THE EFFECTS OF ACCULTURATION ON NEUROPSYCHOLOGICAL TEST PERFORMANCE IN ENGLISH-SPEAKING AND FARSI-SPEAKING IRANIAN INDIVIDUALS

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by

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DEDICATION

“The function of education is to teach one to think intensively and to think critically. Intelligence plus character – that is the goal of true education.”

-Martin Luther King Jr.

“The only person who is educated is the one who has learned how to learn and change.”

-Carl Rogers

I dedicate this thesis to family and friends for their unconditional love and support. Mom, as a Hispanic woman with a master’s degree, you have paved a path for me to achieve success in higher education. Thank you for teaching me the value of education, never giving up on me, and always pushing me to be the best I can be. Dad, thank you for always being my number one fan and continuing to support me throughout my journey. Jonathan, Papa, Tata, and Iris, thank you for always believing in me.
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ABSTRACT

THE EFFECTS OF ACCULTURATION ON NEUROPSYCHOLOGICAL TEST PERFORMANCE IN ENGLISH-SPEAKING AND FARSI-SPEAKING IRANIAN INDIVIDUALS

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The aims of this study were to (1) characterize and provide descriptive statistics for the neuropsychological test performance of both English-Speaking and Farsi-Speaking Iranian individuals on three measures that involve little verbal mediation, (2) examine differences in the performance of English-Speaking Iranians, Farsi-Speaking Iranians, and Caucasians on three measures that require very little verbal mediation and are typically regarded as culture-free, and (3) assess the relationship between cultural factors and neuropsychological test performance of the English-Speaking and Farsi-Speaking Iranians. One-hundred-eight healthy adult participants composed three groups in this study: 44 Caucasian, monolingual English-speakers, 28 English-Speaking Iranian, and 36 Farsi-Speaking Iranian. Participants’ performance on the Wisconsin Card Sorting Test (WCST), Trail Making Test (TMT), and Color Trails Test (CTT) was assessed. Results from a MANCOVA, using age as the covariate, indicated that group means were significantly different for the WCST percent conceptual response score, TMT-A, and TMT-B. Specifically, the Farsi-speaking Iranian group had lower conceptual level scores
and slower completion times for TMT-A and TMT-B compared to the English-speaking Iranian group and the Caucasian group, who performed the same. Additionally, correlation analyses revealed that the Iranian participants’ (Farsi- and English-speaking) level of acculturation and percentage of education obtained inside the US were related to performance on several of the neuropsychological variables. These findings provide support for the presumption that culture affects performance on neuropsychological measures. Furthermore, it is imperative that clinicians, who administer neuropsychological tests to ethnically diverse individuals, account for the influence of specific cultural factors when interpreting test results.
CHAPTER I
INTRODUCTION

Neuropsychological Testing

Neuropsychological investigations emphasize the relationship between human behavior and brain function, based on the assumption that certain behaviors are determined by the central nervous system. Accordingly, it is assumed that physical changes in the brain must influence change in behavior (Heilman & Valenstein, 2012). Therefore, the neuropsychological instruments used in such investigations enable the identification of dysfunctional components of the brain that are responsible for changes in behavior (Kolb & Whishaw, 1996; Mitrushina, Boone, Razani, D’Elia, 2005). As research and diagnostic tools, neuropsychological tests continue to be successful in producing information to aid in the diagnosis and treatment planning of individuals with various forms of brain pathology (Chaytor & Schmitter-Edgecombe, 2003). A comprehensive evaluation of cognitive domains (i.e., memory, attention/concentration, language, executive functions, visuospatial skills, and verbal/nonverbal learning skills) provides an index of strengths and weaknesses within the particular brain regions that are of diagnostic relevance (Mitrushina et al., 2005).

Although the use of technology has evolved so that brain-scanning methods may lead to more accurate depictions of lesion locations, neuropsychological tests remain invaluable in the diagnosis of several brain-related diseases as well as in the ability to identify specific cognitive deficits (Chaytor & Schmitter-Edgecombe, 2003; Kolb & Whishaw, 1996). For example, the evidence needed to render a definitive diagnosis of Alzheimer’s Disease (AD), which is caused by brain degeneration and plaque formation
(Plante, 2005), can only be obtained post-mortem by brain autopsy. Therefore, while alive, a tentative dementia diagnosis is presented when other medical illnesses are ruled out and the patterns of cognitive deficits indicate a particular type of dementia (APA, 2000). A neuropsychological evaluation of an individual’s cognitive and psychological functioning assist in ruling out potential explanations and, ultimately, arriving at a “possible” or “probable” diagnosis for AD (Plante, 2005). Additionally, neuropsychological test results may also be useful in predicting an individual’s ability and/or inability to perform everyday activities (e.g., work, school, manage finances, drive, live independently, etc.) (Kolb & Whishaw, 1996; Chaytor & Schmitter-Edgecombe, 2003). Furthermore, as a research tool, instruments that measure memory and executive function have demonstrated utility in the identification of individuals at risk of developing AD (Albert, Moss, Tanzi, & Jones, 2001).

Collecting data on the neuropsychological test performance of neurologically and medically healthy individuals is imperative for the standardization of these instruments (Mitrushina et al., 2005; Strauss, Sherman, Spreen, 2006). For any particular test, these data provide an index for the range of scores that represent “normal” performance. Upon neuropsychological evaluation, an individual’s performance is interpreted according to where their scores fall in regard to the normative reference group (Mitrushina et al., 2005). Therefore, the applicability of the normative data is fundamentally dependent on the characteristics of the sample in which they were attained (Strauss, Sherman, Spreen, 2006). That being said, it has become increasingly clear that demographic characteristics such as, culture and ethnicity, play a critical role in cognitive test performance.

A growing number of studies have demonstrated that differences exist in
neuropsychological test performance between Caucasian Americans and various ethnic minority groups (Artiola i Fortuny, Heaton, & Hermosillo, 1998; Boone, Victor, Wen, Razani, & Ponton, 2007). This discrepancy may be due to the fact that psychological instruments that are currently in use have been standardized and validated with non-Hispanic Caucasian samples, and essentially reflect the values of western culture. Therefore, as the US becomes more ethnically diverse, clinicians are challenged by the potential risk of misclassification for cognitive impairments among these individuals (Strauss, Sherman, Spreen, 2006; Kemmotsu, 2010). Considering that the western constructs measured by these tests may not be relevant to other cultures, it is possible that the discrepancy in test scores do not indicate a lack of ability, rather an unfamiliarity with the western culture. Nonetheless, much research is needed in this area in order to pinpoint the distinct factors which contribute to the performance gap.

