbal information and its retention for both short and long periods of time.

The second factor within this model is comprised of the subtests Semantic Memory Immediate Recall (.89), Semantic Memory Delayed Recall (.73) and Vocabulary (.46). The correlations of these subtests with the factor ranged from large to moderate. The first subtests loading onto this factor, Semantic Memory Immediate Recall and Semantic Memory Delayed Recall, were the subtests with the strongest correlations with the factor. Therefore, this factor was identified as the semantic memory factor. Overall, the subtests loading onto this factor include tasks measuring skills such as immediate and delayed recall of verbal information as well language knowledge skills. The Vocabulary subtest involves a task that can provide information about academic achievement and can be a useful tool in estimating intellectual abilities and pre-morbid levels of functioning. It appears that the nature of this task involving the processing of verbal information accounted for the relationship with the subtests with the strongest correlation with the factor.

Factor three is comprised of the subtests Speeded Repetition (.98), Motor Coordination (.55) and Interference (.47). These three subtests involve the execution of a very specific command within a time frame. This factor was identified as the inhibitory control factor. Particularly, the Speeded Repetition subtest involves the accurate repetition of a word or phrase within a 10 second span. The Motor Coordination subtest involves the execution of a specific motor command as quickly and accurately as possible in 10 seconds. Overall, the three subtests loading onto this factor include tasks measuring abilities such as planning, interference and motor programming of basic directives. The Interference subtest includes three different tasks with different conditions. During the first condition participants were asked to read aloud as quickly as possible a page that included the words “one”, “two” and “three” distributed across three columns. During the second condition participants were asked to read aloud as quickly as possible a page that contained the numbers 1, 2, and 3 distributed across three columns. The third condition includes a page with the numbers 1, 2, and 3 grouped together in different combinations and participants were asked to say as quickly as they could how many digits they saw, rather than reading aloud the actual number. The final score of the Interference subtest was the total of the three conditions. The subtests loading onto this factor include tasks demanding attentional control, a relevant aspect in cognitive functioning. Therefore, these tasks heavily rely on abilities such as planning, organization and self-regulation in order to execute goal-directed responses. Examination of the pattern of performance across the subtests allows the assessment of these abilities in the processing of both verbal and non-verbal stimuli.

The subtests loading onto factor four include Inverse Order (.83) and Visual Memory Span (.67). This factor was identified as the non-verbal working memory factor. In the Visual Memory Span subtest, the examiner presented cards that had holes in different areas and touched the holes in a specific sequence. Participants were then asked to reproduce that sequence. The Inverse Order subtest involved the same task, yet participants were required to provide the responses in the inverse order they were presented. Overall, these subtests are measures of abilities such as sustained attention and concentration in the context of visual stimuli. They also assess the ability retain and manipulate visuo-spatial information for a short period of time.

Factor five is comprised of subtests measuring the immediate recognition and delayed recognition of verbal information. The two subtests loading onto this factor are Semantic Memory Delayed Recognition (.85) and Semantic Memory Immediate Recognition (.66). Both subtests have strong correlations with the factor. This factor was identified as the semantic memory recognition factor. These subtests involve the immediate and delayed recognition of verbal information presented in a story format. These subtests were administered in conjunction with the subtests Semantic Memory Immediate Recall and Semantic Memory Delayed Recall. Particularly, during these tasks, the examiner read two stories to the participants and they were asked to recall as many details they could from the stories. Immediately after the spontaneous recall of the first story, a recognition trial was administered. This recognition trial consisted of asking the participants specific questions about the stories using a multiple choice format. Then, this same procedure was conducted with a second story. Twenty minutes later participants were asked to spontaneously recall the stories and to answer the questions in the same multiple choice format.

Two subtests comprised factor six. These include Visual Spatial Puzzle Total Correct (.83) and Visual Spatial Puzzle Total time (-.44). This factor was identified as the visuo-spatial ability factor. Overall, these subtests involve the manipulation of puzzle pieces to complete a design within a time frame. Higher scores are obtained when all the puzzle pieces are arranged correctly in a short period of time. Thus, the negative correlation of the second subtest reflects the tasks demands and characteristic of performance. Examination of the performance on both tasks provides information about the ability to organize visual stimulus and motor skills.

Factor seven only included one subtest with a loading greater than .40: Memory for Figure Delayed Recall subtest (.85). This subtest was described as the visual memory factor. During this subtest, participants were presented with a page containing different figures for three seconds. Then, they were presented another page and they were asked to point to the figures that were presented previously. This same procedure was conducted during three trials of immediate recognition. Twenty minutes later participants were presented a page and asked to point to the figures they saw during the immediate recall trials. This subtest is a measure of the delayed recall of information presented in a visual format. Evaluation of the performance on this subtest also provides information about the use of other cognitive strategies such as visual perceptual skills. Unlike commonly used visual memory measures, this visual memory subtest does not require a visuo-motor response such as drawing. Therefore, this task can provide evidence of how visual information can be retained and recognized without the possible effect of constructional difficulty or visuo-spatial memory difficulty.

Factor eight includes the subtests Serial Learning (.65) and Memory for Figures Immediate Recall (.44). These subtests tap into cognitive abilities including visuo-spatial perception and processing of visual stimuli, thus this factor was identified as the perceptual reasoning factor. During the Serial Learning subtest participants were asked to examine a figure containing different colors for three seconds. Then the picture was presented in black and white and participants were asked to point to the colors corresponding with the picture. The subtest includes three trials. During the subtest

Memory for Figures Immediate Recall participants were presented with a page containing different figures for three seconds. Then, they were presented another page and they were asked to point to the figures that were presented previously. Overall, the subtests loading onto this factor include tasks measuring the perception, manipulation and processing of visual information within a time frame.

The last factor of this model, factor nine, includes the subtests Categorical Fluency (.41), and Motor Component of Visual Scanning (-.68). The first subtest has the strongest correlation with the factor and it involves processing of verbal information, thus this factor was identified as the language factor. During the Categorical Fluency subtest participants were asked to produce as many words as they could within a given category (i.e. animals, fruits and colors) in 60 seconds. The Motor Component of Visual Scanning subtest involves the tracing of a line to connect puzzle pieces as quickly as possible. Therefore, better performance on this task is achieved when it is completed within a short period of time. This last subtest has a negative loading and does not tap into the same cognitive skills as the first subtest.

This first retention model yielded in a fragmented factor structure comprised of nine factors with subtests measuring a wide range of cognitive skills. There is also variability in the number of subtests loading across the identified factors with the different factors including four, three, two and one subtests.

Examination of this pattern structure indicates the presence of very specific domains within the model. Particularly, learning and memory were identified as separate factors including very specific subtests comprised of tasks measuring the ability to encode, store and retrieve information. Within the memory domain, visual memory and verbal memory were identified as separate factors. Both factors are comprised of subtests tapping into the recognition of verbal information and the recall of visual information both immediately and after a delay. This indicates that when mode of information is considered, subtests from this battery can be useful tools in examining the recognition of verbal information and the immediate recall and delayed recall of visual information. Information obtained from this type of assessment can be helpful in determining whether the performance is within the expected limits or whether there is the presence of a decline. That is, the assessment of the acquisition and retention of information can indicate whether there is a rapid rate of forgetting or recalling difficulties and to what extent environmental cues can aid the recall of information. More specifically, whether there is a decline in the capacity to retain information and use it for a short period and to what extent external stimulus can significantly improve the recall of the information verbally acquired.

Furthermore, two separate factors within the executive functioning domain were identified. These factors were classified as inhibitory control and non-verbal working memory. These findings indicate that although these domains emerged as separate factors, the subtests from the NMNB can be used as measures of executive functioning abilities. The emerged factors tap into different skills or abilities, allowing the examination of both simple and/or more automatic responses as well as more complex abilities. That is, these can be combined into a global domain or used to examine specific abilities like the ones targeted by the specific tasks within the factors.

Seven out of the 28 subtests from the NMNB that were included in the exploratory analysis did not load onto any of the nine factors obtained with this retention model. These include Spelling, Categorization, Complex Figure, Visual Sensory Memory, Sequential Picture Analysis and Embedded Figures. These subtests tap into abilities including language processing, non-verbal reasoning and visual perception. The Spelling subtest involves aspects of language functioning related to academic achievement. The subtests Categorization, Complex Figure, Sequential Picture Analysis, and Embedded Figure involve the perceptual reasoning. Visual Sensory Memory taps into aspects such non-verbal working memory. Although these subtests measure abilities like the ones identified with some of the factors, it appears that their demands differ from the other subtests, therefore they did not correlate with factors obtained from this model.

Taken together, results from this retention model showed a fragmented factor structure tapping into various cognitive functions and domains. The cognitive functions assessed by the subtests loading onto the different factors include abilities such as verbal learning and memory, visual memory, executive functioning, visuo-spatial perception, and language functioning. The current model suggests that the subtests from the NMNB can be a useful tool in examining learning and memory skills. Specifically, examination of the performance during immediate and delayed trials can provide information regarding how new verbal information is encoded, stored and retrieved and how more complex verbal information can be retrieved through recognition skills. Visual memory skills such as acquisition and retention can also be examined using this model.

Examination of these different components of cognitive functioning can provide valuable information of the impact on specific areas as well as how all of them in conjunction can influence overall functioning. That is, although the nature of the correlations among the subtests loading onto the different factors within this model appears to emphasize on the independent aspects of cognitive functioning, it also allows the examination of cognitive functioning from an integrative approach. That is, through the evaluation of how cognitive functions within all the factors as whole can impact overall functioning.

Results from this model put into perspective the importance of evaluating specific domains versus global functioning. That is, how individual or specific areas work independently and how they interact with other areas of functioning. Given the variability within this model, examination of the pattern of performance across the different subtests would allow the implementation of a systematic approach in the evaluation of neuropsychological functioning.