Iranian Population

A broad focus of ethnically diverse individuals in general, rather than a particular ethnic group, is advantageous in uncovering the basic principles needed to improve the utility of neuropsychological measures (Manly, 2008). However, as will be discussed later, there is much variation in performance between various ethnic groups and sometimes within ethnic groups. Therefore, it is important to explore these differences by assessing specific ethnic groups and the unique cultural factors that may affect test performance. As a large immigrant group that resides in the US, Iranian individuals are an understudied population, particularly in regards to examining their performance on neuropsychological tests (McIntosh, 2004). Yet, between the years 1990 to 2010, the number of Iranian individuals living in the US has nearly doubled (from 235,521 in 1990
to 463,552 in 2010) (Census of Population, 2010). Over half of these individuals reside in major cities in Southern California; particularly Los Angeles, where they constitute approximately 20% of the total population in the affluent city of Beverly Hills (Mastashari & Khodamhosseini, 2004).

The Iranian community has been established in the US as one of the most educated and successful ethnic groups (Mastashari & Khodamhosseini, 2004). In regards to educational attainment, approximately 74% have at least a high school degree, 59% have a bachelors degree, and 28% have received a graduate or professional degree (Census of Population, 2010), and both males and females surpass the average US education level (Mastashari & Khodamhosseini, 2004). Additionally, approximately 54% of working Iranians have occupations that fall under the category of management, business, science, or art (Census of Population, 2010). Furthermore, the average income of Iranian individuals, per person, is 50% higher than the average income of all other Americans (Mastashari & Khodamhosseini, 2004).

Although Iranians are suggested to be one of the most highly educated ethnic groups in the US and are rarely known to face socioeconomic difficulties, they tend to preserve their cultural practices and language, particularly Farsi (Davoudzadeh, 2010). Nearly two-thirds of the Iranian population living in the US are foreign born and speak both English and Farsi within the household (Census of Population, 2010; Mastashari & Khodamhosseini, 2004). However, 20% speak English only and 7% do not speak English at all (Mastashari & Khodamhosseini, 2004).

To date, no known studies have examined the specific performance of Iranian individuals on neuropsychological measures. Notwithstanding, there are two published
studies that examined the psychometric properties of Farsi translations of an emotional intelligence scale and a clinical assessment (Besharat, 2007; Ghanizadeh, Mahammadi, Yazdanshenas, 2006). Additionally, an unpublished masters thesis examined the performance of bilingual Iranian-Americans on both English and Farsi versions of the Mini Mental State Examination (MMSE; Folstein, Folstein, & McHugh, 1975), commonly used to assess the mental status of individuals (Davoudzadeh, 2010). Although these studies provide promise for developing reliable and valid measures in Farsi, there is still a great need for the development and norming of an expanded neuropsychological test battery for Iranians.

**Neuropsychological Test Performance in Ethnically Diverse Groups**

Given the lack of literature concerning the neuropsychological test performance of Iranian individuals, research on other ethnic groups will be reviewed in order to draw parallels in the role of culture on neuropsychological test performance. A majority of these studies have focused on African American and Hispanic samples, and findings have been consistent across. Both ethnic groups have demonstrated poorer performance when compared to Caucasian samples on the Boston Naming Test (BNT; Taussig, Henderson, & Mack, 1992; Carlson, Brandt, Carson, & Kawas, 1998), measures of verbal phonemic fluency (Gladsjo et al., 1999; Taussig, Henderson, Mack, 1992) and category fluency (Schwartz et al., 2004; Jacobs et al., 1997), Trail Making Test (Schwartz et al., 2004; Lee, Cheung, Chan, & Chan, 2000), Halstead-Reitan measures (Heaton, Miller, Taylor, & Grant, 2004; Arnold, Montgomery, Castaneda, & Longoria, 1994), and various WAIS-R and WAIS-III subtests (Heaton, Taylor, & Manly, 2003; Lopez & Taussig, 1991). Additionally, African Americans have demonstrated poorer performance compared to
Caucasian Americans on the Repeatable Battery for the Assessment of Neuropsychological Status (RBANS; Patton et al., 2003) and the California Verbal Learning Test (CVLT; Norman, Evans, Miller, & Heaton, 2000).

Roberts, Garcia, and Desrochers (2002), assessed the performance of highly educated Spanish and French bilinguals on the Boston Naming Test and found that the bilingual groups scored far below the less educated English-speaking group. Similar differences have been observed with other measures of verbal category fluency (i.e., F,A,S) (Loewenstein, Duara, Arguelles, & Arguelles, 1995). When comparing two groups of English-speaking non-Hispanic Caucasian elders, who were either foreign born or born in the US, lowered scores were observed in the former on measures of verbal abstract reasoning, naming, and fluency (Touradji, Manly, Jacobs, & Stern, 2001). Accordingly, poor performance on tasks with higher verbal loadings have been associated with the orthographic complexity of the tasks, English language fluency, and bilingualism (Taussig, Hederson, Mack, 1992; Gasquoine, 2009).

Most perplexing are the differences observed between ethnically diverse and Caucasian individuals on measures that require little verbal mediation. One might assume that eliminating verbal items from these measures is a plausible strategy to ameliorate performance in ethnically diverse individuals, paradoxically, differences in performance seem to be greater on non-verbal tasks (Rosselli & Ardila, 2003). Razani, Burciaga, Madore, and Wong (2007), found that Caucasians performed significantly better than ethnically diverse participants on tasks that required very little verbal mediation. Comparably, in a study examining the performance of two Spanish-speaking samples, from geographically distinct areas, the most pronounced group differences were observed
on nonverbal tests (Artiola i Fortuny et al., 1998). These findings contradict the postulation that nonverbal skills are universally applicable and indicate a need to further investigate commonly used nonverbal measures.

The Wisconsin Card Sorting Test (WCST) is frequently used as a measure of executive functions in neuropsychological settings (Rosselli & Ardila, 1993). Although much of the literature has demonstrated the utility of the WCST in detecting cognitive impairments in clinical samples, there is uncertainty as to its cultural sensitivity (Coffey, Marmol, Schock, & Adams, 2005). Several studies have revealed significant differences in performance on the WCST indices between Caucasian and ethnically diverse individuals. For example, Kohli and Kaur (2006), compared a sample of Indian subjects to age-matched Caucasian monolingual English-speaking subjects and found that the Indian subjects committed more errors, obtained a lower level of conceptual understanding, and displayed overall poorer performance on the task. Similar studies, involving Taiwanese and Hispanic participants, also revealed relatively lower performance in these groups on the WCST indices when compared to US norms (Shan, Chen, Lee, & Su, 2008; Artiola i Fortuny et al., 1998; Coffey et al., 2005).