Therefore, taking this perspective into consideration, the utility and clinical implications of this model do not merely imply the evaluation of specific cognitive domains, rather this model provides important tools to examine how different tasks are performed through the integration of multiple abilities.

Furthermore, the utility of the current model in the examination of cognitive functioning is consistent with the general purposes of neuropsychological evaluations, which include establishing diagnosis and differential diagnosis and providing recommendations in accordance with the potential impact of cognitive deficits on different areas of functioning. Regarding diagnosis, the identified factor structure of the NMNB includes measures that can provide information about the presence of brain dysfunction. Particularly, the factors include subtests measuring both verbal and non-verbal cognitive abilities, thus examination of the pattern of performance can aid in determining right or left hemisphere involvement and how specific deficits can manifest in cognition and behavior. Both general and specific areas can be examined using this model.

Additionally, since the identified factors include subtests measuring a widespread of cognitive domains, examination of the pattern of performance also allows the identification of areas of relative strengths and weaknesses, which is relevant for treatment recommendations. This is an important aspect since even though examination of the pattern of performance constitutes a significant aspect in a neuropsychological evaluation, its interpretation plays a major role because it represents the foundation of treatment planning. Once a diagnostic formulation for an individual has been defined, then it is important to develop a treatment plan based on the proposed recommendations. Strengths and weaknesses play an important role in determining presence of variability across an individual's abilities and how they relate to aspects such as occupational functioning, daily activities and independent living. Therefore, evaluation of different aspects of cognition can offer valuable data that can be employed in predicting whether a person would be able to engage in specific tasks. Based on this, treatments and therapies can be tailored for individual needs to target specific areas.

Model two. The second retention model employed was the model based on the hypothesized factor structure, which consisted in the retention of five factors. It was hypothesized that subtests from the NMNB would load onto the following five factors: language, perceptual reasoning, executive functioning and psychomotor abilities. Results from this model showed a five-factor structure composed of factors associated with cognitive skills including verbal learning and memory, visual memory, processing speed and executive functioning.

The first factor from this model is comprised of five subtests. These include Semantic Memory Immediate Recall (.84), Semantic Memory Immediate Recognition (.74), Semantic Memory Delayed Recall (.70), Semantic Memory Delayed Recognition (.66), and Visual Sensory Memory (.49). Overall, these subtests have strong correlations with the factor and they include tasks measuring the immediate and delayed recall and the immediate as well as the delayed recognition of the details of two stories. The subtests Visual Sensory Memory has the lowest correlation with the factor and does not share any characteristics with the remaining subtests. Therefore, this factor was identified as the semantic memory factor. These subtests measure the spontaneous recall and recognition of verbal information. Specifically, the subtests comprising this factor include the spontaneous immediate recall, immediate recognition, delayed recall and delayed recognition of two stories. The subtests with the strongest correlation with the factor are a set of tasks that were administered altogether to measure the ability to encode and retrieve verbal information that is presented within a context.

Particularly, the administration procedure involved asking participants to recall as many details as possible from two short stories. After the spontaneous recall of each of the stories, a recognition trial in a multiple-choice format was administered. Twenty minutes later, the same procedure was conducted. This retention model resulted in a factor structure that allowed the loading of all the tasks involved in the assessment of the patterns associated with the storing and retrieval of verbal information.

Taken together, the subtests within this factor include tasks that allow the examination of how high-context verbal information is encoded, retrieved and recognized immediately and after a delay. The pattern of performance across these subtests can provide information of whether there is a rapid rate of forgetting of verbal information within a context and whether recognition of that information, using a multiple-choice format during immediate and delayed spontaneous recall, can improve the recall of verbal information.

The second factor of this model is comprised of the subtests Verbal Learning Delayed Recall (.82), Oral Word Delayed Recognition (.79), Verbal Learning Immediate Recall (.70) and Oral Word Immediate Recognition (.54). This factor includes a group of tasks administered in conjunction to measure verbal learning skills, thus this factor was identified as the verbal list learning factor. The subtests loading onto this factor measure the learning and memorization of a list of 12 unrelated words across four successive trials. The administration procedure of these tasks involves the administration of yes/no recognition trials immediately after each spontaneous recall. The same procedure is conducted after a 20-minute delay.

This second factor includes the four tasks used to measure verbal learning. The tasks associated with the assessment of verbal learning skills during delayed trials were the ones with the strongest correlation. The subtests within this factor allow the examination of the pattern of learning, memorization and recognition of low-context verbal information and how this information is consolidated and retained for a period.

The third factor of this model includes the subtests Interference (.64), Motor Coordination (.64) and Speeded Repetition (.61). This factor was identified as the speed of processing factor. It includes subtests measuring cognitive interference, repetition and articulation and motor coordination of specific verbal commands.

The interference subtest involves reading words and numbers as quickly and accurately as possible in three different conditions in 30 seconds. The first condition involves reading aloud the words “one”, “two”, and “three” displayed on a page and distributed across three columns. The second condition involves reading aloud a page containing the numbers 1, 2, and 3 as they appear distributed across the three columns. During the last condition, participants were presented with a page that had different combinations of the numbers 1, 2, and 3 and they were required participants to read out loud as quickly and accurately as possible the number of digits in each combination rather than the number itself. The total score of the Interference subtest is the total number of words accurately read across the three conditions. The Motor Coordination subtest involves the execution of specific commands within few seconds. During this task participants, were asked to execute a series of specific movements as quickly and accurately as possible. The total score of the Motor Coordination subtest is the number of correct movement repetitions in 10 seconds. The Speeded Repetition subtest measures repetition and articulation abilities of words and phrases within a time frame. During this task, participants were asked to repeat specific words and phrases as quickly and as accurately as possible. The total score of the Speeded Repetition subtest is the number of accurate repetition in 10 seconds. The three subtests loading onto this factor rely on the execution of specific tasks within a specific period. This includes the execution of specific motor and verbal tasks.

Factor four is comprised of the following two subtests: Memory for Figures Immediate Recall (.57) and Memory for Figures Delayed Recall (.56). This factor was identified as the visual memory factor. It includes a series of tasks measuring immediate and delayed recognition of visual information. The Memory for Figures subtests involve the presentation of a page containing different figures for three seconds, then another page is presented and participants were asked to point to the figures they saw moments earlier. The immediate recall involves three trials. Twenty minutes later participants were presented a page and were asked to point to the figures they saw during the immediate recall trials. The subtests loading onto this factor include tasks demanding skills such as visuo-spatial perception and visual memory abilities. Therefore, examination of the pattern of performance on these tasks can provide information of how visual information is encoded and stored for a period.

The last factor of this model is comprised of the subtests Inverse Order (.82) and Visual Memory Span (.65). This factor was identified as the non-verbal working memory factor. These two tasks asses the retention and manipulation of visual information for a short period. These subtests measure similar cognitive skills, yet they vary on their complexity. The Visual Memory Span subtest is administered prior to the Inverse Order subtest and it requires participants to reproduce a pattern of movements on different cards with holes. The Inverse Order subtest requires participants to reproduce the movements in a reverse sequence, thus it is a similar, yet a more complex task. Both subtests demand abilities such as attention, visual scanning, mental manipulation of visual stimuli and motor execution.

A total of 12 subtests from the NMNB that were also included in the exploratory analysis did not load onto any of the factors obtained with this five-factor retention model. These include Visual Spatial Puzzle Total- Time, Visual Spatial Puzzle Total- Correct, Spelling, Vocabulary, Categorical Fluency, Categorization, Figural Rotation, Serial Learning, Embedded Figures, Complex Figure, Sequential Picture, and Sequential Picture Analysis. These subtests include various tasks that rely on specific skills including language abilities, visuo-spatial perception and reasoning, visual scanning and processing speed. These are different abilities from the ones assessed by the subtests that loaded onto the five factors of this model, resulting in low correlation among these subtests.

Examination of a varimax rotation showed that when a solution of uncorrelated factors was used, the correlation among the retained factors was predominantly small. However, it was also observed that there was a moderate correlation between the semantic memory factor and the verbal list learning factor. The use of an uncorrelated factor solution did not yield a different factor structure.

This second retention model yielded a more specific pattern of factor loadings, yet these results did not match the hypothesized factor structure. This retention model includes five factors measuring a very specific set of cognitive skills including verbal learning and memory, visual memory, speed of processing and working memory. The first two factors within this model represent the strongest factors with the highest loadings and they include subtests tapping into verbal learning and memory skills. The remaining identified factors generally include less subtests with tasks demanding abilities such as processing speed, attention and non-verbal working memory.

Examination of this pattern structure indicates this model taps into two main cognitive domains. These identified domains include memory and executive functioning. Within the memory domain, verbal learning, verbal memory and visual memory emerged as three well-defined and separate factors. These factors are comprised of subtests measuring the learning and memorization of simple verbal information as well as the encoding, retention and recognition of complex verbal information and learning, retention and recognition of simple visual information. The two remaining factors are associated with processing speed and executive functioning. These factors include subtests tapping into cognitive skills involving the ability to execute specific commands within a time frame as well as the ability to sustain attention to process and manipulate visual information for a short period.

Results from this model indicate that when a five-factor structure is considered measures of memory, attention, concentration and speed of processing are identified. One aspect of this model involves the assessment of specific verbal memory domains, thus the NMNB is an instrument that can aid in determining the presence of strengths and weaknesses in this area. This can be achieved through the systematic evaluation of the pattern of performance in each of the tasks comprising the subtests. Particularly, both measures of verbal learning and verbal memory from this battery include recognition tasks that are administered in a very specific manner and it is a distinctive feature of the NMNB. Different from common practices in neuropsychological assessment, the recognition tasks administered during the verbal learning subtests and the semantic memory subtests are administered immediately after each trial. Examination of the performance on these measures can provide information of whether this method is an appropriate strategy to aid learning and memorization of verbal information.