The Trail Making Test (TMT) is a popular measure frequently included as a standard test in neuropsychological test batteries (Mitrushina et al., 2005). The TMT is typically used as a measure of attention and psychomotor speed (Lee et al., 2000); however, because Part B requires sequence alteration, it can also be used as a measure of executive function (Mitrushina et al., 2005; Razani et al., 2007). Prior literature suggests that English-speaking Caucasian participants are quicker in completing both parts of the test when compared to ethnically diverse participants (Lee et al., 2000; Arnold et al.,
1994). When examining the performance of ethnically diverse and monolingual English-speaking Anglo-American participants on the TMT, it was observed that the latter outperformed the former on part B of the test (Razani et al., 2007). Additionally, another study found that in a group of elderly patients, Caucasians outperformed African American participants on part A (Boone et al., 2007). These findings give reason to question the use of published norms of the TMT with non-Caucasian individuals.

The Color Trails Test (CTT) is another commonly used neuropsychological instrument that is intended to measure attention and psychomotor speed as well as executive functioning (D’Elia, Satz, Uchiyama, & White, 1996). Interestingly, this test was designed (due to its lessened dependence on language and culture relative to the TMT) by substituting the English alphabet letters used in the TMT with colors in the CTT, to be appropriately used among ethnically diverse individuals and measure the same abilities. Whereas some studies have demonstrated construct validity as well as comparable sensitivity and specificity between the two measures (Lee & Chan, 2000); others have uncovered significant differences, suggesting each test measures different cognitive abilities (Dugbarty, 2000). Additionally, several studies have revealed differences in performance that were attributable to age, education, as well as geographical region of residence (Lee et al., 2000). La Rue, Romero, Ortiz, Liang, and Lindeman (1999), found that Hispanic participants took longer to complete the task than non-Hispanic participants at nearly all age and education levels. Also, it was observed that participants who spoke Spanish during testing performed worse than those who did not. Similar differences in CTT scores have also been observed between matched samples of Russian and American participants (Agranovich, Panter, Puente, & Touradji,
2011). Consequently, the CTT may not exactly be a “culture fair” version of the TMT (Dugbarty, 2000). Merely replacing the English alphabet with colors may not transform the utility of a test when used with ethnically diverse groups.

**Factors Affecting Test Performance**

A variety of factors related to acculturation/cultural factors have been suggested to account for the variability in cognitive test performance. The intricate process of acculturation involves an individual assimilating into a dominant culture as a result of continuous contact with that culture (Razani et al., 2007; Coffey et al., 2005). Varying levels of acculturation are conceptualized by the extent to which an individual embraces the language, values, customs, and behaviors of the majority culture (Razani et al., 2007). As the US population continues to grow more diverse, neuropsychological researchers have began to examine the relationship between acculturation and cognitive test performance. Arnold et al. (1994), examined the relationship between Hispanic and Caucasian participants’ level of acculturation (i.e., Mexican, Mexican-American, Caucasian-American) on several Halstead-Reitan neuropsychological tests. Results demonstrated poorer performance in the Mexican group compared to Caucasians, with the Mexican-American’s performance in the middle. Similarly, when examining performance of Spanish-speakers of Mexican heritage on the WCST, Coffey et al., (2005) found that the more acculturated subgroup demonstrated an overall better performance compared to the less acculturated subgroup. Other studies have found similar results on cognitive measures that do not require a substantial amount of language skills (Artiola i Fortuny et al., 1998; Manly et al., 1998; La Rue et al., 1999; Boone et al., 2007), suggesting that facets of acculturation influence both verbal and non-verbal
performance (Razani et al., 2007; Coffey et al., 2005).

Some studies have observed differences in performance between native English-speakers and those who speak English as a second language (ESL). For example, when examining a group of patients, participants who were ESL speakers performed poorer than native English-speakers on Digit Span, BNT, and FAS (Boone et al., 2007).

Nevertheless, few studies have actually examined the effect of language of administration on cognitive performance and findings have been ambiguous as to whether language dominant groups actually perform better in their dominant language (Artiola i Fortuny et al., 1998). A majority of these studies have been done by translating commonly used English language neuropsychological instruments into Spanish. Findings suggest that language of administration has a significant effect on neuropsychological tests with higher verbal mediation (Gasquoine, Croyle, Cavazos-Gonzalez, & Sandoval, 2007). In other words, individuals who were identified as Spanish language dominant performed significantly better on the Spanish version of verbal tests than they did on the English version. Although performance on nonverbal tests were equivalent across both language versions, when scores were compared to English norms individuals were falsely classified as neurologically impaired. This suggests that discrepancies in performance may go beyond language differences (La Rue et al., 1999).

The influence of education on cognitive test performance has been repeatedly demonstrated throughout the literature, suggesting that individuals who are more educated perform better on neuropsychological tests (Rosselli & Ardila, 2003). However, educational attainment does not always imply an equivalent type or level of education especially when comparing across cultures. Several studies have pointed to such factors
as quality of education and time spent in the US as influential predictors of test performance (Artiola i Fortuny et al., 1998; Artiola i Fortuny & Heaton, 1996). More specifically, researchers have demonstrated that years of education obtained in the US is highly correlated with performance on neuropsychological measures (Razani et al., 2007; Boone et al., 2007; Cave & Grieve, 2009; Harris, Tulsky, & Schultheis, 2003). Additionally, individuals with high levels of acculturation tend to have obtained a greater number of years of education in the US compared to those with lower levels of acculturation (Coffey et al., 2005). Furthermore, not only is the amount of education received in the US important, but quality of education, as assessed with reading competency, has also been observed as an influential factor in neuropsychological test performance (Manly, Jacobs, Touradji, Small, & Stern, 2002).

The discrepancies in performance on nonverbal measures between Caucasian and ethnically diverse individuals indicate a need to investigate what culturally related factors may be responsible for the gap in performance. Additionally, from a professional standpoint, it is unethical to use inappropriate measures on culturally diverse people. Therefore, it is imperative that these issues be assessed for the integrity of the theoretical and empirical infrastructure of neuropsychological practice (Manly, 2008). By examining the unique contributions of cultural influences in specific cultures/ethnicities on cognitive test performance, we will be able to develop tools to improve the precision and value of neuropsychological measures.

**Rationale for Studying the Iranian Population**

The first rationale for studying this population is that there is no published literature on the neuropsychological test performance of this ethnic group. Additionally,
despite the high level of education and socioeconomic prosperity of Iranians as a group, there is evidence from studies on other ethnic groups that level of educational attainment alone does not predict neuropsychological test performance. Therefore, it is unclear how Iranian individuals would perform on cognitive tests relative to Caucasians with the same years of education. Considering that this group of individuals is at risk of being falsely classified as neurologically impaired, examination of their cognitive performance is imperative in regards to developing norms and interpretation of test results. Furthermore, examination of Iranian individuals on selected cognitive tests will not only establish a basis for further exploration of this population but will also contribute to understanding the performance of ethnically diverse populations as a whole.

**Overall Goal of Present Study**

The overall goal of the present study was to examine the neuropsychological test performance of both Farsi- and English-speaking Iranians. Typically, in neuropsychological practice, ethnically diverse individuals who are conversantly fluent in English are presumed to be considerably acculturated to the US. Consequently, clinicians will administer cognitive tests to these individuals and interpret their results based on standard norms (Razani et al., 2007). Therefore, it is important to have information on how Iranian individuals will perform on these tests and to develop normative data for tests that are appropriate for use with English-speaking Iranians. Additionally, this study developed neuropsychological tests for Farsi-speaking individuals, so that a greater proportion of this cultural group can be served. For the current study, neuropsychological tests that involve little verbal mediation were chosen to characterize the performance of Iranian individuals. The WCST, TMT, and CTT are regarded as relatively “culture fair”
neuropsychological measures (Rosselli & Ardila, 1993; Coffey et al., 2005; D’Elia et al., 1996). However, the literature suggests otherwise and demonstrates the importance of investigating the utility of these measures with Iranian individuals.

**Specific Aims of the Current Study**

The following are the specific aims of the current study:

Aim 1: This study aims to characterize and provide descriptive statistics for the performance of Iranian individuals on three neuropsychological test measures that are believed to have little verbal mediation and thus, assumed to be “culture free” in Farsi- and English-speakers.

Hypothesis 1: For Aim 1, there is no specific hypothesis. Descriptive statistics will be obtained for the neuropsychological measures in order to provide normative data for these two Iranian groups.

Aim 2: To examine differences in the performance of English-speaking Iranians, Farsi-speaking Iranians, and Caucasians. Hypothesis 2: It is hypothesized that group comparisons will demonstrate differences in test performance of the Iranians relative to the Caucasians on most of the outcome measures, but that no differences will be found between the two Iranian groups.

Aim 3: To assess the degree to which cultural factors (such as acculturation) account for neuropsychological test performance of the Iranians (English- and Farsi-speakers).

Hypothesis 3: It is hypothesized that there is a relationship between specific cultural factors (such as acculturation and education obtained in the US) and neuropsychological tests in the Iranian groups, such that the less the education obtained inside of the US and the higher the acculturation level, the better the neuropsychological test performance will
be.
CHAPTER II
METHODOLOGY

Participants

A comprehensive neuropsychological battery was administered to one-hundred-eight healthy adult participants. Forty-four participants were Caucasian, monolingual English-speakers, twenty-eight were English-speaking Iranian, and thirty-six were Farsi-speaking Iranian.

Participants were recruited from the greater Los Angeles area via word-of-mouth, flyers, and newspaper advertisements. An examiner-administered health questionnaire was used to screen participants for the following factors: history of neurological or psychiatric illness, head injury resulting in less than 5 minutes of loss of consciousness, learning disability, and chronic untreated medical illness (Razani et al., 2007). Participants who met the health criteria and were Caucasian, US born, and monolingual English-speakers were eligible to participate. Participants who were of Iranian decent and met the health criteria were also eligible for participation. Additionally, the Iranian participants who were administered the test in English, were conversantly fluent in English. Examiners decided if the participant was conversantly fluent based on whether the participant could clearly communicate as well as comprehend what was required for each task (Razani et al., 2007). Farsi-speakers were likewise fluent in Farsi and reported this to be their first and primary language.

Materials

Neuropsychological Measures

Participants in the Caucasian and English-speaking Iranian group were given
standard instructions for the WCST, TMT, and CTT in English. The same test instructions and stimuli, when necessary, were adapted for the Farsi-speaking Iranian group in Farsi. For the Farsi adaptation and translation, Brislin’s (1983) three step procedure was employed. First, the tests were translated into Farsi, then they were back translated from Farsi to English (by a different translator), and if there were any differences between the original English version and the back translation, two English and Farsi fluent translators were used to resolve the difference. There were no discrepancies found between the translated and back-translated versions of the tests used for this study.

**Wisconsin Card Sorting Test (WCST).** The 64-card deck of the WCST was administered, which required participants to match each of the cards to 1 of 4 stimulus cards on the basis of three principles (color, form or number). Very little feedback is given to the participant regarding their responses, therefore, requiring the use of abstract reasoning skills in order to carry out the task (Translated in the same format as Heaton, Chelune, Talley, Kay & Curtiss, 1993). Participants are required to correctly sort to a given principle (e.g., color) ten consecutive times, before the sorting principle is changed (e.g., to form). The task is continued until the participant has sorted all 64 cards in the deck. The following WCST outcome variables were used in the analyses:

1. *categories completed* (every 10 correct consecutive sort to a correct principle is counted as one completed category)
2. *total errors* (every time a card is incorrectly sorted)
3. *perseverative responses* (repetitive sorting)
4. *percent conceptual level response* (a percentage of the participant’s overall
understanding of the conceptual understanding of the task)

(5) set failure (loss of the correct sorting principle during the task)

**Trail Making Test (TMT).** The TMT consists of parts A and B. In Part A (TMT-A), using a pencil to draw lines, the participant is required to connect encircled numbers (1 through 25) that are arbitrarily positioned on a page, in sequential order as fast as they can. In Part B (TMT-B), encircled numbers from 1 through 13 and encircled letters from A through L are arbitrarily positioned on a page. The participant is required to connect the numbers to letters in an alternating order as fast as they can. The time, in seconds, it takes the participant to complete each part separately were used as the outcome measures (Razani et al., 2007; Mitrushina et al., 2005; Lee et al., 2000).

**Color Trails Test (CTT).** The CTT (D'Elia, Satz, Uchiyama, & White, 1996) consists of two parts. Part 1 (CTT-1), using a pencil, the participant is required to connect encircled numbers (1 through 25) that are arbitrarily positioned on a page, in sequential order. Circles containing odd numbers have a pink background, and circles containing even numbers have a yellow background. Part 2 (CTT-2) encircled numbers from 1 to 25 are displayed twice on a page (one set with a yellow background, and the other set with pink). The participant is required to alternate between pink and yellow circles as they connect the numbers from 1 to 25 in sequential order, ignoring the encircled numbers of the alternate color. Completion time for CTT-1 and CTT-2 is recorded in seconds, in addition to the number of inappropriate connections.

**Acculturation Materials**

An adapted version of the Acculturation Rating Scale for Mexican Americans (ARSMA; Cuellar, Harris, & Jasso, 1980) was used, since there was no available
acculturation measure that specifically targets Iranian individuals. Razani et al. (2007), created the Iranian version of the ARSMA (using a method comparable to Suinn, Rickard-Figueroa, Lew, & Vigil (1987)), by modifying original ARSMA terminology such as “Mexican” and “Spanish” to “Iranian” and “Farsi”.