Furthermore, subtests from this model can be useful clinical tools to conduct screenings or quick evaluation of specific areas of functioning. Data gathered from this type of assessments can answer specific clinical questions about how an individual process information and can be used as a baseline during follow-up assessments and future comprehensive assessments, if warranted. This is an important aspect of relevance in rehabilitation settings where evaluation of progress is an important component of the clinical intervention. Also, this type of assessment can provide useful clinical information in determining an individual's status for specific interventions. That is, whether someone can engage in therapeutic interventions demanding abilities such as verbal learning and memory, rapid processing of information, non-verbal working memory and visual memory. Therefore, taking all this into consideration, treatment and recommendations can be tailored for specific reasons or situations pertaining to the areas identified with this factor structure.

In addition to this clinical utility, this model suggests that the NMNB can be a useful tool for clinical research. That is, measures from this battery can be used to conduct investigations to examine different aspects involved in memory functioning. It can also be a useful tool in investigating the impact of test administration procedures on neuropsychological test performance.

Examination of the results also puts into context that the current model addresses aspects such as verbal learning and memory as previously discussed, yet it does not target other areas of cognitive functioning intended to be examined with this battery. These include language, visuo-spatial perception, reasoning, spelling, and psychomotor skills. The NMNB is an assessment tool designed with the purpose to measure a wide range cognitive and intellectual abilities. Therefore, the current results suggest that given the specificity of this model, the NMNB is a useful clinical tool for the evaluation of well identified cognitive domains.

In contrast to the model earlier discussed, there are several similarities and differences. Regarding similarities, the factor structures of both models allowed the identification of very comparable factors based on the subtests and their demands. Particularly, both models identified factors measuring abilities such as verbal learning and memory, visual memory, non-verbal and working memory. However, there is variability within the identified factors. The observed differences between these two models include the number of identified factors, the specific subtests loading onto each of them and the order in which the factors emerged. Specifically, within the verbal memory domain, the current model includes a factor comprised of tasks measuring both recall and recognition of verbal information within a context, whereas in the previous model the recall and recognition of semantic information emerged as separate factors. The verbal memory factor emerged as the first factor in the current model and it includes five subtests. In contrast, the factor associated with the measure of verbal memory abilities is the second factor in model one and although is comprised of three subtests only two of them have strong correlations with factor. The verbal list learning factor emerged as the second factor in model two and as the first factor in model one. The verbal list learning factor has four subtests in model two and four subtests in model one. Visual memory was identified as a factor in both models, yet the two models differ in the number of subtests and the factor loadings, resulting in a different structure in the two models.

Another difference is the identification of a language factor in the previous model, although this factor was one of the weakest factor with only one subtest measuring language functioning. Some of the subtests that failed to load onto the five retained factors are measures associated with language functioning. Additionally, visuo-spatial ability and perceptual reasoning emerged as factors in the first model and they are comprised of a specific set of subtests that did not load onto any of the identified factors in model two.

Overall, the examination of this factor pattern suggests the specificity of the battery using this model regarding the examination of select areas of cognition such as memory and executive functioning. Collectively, the well-defined pattern structure can be an important clinical and research tool and can be used as a baseline for comprehensive assessments.

Model three. To further examine the factor structure of the NMNB, a four-factor retention model was also conducted. A Varimax (orthogonal) rotation provided a better interpretation of the factor structure using this model. The first factor of this model includes the subtests Verbal Learning Delayed Recall (.80), Oral Word Delayed Recognition (.75), Verbal Learning Immediate Recall (.72) and Oral Word Immediate Recognition (.54). The subtests with the highest loading include measures of learning and memorization of a word list, thus this factor was identified as the verbal list learning factor. These subtests include the learning and memorization of a list of 12 unrelated words presented over four successive trials. Altogether they measure spontaneous recall and recognition of the 12 words immediately and after a delay. Recognition trials are embedded into the administration of the immediate recall and delayed recall of the word list. The pattern of factor loadings indicates stronger correlation between the factor and the subtests measuring the ability to recall and recognize the list of words after a delay. This suggests that these subtests can aid in evaluating how information is retained and recognized after a period. Examinations of the abilities are important in determining whether there is a difficulty in learning and memorization of new information. It can also provide information about what other factors can affect learning and what kind of strategies individuals can employ for the effective learning and subsequent recall of low-context verbal information.

The second factor of this model is comprised of the following subtests: Semantic Memory Immediate Recall (.80), Semantic Memory Delayed Recall (.71), Semantic Memory Immediate Recognition (.69) and Semantic Memory Delayed Recognition (.63). These subtests have strong correlations with the factor. Overall, the subtests loading onto this factor include tasks measuring immediate recall and delayed recall of verbal information presented in a narrative format as well as the immediate recognition and delayed recognition of this information. This factor was identified as the semantic memory factor.

The subtests loading onto this factor consist of two short stories. Participants were read the stories and they were asked to spontaneously recall all the details immediately and after a 20-minute delay. Both immediate recall and delayed recall subtests are followed by recognition subtests administered in a multiple-choice format. The pattern of factor loadings shows strongest correlation between the factor and the subtests measuring recall of the information during immediate and delayed trials. The recognition subtests have the lowest loading. This suggests these subtests are strong measures of the ability to encode and retrieve high-context verbal information as well as the ability to retain this information for a period.

The third factor obtained from this retention model is comprised of the subtests Speeded Repetition (.55), Inverse Order (.52), Interference (.49), Motor Coordination

(.47), and Visual Memory Span (.45). Overall, these subtests have moderate correlations with the factor. These subtests have strong correlations with the factor and they share similar characteristics in terms of demands and measured abilities, therefore this factor was identified as the control of cognitive interference factor. The Speeded Repetition subtest is a task where participants were asked to repeat a series of words and phrases as accurately as possible in 10 seconds. The Inverse Order subtest involves asking participants to reproduce a series of movements in a reverse sequences using a card with holes. The Interference subtests includes three different conditions where participants were asked to read aloud the words "one" "two" and "three" as quickly as possible. Then they were required to read the numbers 1, 2, and 3 as quickly as possible. During the final condition participants were asked to read how many digits they saw rather than the actual number. The Motor Coordination subtest involves executing a series of verbal commands following a specific set of instructions. The subtest Visual Memory Span involves asking participants to reproduce a sequence of movement using a card with holes. These first subtests loading onto this factor require manipulation and control of both verbal and non-verbal stimuli to execute a response.

The last factor of this model is comprised of two subtests. These include Memory for Figures Delayed Recall (.52) and Memory for Figures Immediate Recall. The subtests loading onto this factor include tasks demanding the ability of process and manipulate visual information within a time frame, thus this factor was identified as the visual memory factor. The two subtests of Memory for Figures involve presenting a page with different pictures and later asking participants to identify the figures they saw.

Examination of the pattern structure indicates the presence of two different factors examining different aspects of verbal abilities including verbal memory and verbal learning. These factors include very specific subtests that evaluate different components of the encoding, retention, recognition and processing of verbal information presented in different formats. Furthermore, subtests from this model also allowed the identification of a non-verbal factor tapping into the encoding and recall of visual information.

Regarding verbal domain, the current model allowed the identification of a semantic memory factor. The measures from this factor can provide relevant clinical information regarding the consolidation of information. Specifically, performance on the subtests loading onto this factor can aid the examination of memory abilities of narrative information. Evaluation of how verbal information is encoded, retrieved and recognized can provide useful information in determining the nature of memory difficulties, if they are present. That is, it can be determined whether a person presents difficulty recalling information and whether recall is likely to improve when very specific recognition cues are presented.

Verbal learning was another factor identified within the verbal domain. Subtests loading onto this factor measure learning, memorization and recognition of words. Different from the previously described factor, the verbal learning factor tap into the examination of acquisition, encoding and retrieval of low-content verbal information. Examination of the pattern of performance on these subtests can provide information about the pattern of acquisition of learning information and allow making inferences about the process of verbal learning.

Additionally, the examination of a visual memory factor allows the examination of how visual information is encoded and manipulated and used during a process of recognition. Examination of the performance on these tasks allows inference how visual stimuli takes place and what environmental cues can improve such a process.

The control of cognitive interference factor was the factor identified within the executive functioning domain. It includes various subtests measuring the ability to manipulate information to execute a desired response. The tasks include both verbal and non-verbal measures. Non-verbal working memory was the factor identified within the non-verbal domain also related to executive functioning. This factor includes measures assessing the ability to execute mental control of visual stimuli in order to generate a particular response. That is, they involve the storage and manipulation of non-verbal information for a short period. Examination of the performance on the subtests loading onto this factor allows the evaluation of other aspects including attention and concentration, which are important aspects within working memory.

Seven out of the 28 subtests from the NMNB that were included in the exploratory factor analysis did not load onto the four identified factors. These subtests include Spelling, Categorical Fluency, Categorization, Vocabulary, Sequential Picture Analysis, Figural Rotation, Visual Spatial Puzzle Total Time and Visual Spatial Puzzles Total Correct. These subtests measure different aspects related to the processing of verbal and non-verbal information, yet their demands appear to tap into different aspects of language functioning, visual perception and processing speed.

Overall, the results from this model suggest a factor structure tapping into three cognitive domains. The verbal domain includes two different factors assessing different aspects of verbal learning and memory. The second domain includes the non-verbal domain and was identified through two subtests correlating with a factor of visual memory. The last domain is related to executive functioning and includes a factor comprised of subtests tapping into cognitive interference.