The ARSMA contains 20 Likert scale items that requires participant rating on a 5 point scale that ranges from (1) original heritage/language (i.e., Iranian/Farsi) to (5) Anglo-American/English. Four domains are assessed in regard to acculturation: (1) language (i.e., their familiarity, usage, and preference of Farsi and English); (2) identification with their ethnicity and generation (e.g., first generation Iranian-American); (3) reading, writing, and exposure to Iranian and American culture; (4) interaction with Iranian ethnicity. Three items were reduced to a 3 point Likert scale, due to irrelevant cultural constructs. An overall score was calculated by total Likert points. A score of 20 represents the lowest level of acculturation and a score of 94 represents the highest level of acculturation (Razani et al., 2007).

Additional information regarding length of time each participant was educated inside the US, was also gathered from an additional questionnaire.

**Procedure**

Recruitment methods consisted of newspaper advertisements, flyers posted in public agencies and buildings, and word of mouth. The WCST, TMT, and CTT were administered as part of a larger neuropsychological test battery, which took approximately 2.5 hours to complete. Additionally, all participants were administered a health questionnaire for screening purposes and both of the Iranian groups were administered the Iranian adapted ARSMA questionnaire and an additional acculturation
measure. All participants were paid $50 for their involvement in the study.

**Analyses**

Descriptive statistics (means and standard deviations) were obtained for all neuropsychological outcome variables for each group in order to provide normative information (Aim 1 of this study). Given the age difference between the groups (see Table 1), \( (F(2,105) = 54.933, p < .001) \), multivariate analysis of covariance (MANCOVA), using age as the covariate, the three groups as the independent variable and the neuropsychological outcome variables as the dependent variable was performed to address the second hypothesis. Outcome measures for the MANCOVA included: WCST *total errors*, WCST *categories completed*, WCST *perseverative responses*, WCST *percent conceptual level response*, and WCST *set failure*; completion time, in seconds, for TMT-A and TMT-B; and completion time, in seconds, for CTT-1 and CTT-2. To further evaluate the differences between each group, several follow-up analyses of covariance (ANCOVAs), again using age as the covariate, and LSD post-hoc comparisons were conducted on each of the outcome variables, individually.

In order to assess the third hypothesis, bivariate correlations were performed in order to examine the relationship between acculturation level, percent of education obtained in the US, and the neuropsychological outcome measures in the Iranian groups. It should be noted, that the length of time the participant was educated inside of the U.S. was calculated for each individual based on a ratio of the years educated inside of the U.S. to the total number of years of education attained.
CHAPTER III
RESULTS

Descriptive Information

The unadjusted (i.e., prior to covarying for age) means and standard deviations for each group by neuropsychological test performance are presented in Table 2. These data provide pertinent normative information. The data represents how Farsi-Speaking Iranians, with a mean age of 57.39, are likely to perform when administered the Farsi translated and adapted version of these neuropsychological tests. Additionally, the data provided on the English version of these measures represents how English-Speaking Iranians, with a mean age of 41.32, and Caucasians, with a mean age of 30.25, are likely to perform when taking the tests in English.

Group Comparisons

Results from the MANCOVA, using age as the covariate, revealed a significant difference between the groups in regard to their performance on the combined outcome variables, Wilks’ Λ = .415, F (18,192) = 5.89, p < .001.

Follow-up ANCOVA’s, using age as a covariate, revealed significant differences between the groups on TMT-A (F (2,104) = 10.93, p < .001), TMT-B (F (2,104) = 14.39, p < .001), and WCST percent conceptual level response (F (2,104) = 5.91, p < .01). However, no other differences were found between the groups on the other outcome variables.

The adjusted means for each outcome variable presented in Table 3 are based on an average age of 42.17. LSD post-hoc analyses demonstrated that the mean time taken for the Farsi-speaking group on TMT-A was significantly higher than both other groups
The English-speaking Iranian group and the Caucasian group performed the same on this task (all p-values > .05). Similarly, the mean time taken for the Farsi-speaking group on TMT-B was significantly higher than both other groups (p< .001); the Iranian English-speaking group performed the same as the Caucasian group (all p-values > .05).

LSD post-hoc comparison on WCST *conceptual level response* revealed that the Iranian Farsi-speaking group had a significantly lower conceptual level understanding of the task than both other groups (p < .01); however, again, there was no significant difference between the Iranian English-speaking group and the Caucasian group (all p-values <. 05).

**Acculturation Variables**

Results of the Pearson’s r correlation analyses are presented in Table 4. Level of acculturation correlated with performance on many of the neuropsychological variables. Specifically, TMT-A, TMT-B, CTT-2, and WCST *set failure, WCST percent conceptual level response*, and WCST *categories completed*. Additionally, percentage of education obtained inside the US correlated with performance on TMT-B and CTT-2. These results indicate that higher levels of acculturation and higher percentage of education received in the US are related to better performance on specific neuropsychological measures.
CHAPTER IV
DISCUSSION

The aims of this study were to (1) characterize the neuropsychological test performance of both English-speaking and Farsi-speaking Iranian individuals on three measures that involve little verbal mediation, (2) examine differences in the performance of English-speaking Iranians, Farsi-speaking Iranians, and Caucasians on these three measures, and (3) assess the relationship between cultural factors and neuropsychological test performance of the English-speaking and Farsi-speaking Iranians.

**Differences in Neuropsychological Test Performance**

*WCST*

Both of the Iranian groups performed similar to the Caucasian group on the WCST outcome measures, with the exception of percent conceptual level response. Conceptual level responses are correct responses made consecutively in sets of three or more (Heaton et al., 1993). Since achieving three or more successive correct matches requires some sort of comprehension of the correct sorting strategy, the percent conceptual level response score is used as an indicator of an individual’s insight into the matching pattern (Strauss, Sherman, & Spreen, 2006; Gadd, 2011; Perkins, 2009). In this study, the Farsi-speakers performed poorer than the Iranian English-speakers and Caucasians, indicating a lack of a conceptual understanding of the demands of the task.

It is unclear to what exactly the poorer performance of the Farsi-speaking Iranians can be attributed. Overall, the Iranian (Farsi- and English-speaking) participants’ level of acculturation was related to their performance on percent conceptual level responses as well as failure to maintain set and number of categories achieved. It was observed that
the participants with higher levels of acculturation demonstrated better performance on these WCST variables. On the other hand, percentage of education obtained in the US was not related to the WCST variables. These findings are interesting, in that, a majority of the literature suggests that a US education would provide individuals with the problem-solving skills needed to perform well on these tasks (Artiola i Fortuny et al., 1998; Coffey et al., 2005). Taken together, the current results indicate that the skills required by the WCST (i.e. regulation of executive capacities (Perkins, 2009)) seem to be attained as one becomes more familiar with US culture. Perhaps, the English-speaking, but not the Farsi-speaking, Iranians have achieved a threshold acculturation level that makes their performance on the WCST indistinguishable from that of Caucasians.