These data suggest that when a four-factor structure is considered these main areas can be evaluated using subtests from this battery. Based on the administration procedure of the subtests loading onto these factors, this battery can be a useful tool for the screening of specific deficits in the processing of verbal information. Specifically, this battery can be employed for a rapid measure of verbal memory skills if there is a suspected difficulty on this area. Specifically, the pattern of performance on subtests measuring verbal learning and memory functions can aid in determining in what area difficulties are observed. That is, whether an individual is presenting difficulty encoding or retaining information and whether recall can be improved with cues. Results from this type of assessment can also examine pattern of encoding of verbal information. This pattern of factor structure also highlights the utility of the subtests from this battery for the evaluation of visual memory skills within the context of non-verbal working memory and recognition of visual stimuli.

Furthermore, cognitive processes such as cognitive interference, speed of thinking, sustained attention, and concentration can be quickly examined with the administration of subtests measuring executive functioning. This is particularly relevant for the assessment of subjective complaints of changes in thinking ability or as a general clinical tool to test hypothesis regarding current level of functioning.

In sum, examination of the pattern structure obtained from this model suggests a less specific factor structure in terms of the examination of broad cognitive domains. However, the subtests loading onto the identified factors were overall consistent measures of the identified cognitive skills. Therefore, results from this model point out the specificity of the NMNB for the evaluation of cognitive abilities when a more limited or restricted factor structure is considered. This put into context the utility of subtests from this battery as screening tools rather than as comprehensive measure of a wide range of cognitive skills. This can be useful in settings where in-depth evaluations are not feasible due to constraints such as time. Furthermore, results from this model can be a useful clinical tool for conducting baseline evaluation to aid the examination of progress and assist in future comprehensive evaluations and treatment plans.

Model four. The last retention method used to explore the factor structure of the NMNB included the retention of three factors. Consistent with the previous model, A Varimax (orthogonal) rotation provided a better interpretation of the factor structure using this model. The first factor of this model is comprised of five subtests. These subtests include Semantic Memory Immediate Recall (.79), Semantic Memory Delayed Recall (.76), Semantic Memory Immediate Recognition (.69), Semantic Memory Delayed Recognition (.64) and Visual Sensory Memory (.49). The first subtests have the strongest correlation with the factors and share common characteristics in terms of the demands and measured abilities, including the encoding and recall of narrative information, therefore this factor was identified as the semantic memory factor. The subtests with the lowest loadings include measures of abilities such as perceptual reasoning, thus they do not share characteristics with the other subtests loading onto this factor. Overall, the subtests with the highest loadings include four measures assessing immediate recall, delayed recall, immediate recognition and delayed recognition of the details of two stories. Both stories were presented to participants once and they were asked to spontaneously recall the stories and recognize their details during a multiple choice trial. The same procedure was conducted 20 minutes later. Therefore, these subtests measure how verbal information provided within a context is encoded, retrieved, retained and recognized.

Verbal Learning Delayed Recall (.78), Oral Word Recognition Delayed Recall (.76), Verbal Learning Immediate Recall (.71) and Oral Word Recognition Immediate Recall (.54) are the subtests comprising the second factor of this model. Examination of the factor loadings indicate that the subtests include tasks measuring the recall and recognition of a word list, thus this factor was identified as the verbal list learning factor.

The subtests loading onto the identified factor include a group of tasks measuring learning, memorization and recognition of a word list. These subtests involve the presentation of a list of 12 words over four learning trials and participants were asked to recall as many words as they could during each presentation. Each learning trial was followed by a yes/no recognition trial. Spontaneous recall and recognition of the words were assessed immediately after each presentation as well after a 20-minute recall. Thus, these subtests measure encoding, retention and recognition of low-context verbal information. Examination of the pattern of performance across the different tasks can provide information regarding characteristic of learning abilities including learning slope, retention rate and memorization.

The third and last factor of this model is comprised of seven subtests. The subtests loading onto this factor include Inverse Order (.56), Speeded Repetition (.53), Visual Memory Span (.51), Figural Rotation (.43), Motor Coordination (.43), Interference (.41), and Memory for Figures Immediate Recall (.41). The first subtests have the highest loadings and they are measures of the process and manipulate both verbal and non-verbal information in order to generate a response; therefore, this factor was identified as the control of cognitive interference factor.

The subtests Inverse Order and Visual Memory Span are separate tasks involving the repetition of a pattern of movement using a card with holes. During one of the tasks participants were asked to repeat the same sequence, while the other one involves repeating the sequence in inverse order. During Speeded Repetition, participants were required to repeat a series of words and phrases as quickly and as accurately as possible. The Figural Rotation subtest required participants to identify a figure from similar ones after it was rotated. The Motor Coordination subtest required participants to execute a series of motor commands. The Interference subtest involves three different conditions where participants were asked to read as quickly and as accurately as possible different pages containing the words "one", "two" and "three", then the numbers 1, 2, and 3. The last condition includes a page with number and participants were required to say the number of digits on the page rather than the actual number. During the Memory for Figures subtest participants were presented a page with different figures for three seconds, then they were asked to identify all the figures the previously saw.

Results from this retention model allowed the identification of factors associated with verbal memory, verbal learning and control of cognitive interference. Subtests within the verbal memory factor include tasks measuring the recall and recognition of two stories during both immediate and delayed trials. The verbal learning factor includes subtests measuring the learning and memorization of a list of unrelated words as well as the recognition of this information immediately after the presentation of each of the learning trials and after a long delay. The last factor within this model includes subtests measuring the processing and manipulation of both verbal and non-verbal information to generate a specific response.

Ten subtests from NMNB that were included in the exploratory factor analysis did not load into the three factors obtained with this retention model. These subtests include Spelling, Categorization, Categorical Fluency, Vocabulary, Sequential Picture Analysis, Complex Figure, Embedded Figures, Serial Learning, Motor Component of Visual Scanning, and Memory for Figures Delayed.

Several of these subtests measure different aspects of language abilities. Others are measures of abilities such as perceptual reasoning, processing speed and visual memory. Interestingly, the subtest Memory for Figures Delayed Recall did not load onto the factor even though the immediate recall task had a moderate correlation with the factor. It appears that the delay condition accounted for this low correlation. These subtests tap into cognitive domains different from the ones assessed by the identified factors, which may explain the lack of correlation with the obtained factors.

Results obtained from this three-factor retention model suggest a factor structure tapping into two main areas of cognitive functioning. These areas include verbal learning and memory and control of cognitive interference. Given the low number of factors specified in this retention model, the identification of more specific factor was more restrictive. However, a clear pattern of correlations among subtests measuring similar cognitive abilities was observed. Verbal learning and verbal memory emerged as two distinct as separate factors, while other measures tapping into a specific aspect within executive functioning were highly correlated and allowed the identification of a different cognitive domain.

Based on these observed factor structure, it can be argued that subtests from the NMNB can be used for the evaluation of these specific areas of cognitive functioning. Information about the pattern of performance on these identified factors can allow the examination of learning skills, the ability to process verbal information and the manipulation of verbal and visual stimuli. Specifically, this group of subtests can be employed to answer specific questions about whether there is a specific difficulty encoding or retrieving verbal information and whether cues can enhance recall of information. Other subtests from this battery can also be useful clinical tools in the evaluation of abilities such as attention and concentration and as well as the ability to execute mental control for the manipulation of verbal and visual information.

Examination of the performance on these subtests can also allow inferences about factors influencing verbal learning and memory as well as sustained attention. Based on this type of information, recommendation regarding treatment or further testing can be provided. Overall, the use of these identified subtests in the evaluation of very specific areas of cognitive functions is relevant within the context of initial clinical evaluations.

The factor structure obtained from this model includes a pattern highly consistent with what was obtained when other retention models were employed. The first retention model used for the examination of the underlying factor structure of the NMNB yielded the identification of nine factors assessing a variety of cognitive domains including verbal learning and memory, visual memory, executive functioning, visuo-spatial perception, and language functioning. This wide range of cognitive domains and the pattern of subtests loading onto the identified factors put into perspective the utility of this battery for the systematic assessment of cognitive functions. Other models used to examine the factor structure of the battery included the retention of five and four factors. Overall, these other two models allowed the identification of factors measuring verbal learning and memory, visual memory, attention, concentration, and speed of processing.

Examination of these results indicates some variability across the retention models, however the identification of very specific domains such as verbal memory and learning was consistent in all models. Therefore, these results point towards the specificity of the NMNB as a clinical assessment tool.

Overall, results from the four retention models yielded factor structures clustering around the same subtests; however, results from the hypothesized a priori factor structure showed a better-defined pattern of cognitive domains. These factor structures identified with the different models include subtests measuring cognitive functions such as memory, learning, executive functioning, and perceptual reasoning. Particularly, it was observed that verbal memory and learning emerged as well-defined factors across each one of the retention methods. Although none of the four retention models matched the hypothesized factor structure, they provided the identification of more specific domains within different cognitive functions.

Hypothesis Two

Hypothesis two stated that language fluency, as defined by the performance on the Categorical Fluency subtest, would moderate the relationship between language group (Spanish/English bilinguals and English monolinguals) and the performance on subtests measuring language abilities. These subtests included Anomia, Speeded Repetition, Categorization, Spelling, Reading Comprehension, and Vocabulary. The subtests Anomia and Reading Comprehension were not included in the analyses since preliminary results showed skewed distributions of the scores. Results from hierarchical multiple regression analyses did not support this hypothesis.

The total score from the Categorical Fluency subtest (i.e. total number of words across three different categories) was used as a measure of language fluency to evaluate its relationship in the performance on language-mediated subtests. That is, to determine whether performance on the Categorical Fluency subtest would impact the performance of the two groups on the subtests considered to measure language abilities.