In clinical settings, WCST scores provide information that is useful in the detection of cognitive impairments associated with executive processes (Rosselli & Ardila, 1993; Coffey et al., 2005; Mitrushina et al., 2005). Additionally, inferences can be made regarding clinical diagnoses when an individual’s test scores reflect a pattern of performance similar to the performance of those with various brain-related diseases and psychopathologies (Perkins, 2009). For example, individuals with Alzheimer’s disease tend to manifest more perseverative tendencies (i.e., perseverative errors and perseverative responses) and achieve less categories than normal controls (Perkins, 2009; Fristoe, Salthous, & Woodard, 1997). Similar findings have been reported with individuals with other neurological disorders, learning disabilities, ADHD, schizophrenia, and OCD (Perkins, 2009; Mitrushina et al., 2005). Considering that the participants in this study were medically, neurologically, and psychologically healthy, it makes sense that the participants’ profile of scores did not reflect, for the most part, deficits in
executive functioning.

**Trail Making Test**

The Farsi-speaking participants took longer to complete both parts of the TMT compared to the English-speaking Iranian group and Caucasian group, who performed the same. TMT-A and TMT-B require a different set of skills and, therefore, performance on each may be affected by different factors.

TMT-A is a measure of visual scanning, numeric sequencing, and visuomotor speed (Gaudino, Geisler, & Squires, 1995). Some studies suggest that the acquisition of visual acuity and directional scanning abilities may vary due to different linguistic experiences of Western and non-Western cultures (Lee et al., 2000; Rosselli & Ardilla, 2003). For example, Eviatar (2000) found that readers of right to left languages develop unique attention habits that can affect performance on tasks that require scanning abilities. Therefore, the Farsi-speaking participants’ may have been at a disadvantage because the stimuli in the TMT-A is likely arranged to favor the scanning abilities of Western cultures.

In addition to scanning abilities, researchers have alluded to the value that is placed on faster performance in American culture (Rosselli & Ardilla, 2003). This presumption was supported by our finding that level of acculturation was related to performance on the TMT-A. Individuals who are more acculturated to the US are more likely to complete timed tasks faster because they are more familiar with the test-taking demands and approaches required by the task (Razani et al., 2007).

Nonnative English-speakers have a clear disadvantage when it comes to performance on the TMT-B because of the linguistic component in the alphabetic
sequencing (Dugbartey, 2000; D’Elia et al., 1996). In an attempt to create compatible versions, the Farsi translated version of the TMT was created by simply replacing the English letters and numbers on the original TMT-B with the appropriate Farsi letters and numbers. However, Farsi orthography is very different than English orthography. The English and Farsi alphabets differ in the physical shape of the characters, the way characters combine to form a word, direction of writing and reading, and sound-to-letter relationships (Nassaji, 2003; Davarpanah, Sanji, & Armideh, 2009). Several studies that examined performance on the Arabic version of the TMT, have suggested that slower performance is related to the complexity of Arabic orthography (Stanczak, Stanczak, & Awadalla, 2001; Taha, Ibrahim, & Khateb, 2013). Considering the similarity between Arabic and Farsi, perhaps Farsi orthography had an effect on the Farsi-speaking participants’ scanning abilities.

In Farsi, more than one letter can represent the same sound and short vowels are not represented by letters. Therefore, Farsi-speakers must rely on lexical knowledge when deciding which letter is represented by a particular sound (Joshi & Aaron, 2006). Additionally, the rote memorization of the order of the alphabets is not taught and encouraged, in the way it is in the English language. Thus, time to connect in alphabetical order may take longer as a result.

On the other hand, it may be that, simply replacing English letters with Farsi letters may not be effective in controlling for the underlying cultural influences embedded in the test. Evidence for this may come from the results that poorer TMT-B performance was related to lower levels of acculturation and lower percentage of education obtained in the US, in the Iranian groups. The relationship between
acculturation and neuropsychological performance may indicate a lack of familiarity with the testing processes. Additionally, the relationship between education obtained in the US and test performance may indicate a familiarity with the order of the English alphabet.

*Color Trails Test*

Contrary to some results with other ethnic groups in the literature (La Rue et al., 1999; Agranovich et al., 2011; Dugbartey, 2000), there were no statistical differences on the CTT between both Iranian groups and the Caucasian group. These findings may support the previous presumption that the CTT a less culturally biased than the TMT (Lee et al., 2000; Mitrushina et al, 2005; Maj et al., 1993). Nevertheless, this statement is made with caution, as the means, despite being adjusted for age, for the Farsi-speaking group were larger than both other groups CTT-1 and CTT-2.

The finding that there were no differences in performance between groups on the CTT-1 yet differences were observed on the TMT-A is interesting, as both tasks are nearly identical. Both the CTT-1 and TMT-A measure simple numerical sequencing abilities, however, the total path length of the CTT-1 is approximately 21.9 cm longer than that of the TMT-A (Dugbartey, 2000; D’Elia et al., 1996). The difference in path length may be the reason why the adjusted means for the CTT-1 in the English-speaking Iranian and Caucasian groups are relatively higher than their adjusted means on the TMT-A. Furthermore, the lack of association between level of acculturation and performance on the CTT-1 provides further evidence that this portion of the test may indeed be a more “culture fair” version of the TMT-A.

Similar performance between groups on the CTT-2 may be attributable to the different set of skills that are required to complete the CTT-2 relative to the TMT-B
(Dugbartey, 2000). While the TMT-B is comprised of only 25 circles, the CTT-2 includes 49 circles. The higher order cognitive flexibility required by the CTT-2 may have slowed down the performance of all three groups, lessening the difference in time between them. Therefore, stating that the CTT is a more “culture fair” version of the TMT should be approached with caution since adapting and modifying test stimuli may affect an instruments’ construct validity (Stanczak, Stanczak, & Awadalla, 2001).

Nonetheless, both the CTT-2 and TMT-B were related to level of acculturation and percentage of education obtained in the US. This relationship suggests that on both tests, higher levels of acculturation and more education received in the US attributed to better performance. However, the differences that were observed in the Farsi-speaking Iranian group on the TMT-B and not on the CTT-2, suggests that performance on the TMT-B may be language specific (Lee et al., 2000).

**Acculturation of Iranians: Closer Examination of Results**

In accord with prior research (Arnold et al., 1994; Coffey et al., 2005; Razani et al., 2007; Artiola i Fortuny et al., 1998) level of acculturation was related to a majority of our variables. Level of acculturation is a concept that can be used with any ethnic background to quantify the extent of one’s assimilation and adaptation to the dominant culture (Razani et al., 2007). However, when examining the effect of acculturation, it is important to consider the influence of unique experiences that are specific to each ethnic group as they undergo the process of acculturation (Coffey et al., 2005).

The difficulties faced by Iranian immigrants during the process of acculturation to the US are not only associated with the vast differences between both cultures, but also the lack of positive images of Iranians in the American culture (McConatha, Stoller, &
Oboudiat, 20001). Negative portrayals and hostility toward Iranians can lead to rejection of the dominant culture (Zarrabian, 2010). Because of this, many Iranians congregate to form small communities that provide them with a sense of belonging and, as a result, they often become resistant to assimilation (McConatha, Stoller, & Oboudiat, 20001; Zarrabian, 2010). Acculturation studies have demonstrated that younger Iranians are more open to learning American customs and, therefore, assimilate faster than older Iranians (Ghaffarian, 1998). Additionally, older Iranians, particularly women, are generally more culturally resistant.

Our results appear to reflect what is described in the literature about the unique cultural experiences faced by Iranian immigrants. The Farsi-speaking Iranian group was significantly older than both other groups and had lower levels of acculturation compared to the English-speaking Iranian group. The association between level of acculturation and the neuropsychological variables, in the Iranian participants, indicate that a lack of exposure or assimilation to the US culture is attributable to poorer performance.

**Education Obtained in the US: Closer Examination of Results**

Level of education is often associated with better performance on neuropsychological tests, however, when it comes to comparing across cultures many researchers have indicated that quality of education, time spent in the US, and years of education obtained in the US are better predictors of performance (Artiola i Fortuny et al., 1998; Artiola i Fortuny & Heaton, 1996; Manly et al, 2002; Razani et al., 2007; Boone et al., 2007; Cave & Grieve, 2009; Harris et al., 2003). It seems as though, the effect of level of education on performance on neuropsychological measures is confounded by the country education is obtained in. The literature suggests that the more
education an individual receives in the country that a test was developed in, the more likely that individual is to perform better on the test than an individual who has received less education in that country (Razani et al., 2007; Harris et al., 2003). This discrepancy in performance is, in part, likely due to a familiarity through training on the abilities that the test is measuring (Rosselli & Ardila, 2003; Artiola i Fortuny et al., 1998).

Nonetheless, many of the measures utilized in the US require abstraction and problem-solving skills, which are highly emphasized in US schools.

In the Iranian system, education is uniform throughout the country and government testing is the motivating force behind what is taught and learned (Iran Chamber Society, 2001). At the end of each school year, students must pass a rigorous cumulative exam in order to proceed to the next level. Therefore, rote memorization is an emphasized skill and lessons focus on content, as students are required to obtain a considerable amount of factual knowledge.

In this study, the Iranian participants who had obtained a larger proportion of their education in the US performed better on the TMT-B and CTT-2. As measures of executive abilities, both tests are susceptible to the effects of education experience (Mitrushina et al., 2005; Jurado & Rosselli, 2007). Additionally, results revealed that level of acculturation was related to proportion of education obtained in the US. This finding provides support for the presumption that individuals who obtain more education in the US are more exposed to the culture and are more likely to display higher levels of cultural assimilation (Ghaffarian, 1998).

Education and culture are interlaced concepts, as culture determines what is learned and at what age. In turn, the goals of schooling, in any culture, are to reinforce
that cultures values and develop certain skills that are deemed useful for future success (Rosselli & Ardila, 2003). Neuropsychological testing measures skills that are emphasized in the US education system. Therefore, individuals who have received education in the US are more likely to have acquired the skills needed to successfully complete these tests and will outperform those who have not acquired such skills (Razani et al., 2007; Rosselli & Ardila, 2003).

Limitations

The current study is limited for several reasons. The overall size of our sample was rather small, especially in the English-speaking Iranian group. This may be the reason why there was a lack of consensus with prior literature that demonstrated differences between ethnically diverse and Caucasian participants on nearly all of the WCST variables (Coffey et al., 2005; Kohli & Kaur, 2006; Coelho et al., 2012; Ryan et al., 2005; Perkins, 2009; Norman et al., 2011; Shan et al., 2008). Therefore, inferences made about the non-significant differences in this study should be viewed as speculative until the findings are replicated with a larger sample size. Additionally, the generalizability of our findings is limited to individuals from the Los Angeles area.

Nearly all of the English-speaking Iranians were bilingual, yet we did not quantitatively assess their proficiency level in English. Prior literature suggests that bilingualism plays a complex role in cognitive testing. Thus, some may have been at a disadvantage related to language competence (La Rue et al., 1999). It is important to consider that preference in one language is different than proficiency in that language (Harris et al., 2003). Therefore, future research should assess the effects of bilingualism in Iranian individuals on neuropsychological test performance.
Implications

This study presents major implications for clinicians who administer neuropsychological tests to ethnically diverse individuals. An individual’s fluency in English does not render it appropriate to use standard English norms in the interpretation of results. The results from this study added to the literature which indicated the critical role of acculturation in neuropsychological test performance. While language preference and competency are both associated with acculturation, it does not necessarily indicate an individual’s level of acculturation (Harris et al., 2003). Furthermore, where one was educated (inside or outside of the US) may be just as important to consider as actual educational attainment. Therefore, measures of acculturation and information regarding amount of education obtained in the US should be utilized during assessment in addition to measures of language competency and level of education. Acculturation factors and demographic factors (i.e., age, education, and gender) play a similar role in neuropsychological test performance and just as adjustments are made for the latter, similar adjustments should be made for the former (Razani et al., 2007).

Individuals who prefer to be tested in their native language and who have resided in the US for a short period of time, should be administered the appropriate preferred version of the tests (Harris et al., 2003). However, translated versions of neuropsychological tests only control for variance attributable to linguistic differences and not for familiarity of the abilities being measured. Therefore, these individuals may be at risk of being misclassified as cognitively impaired if test scores are compared to the standard normative sample.

Recently, new demographic normative corrections have been created for African
Americans as well as Spanish individuals. Researchers have found that using these separate norms resulted in less false impairment rates than when scores were compared to standard norms (Gasquoine et al., 2007; Coffey et al., 2005; Norman et al., 2011). The development of separate norms for Iranian individuals would likely demonstrate the same results. Although this study provides normative data for Iranian individuals, its utility is limited by a small sample size and should only be viewed as preliminary. Future research should develop separate norms for both English-speaking and Farsi-speaking Iranian individuals that is stratified by age.