The first subtest examined was Speeded Repetition. This is a measure of enunciation and articulation where participants were asked to repeat a series of words and phrases as many times as possible within 10 seconds. Results from this first hierarchical regression model showed that language fluency, as measured by the performance on the Categorical Fluency subtest, did not moderate the relationship between language group and the performance on the Speeded Repetition subtest from the NMNB. Specifically, the total score on the Categorical Fluency subtest did not change or influence the total scores of both groups on the subtest. That is, the results indicated that the performance on Categorical Fluency did not affect the relationship between group membership (i.e.

Spanish/English bilingual group or English monolingual group) and the performance on the Speeded Repetition subtest.

Based on this, it can be inferred that the ability to name as many words within a specific category does not affect how Spanish/English bilinguals and English monolinguals plan and execute the repetition of words and phrases. Therefore, identifying an individual's language fluency abilities does not provide additional information about their performance on the articulation/enunciation task from the NMNB. This is particularly important in the assessment of individuals of Spanish/English backgrounds when there is a question about their ability to speak Spanish and English and their abilities to accurately enunciate in these languages.

Given that enunciation and repletion difficulties is often observed in patients with neurological disorders such aphasias, evaluation of this aspect of language functioning is relevant in clinical contexts. Therefore, the examination of the potential influence of other aspects is crucial. Thus, a clinical situation where there is a question about whether language fluency would affect the performance on a repetition or enunciation task can be addressed by taking into consideration that these two abilities appear to be independent from one another and would not significantly impact the pattern of results. Consequently, examination of language fluency would not be a pre-requisite in a clinical context where there is a question about the presence of problems with articulation or pronunciation. That is, a clinician may be able to carry an evaluation without expecting that language fluency abilities would affect how a patient would perform during these type of tasks. Based on these results, examination of articulation and pronunciation abilities can be conducted independently from establishing language fluency skills. That is, lack of information about of an individual's fluency ability would not hinder the examination of pronunciation and articulation skills. Results from such evaluations can be interpreted in the clinical context where they emerge and interpretation incorporating other possible explanations can be made. That is, since these results suggest that the relationship between language group and repetition abilities is not influenced by language fluency, performance on this type of task can provide information about the influence of other possible factors on test performance. These other possible factors may include neurological deficits.

Similar results were obtained with the subtests Categorization and Spelling. Results from the moderation analyses also showed that there was not a moderation effect between language fluency and performance on the Categorization subtest. During the Categorization subtest participants were presented a group of pictures and they were asked to point to all the pictures that belong to a particular category. Based on these results, there is not a relationship between language fluency and the performance of Spanish/English bilinguals and English monolinguals on Categorization subtest. That is, the ability to group objects and pictures into specific categories does not appear to be affected by fluency in English and Spanish. According to these results, monolingualism and bilingualism and the ability to mentally organized information into specific categories are not influenced by expressive language functions such as language fluency in either language.

As mentioned earlier, similar results were found with the Spelling subtest. This subtest involved asking participants to write letters, words and sentences. The current results indicated that there is not an effect of language fluency on the performance of the two different groups on the ability to spell letter, words and sentences. Once again, according to the observed pattern of results, the evaluation of such abilities in this population appears to be independent from fluency abilities in both languages. The evaluation of language-mediated abilities such as spelling is important when there is a question about pre-morbid declines and the presence of neurocognitive disorders affecting motor execution. Thus, information about an individual may perform in such tasks independent from other variables can provide valuable information about the presence of real declines or deficits in that area of functioning.

A different pattern of results was observed with the Vocabulary subtest. This subtest involves asking participants to verbally provide definitions of different words. Results from the moderation analyses showed a significant relationship between the Categorical Fluency subtest and the Vocabulary subtest, however the interaction between language group and the scores from the Categorical Fluency was not significant. According to this, performance on the Categorical Fluency subtest does not appear to be a factor affecting the performance of the two different groups on the Vocabulary subtest. The ability to provide definition of words in individuals who only speak English or that speak both English and Spanish is not influenced by their fluency abilities in English and Spanish.

Examination of vocabulary skills provides important information of an individual's intellectual skills. Similar the examination of other intellectual abilities, examination of vocabulary skills can be helpful in making inferences about pre-morbid level of functioning as well as about the extent to which certain declines manifest.

Overall, the results from the regression analyses did not support the hypothesis that language fluency moderates the relationship between language group and performance on the four subtests from the NMNB considered to measure language abilities. That is, language fluency, as measured by the performance on the Categorical Fluency subtest, did not affect the outcome of the performance of the participants regardless their group classification. That is, the performance of the Spanish/English bilinguals and English monolinguals on language mediated subtests appears to be independent from the abilities measures by the Categorical Fluency subtest. It was determined that language fluency is not a moderating variable that could enhance, buffer or reduce the performance of English monolingual or Spanish/English bilinguals on subtests considered to measure language functioning.

The subtests from the NMNB identified to include strong language or verbal components appear to be independent from language fluency. That is, fluency abilities in English or Spanish do not affect how an individual's ability to repeat words and phrases, identify categories, spell words and define words.

Language fluency, as defined by the performance on the Categorical Fluency subtest, did not have a significant impact on the results within these two groups. The effects of language fluency were not observed with these data. These results suggest that the presumed effects of bilingualism on language functioning are not observed with measures of the NMNB. That is, the alleged pattern of disadvantages of bilingualism are not manifested when language abilities are assessed using NMNB. On the contrary, it appears that measures from this battery that were utilized to assess different areas of verbal functioning can provide adequate information about an individual's abilities independent from whether they are Spanish/English bilinguals or English monolinguals.

The subtests used for the analysis include different tasks relying on different modalities of language abilities. Specifically, the subtests involved verbal tasks including aspects such as expression, comprehension, reading and writing skills. These are aspects strongly related in language functioning and are manifested through the different levels of language proficiency. The pattern of the observed results could be attributed to the use of measures developed to address aspects such as bilingualism and language proficiency in different aspects of language functioning. The NMNB was developed to address the influence of demographic variables such as bilingualism, thus these results highlight the adequacy of the NMNB as a clinical tool for the evaluation of Spanish/English bilinguals.

The observed results have various clinical and theoretical implications. First, these results address relevant aspects related to the neuropsychological assessment of bilingual individuals including the evaluation of bilingualism, accurate evaluation of language fluency, the importance of appropriate assessment tools as well as the impact of these factors on test performance. When working with individuals from diverse ethnic and cultural backgrounds, addressing these factors is a fundamental aspect of the clinical work. Unfortunately, they are often overlooked due to the lack of understanding about their influence and the lack of appropriate instruments that can measure these aspects. These results provide information regarding the impact of a very specific aspect on test performance and how its influence could be addressed when confronted with questions about the potential impact on the specific areas of language functioning.

From a more specific clinical standpoint, these data suggest the appropriateness of language-mediated subtests with Spanish/English bilinguals. Therefore, these subtests can be adequate clinical tools for the evaluation of individuals presenting with specific language-related difficulties like typically observed in neurological conditions such aphasias or neurocognitive disorders affecting language functioning. Thus, subtests from the NMNB can be useful clinical screening tools even when there is a concern about whether language proficiency is responsible for declines in language functioning.

Taken together, the discussed findings put into perspective the importance of addressing different aspects that can impact the assessment of very specific abilities in this population. Such practice and understanding provide valuable information when interpreting the manifestation of declines and their impact on every day functioning.

In addition to the above discussed, examination of the pattern of results observed with these data provide the opportunity to closely investigate the conceptualization, operationalization and assessment of language fluency and how these can be applied to the assessment of language functioning in Spanish/English bilinguals. Given that one of the aims of the current study was the examination of demographic variables such as language fluency, interpretation and analysis of this construct using these data and this population can offer an adequate scenario for understanding its manifestations throughout different aspects of language functioning.

The Categorical Fluency subtest was used to use an objective measure of language fluency. This subtest from the NMNB involved asking participants to produce as many words as they could within a specific category in 60 seconds. This subtest included three different categories: animals, fruits and colors. The total score from this task (i.e. number of words across the three categories) was used as a measure language fluency to evaluate its relationship to performance on language-mediated subtests.

Language fluency abilities are often used as measures of expressive language functioning during neuropsychological evaluations. These evaluations typically involved examination of both semantic and phonemic fluency and are also often considered as measure of cognitive flexibility and inhibitory control, based on the variety of cognitive abilities they tap. In this case, the Categorical Fluency subtest, as suggested by its name, only includes the semantic aspect of language fluency. Therefore, interpretation of the current results based on the influence of a specific component of language fluency such as semantic fluency can yield a different understanding its influence on other language-mediated tasks or abilities.

Specifically, given that the subtest from the NMNB used as an objective measure of language fluency only addressed one aspect within this construct, it is possible that the moderation effect of this variable was not observed. That is, it appears that the use of the Categorical Fluency as a measure of language fluency addressed the influence of language representation in verbal ability.

Therefore, based on this observation, the semantic fluency or the ability to provide names within a category does not affect the performance of Spanish/English bilinguals and English monolinguals on tasks measuring repetition, organization of pictures based on categories, and vocabulary. That is, these results indicate that there is not a relationship between semantic fluency and other aspects of language functioning including both expressive and receptive language abilities.

The results indicate that although performance on a task such as categorization and vocabulary involves the language representation of objects, performance on these tasks does not appear to be moderated by semantic fluency. In the same way, semantic fluency did not moderate the relationship between performance on other tasks measuring other language-mediated skills such as repetition and spelling. Thus, it can be concluded that aspects such as lexical access ability is a skill independent from other aspects of expressive and receptive language functioning.

Taken together, the current results indicate that based on these data and this sample of Spanish/English bilinguals and English monolinguals, the ability to produce semantically-related words does not have a significant impact on the four language-dependent measures used in these analyses. Therefore, it appears that the cognitive demands of a semantic fluency task do not have a moderating effect on the relationship between language group and the performance on measures of speeded repetition, categorization, spelling and vocabulary.

Hypothesis Three

Hypothesis three stated that level of acculturation would moderate the relationship between language group (Spanish/English bilinguals and English monolinguals) and the performance on subtests measuring executive functioning and perceptual reasoning abilities. The subtests measuring executive functioning abilities included Visual Memory Span, Inverse Order, Interference, and Complex Figure. The subtests measuring perceptual reasoning abilities included Serial Learning, Figural Rotation, Sequential Picture Analysis, Visual Spatial Puzzle Total Correct, Visual Spatial Puzzle Total Time, and Angular Rotation. This last subtest was not included in the analyses after preliminary results showed a skewed distribution of scores. Results from the hierarchical multiple regression analyses did not support this hypothesis.

Level of acculturation was measured using a questionnaire including 21 questions about language, culture and socialization preferences. This questionnaire was developed for this battery and included questions adapted from other standardized measures of acculturation. Higher scores on this questionnaire were interpreted as more acculturated to the United States culture. Thus, it was hypothesized that participants' scores on this questionnaire would moderate the relationship between language group and the performance on nine subtests considered to measure executive functioning and perceptual reasoning skills. These subtests were identified as measures of different aspects of executive functioning and perceptual reasoning based on their characteristics and demands. Thus, the identification of different skills allowed the examination of different aspects within these two cognitive abilities.

Visual Memory Span was the first subtest examined within executive functiong. This is a measure of visuo-spatial working memory where participants were asked to reproduce a series of movements touching an arrangement of holes on a card. Results from the first hierarchical model showed that level of acculturation did not moderate the relationship between language group and the performance on this subtest from the NMNB. That is, whether an individual obtained high or low scores on this questionnaire was not related to the scores the obtained during this measure of visuo-spatial memory.

The second subtest examined was Inverse Order and results were similar to what was observed with the previously discussed measure. The Inverse Order subtest is also a measure of visuo-spatial memory like the Visual Memory Span subtest, but participants were asked to reproduce the movements backward. These results suggest that individuals' preferences about language usage, culture and social interaction as reflected in high or low level of acculturation do not influence the performance on measures of visuo-spatial memory.

The Interference subtest was another measure of executive functioning examined. This measure includes three separate tasks measuring sustained attention and inhibitory control. Results revealed that level of acculturation did no moderate the relationship between language group and the performance on this subtest.

Similar results were observed with the last subtest examined, Complex Figure. This subtest is a measure of visuo-spatial memory and visual perception where participants were asked to examined a figure and then to identify parts of that figure. Similar to what it was observed with the previous subtests, results from the regression analysis indicated that level of acculturation did not moderate the relationship of the two groups of participants and their performance on this task.

Based on these results, it can be inferred that language, cultural identification and social preferences appear to be factors independent from how these two groups of participants execute mental activities that rely on different aspects including attentional control, inhibitory control, and working memory. The current results put into perspective the impact of demographic variables such as acculturation on specific aspects of cognition in this population. The effect of acculturation as examined through the individuals' reports about their preferences and level of comfort in every-day activities involving language usage and preferences in individual and social interactions as well as cultural identification appear to be minimal on the processing of information requiring mental control and execution.

The observed pattern of results suggests that although demographic variables such as acculturation may play an important role in neuropsychological test performance, it does not appear to be a factor associated with the performance on specific tasks from the NMNB. From a clinical standpoint, it can be inferred that information about level of acculturation may not need to be regarded as an influential factor when examining executive functioning abilities in this population. However, knowledge and understanding of how this aspect manifests in each individual can provide valuable information to support clinical inferences and guide recommendations and treatment planning.

This hypothesis also examined the effect of level of acculturation on the performance of Spanish/English bilinguals and English monolinguals on four subtests considered to measure perceptual reasoning abilities. The first subtest examined was Serial Learning. This is a measure of visuo-spatial learning and perception where participants were presented a series of figures for three seconds. Each figure had a different color and participants were then asked to look at a page that contained the figures without the color and select from a color swatch the color corresponding to each figure. The results did not show a moderation effect between language group and performance on this subtest. That is, level of acculturation did not have an impact on how participants processed visual information as measured on this task.

Figural Rotation was the second perceptual reasoning subtest examined. This subtest is a measure of visuo-spatial perception where participants were presented a figure and then asked to identify it after it was rotated and changed in position. Examination of the pattern of results of the hierarchical regression analysis using acculturation as moderator showed that the interaction was not significant.

Sequential Picture Analysis was another perceptual reasoning measure examined during these analyses. This task involved asking the participants to arrange a series of pictures in a logical or coherent order. Similar to what was observed with the other measures of perceptual reasoning examined, the results did not show a moderation effect between level of acculturation and the performance of the two groups on this task. This suggests that acculturation status do not appear to be an influential variable in problem-solving.

An additional subtest completed the series of analyses to evaluate the moderation effect of acculturation on language group and performance on perceptual reasoning tasks. This included Visual Spatial Puzzle. The Visual Spatial Puzzles subtest is a measure of visuo-spatial problem solving where participants were asked to arrange various puzzle pieces as quickly as possible.

Results from the regression analyses indicated that level of acculturation of the participants did not moderate the relationship between language group and the performance on this measure. Therefore, it can be concluded that acculturation does not improve or diminish the strength of the relationship between Spanish/English bilinguals and English monolinguals and their performance on tasks measuring visuo-spatial perception.

Consistent with the results from the executive functioning measures, these results showed that level of acculturation did not moderate the relationship between language group and the four subtests from the NMNB identified as measures of perceptual reasoning. Based on these findings, acculturation does not appear influence how individuals use reasoning skills to process non-verbal stimuli. Therefore, as suggested by these data, interpretation of results and clinical inferences regarding individuals' perceptual reasoning abilities may be conducted even when information about cultural preferences is not available. Information about an individual's acculturation level may be helpful in understanding an individual's background and history, yet its direct impact on the manifestation of abilities or deficits on specific aspects of perceptual reasoning may not be apparent during direct examination of these abilities.

Findings from these analyses allowed the examination of the influence of a demographic factor such as acculturation on neuropsychological test performance within a specific population. It was investigated whether aspects related to cultural preferences can impact the use and/or manifestation of cognitive abilities. This was conducted based arguments regarding the influence of demographic factors on neuropsychological performance and the lack of research regarding this issue. Also, arguments suggesting that high level of acculturation are associated with increased performance on tasks demanding abilities such as executive functioning and perceptual reasoning guided the analyses.

Findings from the current study did not show the alleged effect of acculturation on neuropsychological test performance. According to the observed results, level of acculturation as measured by the scores on a self-report measure including questions about language preferences, usage, and social interactions does not appear to influence performance on tasks demanding executive functioning and perceptual reasoning abilities in the population examined in this study.

Acculturation is a multidimensional construct that involves many aspects related to habits, preferences and customs. It also manifests in different ways throughout individual and social activities and it involves different processes unique for each individual. The acculturation measure used in this study addressed general aspects within the construct, as typically evaluated by most measures of acculturation. Thus, the observed pattern of results may be influenced by how these different aspects were accounted for in the acculturation measure employed in this study. It is possible that a more comprehensive approach to the assessment of acculturation would have yielded a different pattern of results. Conversely, this may have required a more qualitative approach beyond the scope of this research.

Furthermore, it is important to highlight that the current study included a sample of young and educated participants. Therefore, these could have been confounding variables impacting the pattern of results. That is, it is possible that although the overall group of participants differed in their ability to speak one or two languages, they were a very homogenous group and the manifestation of other variables did not differ significantly.

Examination of the overall findings from these analyses indicated that level of acculturation, as measured by the total scores from a research-based and adapted questionnaire, does not appear to be a moderating factor of the relationship between language group and the performance on select measures of executive functioning and perceptual reasoning abilities from the NMNB. Based on the discussed results, an individual's identification and/or assimilation to the United States' culture does not have a significant impact on the manifestation of higher order cognitive skills and manipulation and perception of non-verbal information.

Even though the reported results did not support the hypothesis of the moderating effect of acculturation, examination of the overall results put into perspective the intricacies of the assessment and measurement of such a dynamic and multidimensional construct. Understanding the mechanisms through which demographic variables impact neurocognitive functioning is a relevant aspect within neuropsychology and it will remain pertinent as demographic changes continue to take place.

General Discussion

Issues concerning the development of appropriate instruments and the use of adequate norms for linguistically diverse individuals such as the Spanish speaking population have been addressed by different authors. Artiola i Fortuny and Mullaney (1997) analyzed the language problems associated with the translation and adaptation of tests used in neuropsychological settings. In particular, the authors discussed that problems such as the linguistic quality of translated tests can affect their validity through item, method and construct bias. They argued that poor translation of specific test items as well as cultural difference in test administration and measurement posit significant threats to the appropriate assessment of cognitive abilities of non-English speaking populations. Furthermore, these authors stated that these errors arise from lack of Spanish-language competency and failure to recognize lack of skills and knowledge in this area. Based on these observations, the authors suggested that professionals should engage in active consultation with more experienced individuals possessing the necessary language skills as well as with in-depth and up-to-date understanding of cultural issues in test development and assessment. Other authors (Echemendia & Harris, 2004) have discussed how important it is to establish whether a measure or test is an English translation, whether it was normed in the target population and whether it was adapted for a specific ethnic group. Nevertheless, very few studies addressing the development, standardization and validation of neuropsychological instrument for individuals of Spanish-speaking backgrounds have been conducted.

The current study addressed the issues discussed by these authors through the evaluation of a battery developed for the assessment of Spanish/English bilinguals taking into consideration the premises of the influence of language and cultural factors. The assessment of both Spanish/English bilinguals and English monolinguals provided relevant information in the understanding of the suitability of the instrument for the intended population. Specifically, it provided information about the appropriateness of different items and tasks in the assessment of abilities including verbal memory and learning and language functioning. These aspects are of particular interest because of their relevance for the appropriate development, adaptation and/or translation of items measuring these abilities.

Similar to a previous study examining the construct validity and the utility of a neuropsychological test developed for monolingual and bilingual Hispanics (Ponton et al., 2000), the current study allowed the identification of factors including verbal learning as well as different aspects within executive functioning including attention and executive control. Nevertheless, given that the current study utilized a more comprehensive battery including a variety of tasks tapping into a wide range of cognitive abilities, results from this study allowed the identification of other factors that consistently emerged across the various retention methods used. These factors included verbal learning and memory. Another relevant aspect about the factor analysis study conducted by Ponton and colleagues (2000) is that the factor structure was consistent with a priori assumptions about the battery. This was a different aspect in the current study since the four different retention methods produced factor structures different from the hypothesized structure of the battery.

Other researchers (Mungas, Widaman, Reed & Farias, 2011) have examined the dimensional structure of a neuropsychological battery for both English-speaking and Spanish-speaking Hispanic older adults. The authors found dimensions consistent with episodic memory, semantic memory/language, spatial ability, attention/working memory and verbal fluency. The factors from the NMNB identified in the current study are somewhat consistent to what these investigators found in the battery that they examined, particularly with respect to semantic memory and working memory. Conversely, the studies differ in their sample. While the current study included a sample of young Spanish/English bilinguals, Mungas and colleagues (2011) included a sample of older adult Hispanic participants who either spoke English or Spanish.

Other neuropsychological measures have been developed for monolingual Spanish speakers outside the United States. Ostrosky-Solís, Ardila and Roselli (1999) examined the underlying factor structure of the NEUROPSI during the standardization study of this battery. This instrument is a short measure of cognitive abilities including orientation, attention/concentration, language, memory, visuo-motor, executive function, reading, writing, and calculation skills. The authors discussed that their analyses showed that the battery includes seven factors. These factors were identified as executive function, writing, verbal fluency, motor sequencing, and memory. The last two factors were not labeled as the author indicated they were difficult to interpret as they included subtests measuring different abilities. Memory was the only factor consistent with the findings from the NMNB. However, it is important to highlight that these two studies have several discrepancies with respect to the sample. First, the NEUROPSI included a sample of individuals from 18 to 85 years of age with an education ranging from zero to 24 years. Second, participant were individuals from five different areas of Mexico. In the contrary, the current study included a sample of young and educated individual with roots in a variety of Spanish-speaking countries.

Ostrosky-Solís and colleagues (2007) also examined the factor structure of the battery NEUROPSI ATTENTION AND MEMORY during its standardization. The battery contains different tasks measuring abilities including orientation, attention and concentration, executive functions, working memory, immediate and delayed verbal memory and immediate and delayed visual memory. The authors found six meaningful factors that were identified as attention-executive function, contextual-executive memory, verbal memory factor, selective and sustained attention and concentration, attention-working memory, and orientation. These findings were slightly more consistent with the findings from the NMNB regarding the identification of factors of memory and aspects within executive functioning. However, it is important to note that similar to the previously discussed study, this standardization study included a large sample of individuals with a wide range in age (6-85 years) and education (0-22 years of education) from Mexico.

Several studies have discussed and investigated the effects of bilingualism on language abilities. Discussions regarding this topic have focused on the examination of patterns of advantages and disadvantages reported across different studies (Rivera, Arentoft, Germano et al., 2008). Abilities such as rapid verbal production or picture naming have been identified as areas affected by bilingualism, whereas abilities involving executive control have been described as enhanced abilities in individuals who speak more than one language (Luo, Luk & Bialystok, 2010). The current study aimed to evaluate whether this effect was observed during the performance on measures of language abilities developed for Spanish/English bilingual populations. Additionally, it intended to examine this issue through the evaluation of aspects such as language fluency.

Lou, Luk and Bialystok (2010) found no group differences in category fluency when they examined different aspects of language fluency in monolinguals and bilinguals with high and low vocabulary size. The authors discussed that their data failed to replicate the pattern of disadvantage in language functioning reported by other studies. Similarly, results from the data obtained using the NMNB did not provide evidence of any moderation effect of bilingualism on language functioning. Based on the results, it seems that performance on tasks from this battery does not appear to be related to language fluency abilities.

Kohnert, Hernandez and Bates (1998) examined the performance of a young sample of Spanish-English bilinguals on the Boston Naming Test (BNT). Participants of this study were tested in both English and Spanish and their self-rating of speaking, listening, reading and writing skills was also examined in relation to their performances. Results from this study showed better performance in English than in Spanish. Regarding language proficiency, they found that higher self-ratings in Spanish was associated with higher scores on the BNT in Spanish and that higher self-ratings in English were associated with higher scores on the BNT in English. The current study did not find differences in performance across a variety of language subtests when an objective measure of language fluency was used. Thus, this puts into perspective the importance of integrating both self-report and objective measures in the evaluation of Spanish-English bilinguals.

Another important aspect addressed with these analyses was the use of an objective measure of language fluency. It has been discussed that the assessment of bilingualism should include both subjective and objective measures of language proficiency (Rivera, Arentoft, Germano et al., 2008). Examination of language proficiency can provide important information about an individual's actual level of abilities and can be used to guide the assessment and interpretation of results. Some studies have used both self-reports and objective measures of language proficiency to establish whether individuals are Spanish-dominant, balanced or English-dominant bilinguals (Gasquoine et al., 2007). This study also incorporated the use of both subjective and objective measures of language proficiency, yet participants were not divided into groups based on their bilingual skills.

This study also examined the effect of acculturation on test performance through testing the hypothesis that level of acculturation, as determined by scores from a research-based demographic questionnaire, would moderate the relationship of Spanish/English bilinguals and English monolinguals and their performance on eight subtests from the NMNB considered to be measures of executive functioning and perceptual reasoning abilities.

Contrary to previous research, findings from the current study did not show evidence of the effects of acculturation on the performance on tasks measuring executive functioning and perceptual reasoning. Herrera, Ponton, Corona and colleagues (1998) found that acculturation, together with age, education and gender, moderated the performance of Hispanic individuals on the NeSBHIS. Razani, Burciaga, Madore and Wong (2007) found that acculturation, together with other demographic variables including years of education outside the United States and amount of English spoken when growing up, correlated with the performance on measures of attention and processing speed in a sample of individuals from Hispanic, Asian, and Middle Eastern backgrounds. It was found that as level of acculturation increased, there was an increased performance on measures of working memory, processing speed and inhibition. Results using subtests from the NMNB and the acculturation questionnaire adapted for this study did not replicate previous findings of the effect of level of acculturation on performance, suggesting that demographic variables such as acculturation does not appear to affect the performance on subtests from this battery.

Limitations

Although this study provided valuable information regarding test development and neuropsychological evaluation of Spanish/English bilinguals, there are several limitations affecting its external and the internal validity. First, there were several issues associated with the sample of participants included in the study. The sample included a group of young (*M* = 27.89) and educated (*M* = 17.27) participants. These participants represented a sample of convenience as they were mostly recruited from a university setting or referred by other participants of the study. The fact that many of the Spanish/English bilingual participants completed or were completing higher education in the United States may have been a confounding factor in the evaluation of the influence of the demographic variables such as acculturation. In the same vein, educational attainment could have been correlated to test performance given that the battery includes many simple and easy tasks. Neuropsychological testing involves procedures and conditions typically used in educational/academic settings. Thus, performance was likely influenced by familiarity with testing procedures and characteristics of the tasks, therefore the results should be interpreted keeping this issue in mind.

Inclusion of a more diverse sample of participants comprising older individuals with different levels of education could have provided a different pattern of results. It could have also allowed further statistical analyses of performances based on educational attainment and age.

Additionally, the lack of a group of Spanish monolinguals was another limitation associated with the characteristic of the sample. This study included Spanish/English bilinguals who were tested in English or Spanish based on their preference for testing. Although this study focused on Spanish/English bilinguals, the inclusion of Spanish monolinguals could have provided useful data regarding the suitability of the Spanish form of the battery as well as its utility with this population. Thus, generalization of the results to Spanish speakers is not plausible. Examination of performance of Spanish monolinguals could have been used to further explore the underlying factor structure of the Spanish version of the battery. This could have also allowed cross comparisons between English monolinguals and Spanish monolinguals.

The use of non-standardized measures for the assessment of language proficiency and acculturation was another limitation. Regarding language proficiency, a subtest from the battery was used to examine participants' language ability. This subtest is a measure of categorical fluency; thus, it does not assess other aspects of language abilities including comprehension, reading, and writing abilities. Consequently, there was not a formal assessment of participants' level of language fluency. Rather the data regarding language fluency ability was obtained from an embedded measure. Furthermore, analyses of the different levels of language fluency based on the performance on this subtest was not conducted. As previously discussed, the evaluation of language proficiency allows the identification or classification of individuals as English-dominant bilingual, dominant in non-English language or balanced (Rivera et al., 2008).

Therefore, this study is limited in this aspect since analyses were not conducted based on results of the assessment of language proficiency. Participants also provided self-ratings of their language skills, yet this information was not analyzed in this study. Age of second language acquisition has also been considered as an important variable in examining levels of bilingualism in many research studies. Although the demographic questionnaire used in this study included several questions regarding language use, age of second language acquisition was not one of them. Examination of both self-ratings and objective measures of language fluency as well as age of second language acquisition could have allowed in-depth investigation of the effects of bilingualism on test performance.

Furthermore, instead of randomly assigning the Spanish/English bilingual participants to be tested either in English or Spanish, participants were allowed to select the language in which they were tested. Thus, this was a thread to the internal validity of the study. It is possible that test selection was associated with participants' self- ratings, yet this cannot be determined since those analyses were not performed.

A similar issue was identified with the assessment of acculturation. Examination of level of acculturation was conducted using a measure developed with the NMNB, thus the validity of this measure has not been established. This research-based acculturation form included a series of questions adapted from the Stephenson Multigroup Scale and the Abbreviated Multidimensional Acculturation Scale and high scores were interpreted as more acculturation towards the United States (Stack, 2010). Furthermore, participants included in the study were likely to be highly acculturated given that they were young and educated. Thus, it is possible that there was a little variability in acculturation scores.

There are some issues regarding the NMNB itself. Examination of the items included in the different subtests also provided relevant insight regarding the participants' performance. As mentioned earlier, many subtests from the battery include simple and easy tasks. Thus, it can be inferred that the small degree of variability in tasks demands was manifested through increased performance across the group of participants. Furthermore, some issues regarding the Spanish form of the battery were noted. Certain subtests include items that have words and descriptions that are more frequent in certain Spanish speaking countries. For example, *carmelita* is the color brown in Cuba but not in other countries. Thus, this types of issues can limit the use of the battery with individuals from other countries. The Hispanic population is a very heterogeneous group that includes individuals from a wide range of countries. Although individuals within this population share beliefs, traditions and value systems, the variation in aspects such as language characteristics is remarkable. Therefore, special considerations should be given to this aspect when developing measures for this population.

There were also statistical limitations in this study. Preliminary data analyses showed there were significant correlations among the subtests; nevertheless, the overall strength of the correlations was small to moderate. This lack of large correlations among the subtests was reflected in the subsequent analyses, which in turn limited the overall findings of the study.

Some problems with the exploratory factor analyses emerged. Specifically, the different retention models yielded patterns of factor structure that varied in the number of factor loadings and their strength. Although the identified factors included subtests with strong loadings (.30 - .80), many of them were weak as the number of subtests loading onto the factors ranged from five to two. Literature suggests that a solid factor includes five or more items with loadings equal or greater than .50 (Costello & Osborne, 2005). Also, many subtests failed to load onto factors across the different retention methods. This again put into context the small correlations among subtests.

Further examination of the issues concerning the factor structure of the battery puts into context the possibility that the first retention method used for the study produced a pattern of over extraction of factors. This retention method involved retaining all factors greater than 1.0 and it has been argued that this method is one of the least accurate methods for factor retention (Costello & Osborne, 2005). This first retention method produced the least solid structure. Thus, interpretation of the identified factors was challenging.

The overall results of factor analyses suggest that the data from the study was strong because the factors included high communalities with a few cross-loadings. However, the observed issues regarding the presence of several weak factors due to limited number of subtests loading onto the identified factors challenge this notion. Based on this observation, a larger sample could have produced a pattern of stronger factors. Thus, the sample size was a limitation in that sense. Generalizability or replicability of the results could have been improved by including a larger sample of participants.

Last, given that the underlying factor structure of the NMNB was examined using an exploratory factor analysis, statistical inferences are not plausible. Results from analyses such as the ones obtained in this study are useful for description of the quality and nature of the data. Although certain conclusions can be reached based on the results from these exploratory analyses, further analyses including other techniques are necessary for more comprehensive interpretations.

Future Research

Further research regarding test development and neuropsychological test performance of individuals of Hispanic background would represent a significant advancement within neuropsychology. The current demographic trends of the country with Hispanics representing the largest ethnic or minority group put into perspective the relevance of such research endeavors. Examination of the validity and utility of the NMNB with Spanish monolinguals would expand the knowledge about the psychometric properties of this battery and would advance the improvement and development of this instrument. Inclusion of a monolingual sample with individuals from different age groups and educational level would extent the use of this battery.

Expansion of the sample by including both monolingual and bilingual participants representing different Spanish speaking countries would also address aspects concerning the diversity within this population. Hispanics comprise a diverse ethnic group of people from different geographical areas and with different racial characteristics. For this reason, there are substantial differences among this group, which go beyond language differences. Heterogeneity within this population is reflected through the differences in race, acculturation, age, language ability, country of origin, and education. Consequently, examining patterns of similarities and differences within this population would provide useful information for test content and item development. Also, comparison of performance across different groups would be possible.

Research with older adult individuals including English and Spanish monolinguals as well as Spanish/English bilinguals would be relevant and appropriate based on the results from this study. Specifically, examination of the performance of older adults would expand knowledge about the validity of subtests within the battery such as the memory and executive functioning measures, as these were consistent factors that emerged across the different models used for the exploratory factor analyses. This is relevant from a clinical perspective since the evaluation of memory functioning is a typical referral question in clinical settings. These types of analyses would also be useful for clinical recommendations when very specific abilities are evaluated and their impact on every day functioning is the focus of the examination.

Accordingly, given that research conducted thus far with the NMNB have focused on the examination of performance of normal populations, studies including clinical populations would add to the body of knowledge regarding the suitability of the instrument and its utility in clinical settings. Results from the exploratory factor analyses conducted with the data from this study suggest that subtests from this battery would be appropriate measures for the evaluation of degenerative conditions such as dementias as well as brain injuries. This assumption would be important to be empirically tested. The evaluation of the validity of the subtests from this battery with neuropsychiatric populations would also provide valuable information about its clinical utility by examining the effects of acute or chronic psychiatric conditions on cognitive functioning.

These types of assessments would be in accordance with the purposes of neuropsychological assessment, which include determining the presence of cognitive dysfunction and clinical judgement of its impact on different areas of functioning. Examination of the clinical utility of the NMNB would be a significant contribution to the field due to the evident need for comprehensive, valid and reliable assessment tools.

In the same vein, future research should also incorporate the assessment of pre-morbid abilities in this population. It would be interesting to examine whether some subtests from this battery would be appropriate for this purpose. This may be achieved through the examination of the utility of subtests such as Vocabulary or Reading Comprehension in the estimation of pre-morbid abilities. Also, it would be appropriate to compare results from these analyses with other developed and validated tests intended to measure this area of functioning.

Expansion of the sample of the study would be advantageous in many other aspects. A larger sample of individuals would allow the development of normative data and the standardization of the battery. Development of standard scores including total test scores as well as performance scores for the different identified factors should be also conducted with future research. For instance, verbal memory was an identified factor, thus an overall performance verbal memory score would be useful for interpretation of test results. The calculation of scores such as initial recall, total recall, retention rate and recognition of information would allow the generation of standard scores for specific aspects within the verbal memory domain. It would be also useful to conduct the same procedure with other cognitive domains within the battery.

Another benefit of the inclusion of a larger sample would be the examination of the reliability of the battery. Part of the sample should be selected to evaluate the test-retest reliability of the instrument. This will be particularly useful to evaluate the psychometric properties of both versions of the battery. Also, there would be the opportunity for further evaluation of test items. That is, this would provide the opportunity to evaluate the characteristics of the questions included in the battery. This information could be used to guide further development of start and end points for item administration as well as to determine the variability of the tasks demands.

This advancement in the development of the quality of the items should also be accompanied by systematic scoring procedures. This would also provide information useful for qualitative analyses based on errors and pattern of performances, which would be important for both research and clinical purposes. Consequently, standardized procedures for both administration and scoring would be achieved with further research.

Additionally, the standardization process would provide the appropriate set-up to conduct analyses to evaluate differences in performance based on gender, age, and educational level. During the process, systematic evaluation of other variables would also be appropriate to conduct. Particularly, formal assessment of level of bilingualism should be conducted. Special attention should be given to determining language proficiency in both languages across different skills. Based on the information obtained from this type of assessment, it would be helpful to evaluate individuals based on their level of language proficiency. Self-report measures would also contribute to the assessment of the language fluency and can be compared with objective measures. This information would guide the understanding of how different levels of language usage can impact neuropsychological test performance. It would also provide information that can guide clinicians in determining what would be the best approach in evaluating a bilingual individual.

Similarly, future research should include comprehensive assessment of levels of acculturation with standardized and valid measures. Given that acculturation is a multidimensional construct, the effects of confounding variables should be taken into consideration. Thus, the moderating effect of variables such as language fluency, education and socio-economic status should be incorporated into the evaluation of the influence of acculturation on neuropsychological assessment.

It is also important to address issues concerning the operationalization of the concept to conduct appropriate assessments with the adequate measures. Although the use of valid measures would strengthen the design of future research, examination of the utility of the current measure of acculturation developed for the NMNB would also add to the research literature. A new acculturation measure with established validity with this population would be a significant contribution to the field of cross-cultural psychology.

The results of the current study did not support the hypotheses of the moderating effects of language fluency and level of acculturation on test performance. That is, results with this data did not answer the question of whether high or low levels of language proficiency or acculturation influence test performance. It would be interesting to conduct further analyses of these variables once they have been systematically assessed. Examination of mediating effects would also provide important information about the impact of these variables. Specifically, mediation analyses would address how these variables affect performance on the different measures of the battery.

Last, further examination of the NMNB should be conducted through confirmatory factor analysis. This would be more appropriate once a larger sample of individuals is evaluated with the NMNB. More informative analytic options can be obtained with the examination of the latent construct of this battery using this technique. This analysis would also allow further examination of relevant theories and the current research literature on bilingualism. It will allow hypotheses testing to determine whether the battery has the same factor structure across different subgroups. Results of such analysis would support the current results or provide alternate inferences about the correlations of the subtests within the battery.

Furthermore, correlation analyses with other well-validated measures would provide further understanding of the validity of this instrument. Although research for the development and standardization of instruments for the assessment of Spanish speakers and Spanish/English bilinguals have been limited, some measures have been developed and tested empirically. Thus, comparisons with other measures would also expand the knowledge about this battery.

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