Although specific adjustments and separate norms are the most favorable recommendations to avoid misclassification, further research is needed to better understand factors that lead to performance differences. Meanwhile, it is imperative that clinicians assess where education was obtained, language fluency/preference, and level of acculturation. Information regarding these variables will help guide decisions on what tests to use and how to interpret results (Razani et al. 2007).

Conclusions

The current study provides support for the presumption that neuropsychological measures are culturally biased. Considering, the poorer performance of the Iranian individuals, as well as other groups throughout the literature, compared to Caucasians, the WCST, TMT, and CTT should not be regarded as “culture fair” measures. Caution should be taken when interpreting the performance of ethnically diverse individuals using English norms (Rosselli & Ardila, 2003). Utilizing an inappropriate normative sample can result in misclassification and/or misdiagnosis of cognitive impairment, and the repercussions for the patients and their families can be serious (Norman et al., 2011).
This study has added to the limited information regarding the Iranian population in the US by providing normative data for their performance on neuropsychological tests, for the first time. They are a well-educated and socioeconomically prosperous group that is rapidly growing in the US. Similar to other immigrant groups in the US, the neuropsychological test performance of Iranian individuals is affected by their degree of assimilation into the culture and amount of exposure to education in the US. Additionally, Iranians’ assimilation to the US is unique, in that, the older seem be more culturally resistant and have lower levels of acculturation. Clinicians should be conscious of this in order to adequately attend to older Iranian immigrants who seek neuropsychological evaluations for issues related to cognitive dysfunction.

The effects of culture on neuropsychological test performance have been repeatedly demonstrated. Even when linguistic differences are controlled for, neuropsychological tests are loaded with underlying western constructs, as they are measuring abilities that are valued in the US. The development of both non-verbal and verbal skills are shaped by cultural values. Each culture values a specific set of skills and cognitive strategies that are intricately related to brain organization. It is not that non-Western cultures are cognitively impaired or culturally deprived, but rather may be unfamiliar with western skills needed for optimal test performance (Rosselli & Ardila, 2003). It is impossible to control for the latent aspects of Western culture in neuropsychological measures (Artiola i Fortuny et al., 1998). However, accurate interpretation of test scores in non-Western groups can be achieved with the appropriate cultural adjustments.
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Measurement, 47, 401-443.
## APPENDIX A

### Table 1. Means and standard deviations for demographic information by group

<table>
<thead>
<tr>
<th>Demographic Variable</th>
<th>Farsi-Speaking</th>
<th>English-Speaking</th>
<th>Caucasian</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>36</td>
<td>28</td>
<td>44</td>
</tr>
<tr>
<td>Gender (M/F)</td>
<td>15/21</td>
<td>8/20</td>
<td>17/27</td>
</tr>
<tr>
<td>Age*</td>
<td>$M = 57.39$</td>
<td>$M = 41.32$</td>
<td>$M = 30.25$</td>
</tr>
<tr>
<td></td>
<td>SD = 9.33</td>
<td>SD = 7.81</td>
<td>SD = 14.68</td>
</tr>
<tr>
<td>Years of Education</td>
<td>$M = 14.08$</td>
<td>$M = 15.43$</td>
<td>$M = 14.39$</td>
</tr>
<tr>
<td></td>
<td>SD = 3.64</td>
<td>SD = 2.65</td>
<td>SD = 1.57</td>
</tr>
</tbody>
</table>

*All groups differed in age, $p < .05$. 
## APPENDIX B

Table 2. Means and standard deviations, unadjusted for age, for neuropsychological measures by group

<table>
<thead>
<tr>
<th>NP Variable</th>
<th>Farsi-Speaking</th>
<th>English-Speaking</th>
<th>Caucasian</th>
</tr>
</thead>
<tbody>
<tr>
<td>TMT-A</td>
<td>$M = 56.08$</td>
<td>$M = 35.07$</td>
<td>$M = 24.18$</td>
</tr>
<tr>
<td></td>
<td>SD = 25.23</td>
<td>SD = 12.09</td>
<td>SD = 6.61</td>
</tr>
<tr>
<td>TMT-B</td>
<td>$M = 159.69$</td>
<td>$M = 79.59$</td>
<td>$M = 57.27$</td>
</tr>
<tr>
<td></td>
<td>SD = 74.36</td>
<td>SD = 26.17</td>
<td>SD = 25.48</td>
</tr>
<tr>
<td>CTT-1</td>
<td>$M = 66.36$</td>
<td>$M = 48.03$</td>
<td>$M = 34.57$</td>
</tr>
<tr>
<td></td>
<td>SD = 31.26</td>
<td>SD = 15.40</td>
<td>SD = 17.30</td>
</tr>
<tr>
<td>CTT-2</td>
<td>$M = 138.17$</td>
<td>$M = 95.00$</td>
<td>$M = 76.36$</td>
</tr>
<tr>
<td></td>
<td>SD = 55.50</td>
<td>SD = 34.75</td>
<td>SD = 45.39</td>
</tr>
<tr>
<td>WCST Total Errors</td>
<td>$M = 24.86$</td>
<td>$M = 17.11$</td>
<td>$M = 13.61$</td>
</tr>
<tr>
<td></td>
<td>SD = 11.21</td>
<td>SD = 10.94</td>
<td>SD = 7.97</td>
</tr>
<tr>
<td>WCST Perseverative Responses</td>
<td>$M = 16.47$</td>
<td>$M = 10.00$</td>
<td>$M = 7.75$</td>
</tr>
<tr>
<td></td>
<td>SD = 10.93</td>
<td>SD = 7.37</td>
<td>SD = 5.53</td>
</tr>
<tr>
<td>WCST Set Failure</td>
<td>$M = 0.19$</td>
<td>$M = 0.14$</td>
<td>$M = 0.30$</td>
</tr>
<tr>
<td></td>
<td>SD = 0.40</td>
<td>SD = 0.45</td>
<td>SD = 0.59</td>
</tr>
<tr>
<td>WCST % Conceptual Level</td>
<td>$M = 38.17$</td>
<td>$M = 67.32$</td>
<td>$M = 74.11$</td>
</tr>
<tr>
<td>Level Response</td>
<td>SD = 19.95</td>
<td>SD = 22.79</td>
<td>SD = 16.99</td>
</tr>
<tr>
<td>WCST Categories Completed</td>
<td>$M = 2.42$</td>
<td>$M = 3.64$</td>
<td>$M = 3.98$</td>
</tr>
<tr>
<td></td>
<td>SD = 1.48</td>
<td>SD = 1.37</td>
<td>SD = 1.19</td>
</tr>
</tbody>
</table>

*TMT = Trail Making Test; CTT = Color Trails Test; WCST = Wisconsin Card Sorting Test.*
### APPENDIX C

Table 3. Means and standard deviations, adjusted with average at age = 42.17, for neuropsychological measures by group

<table>
<thead>
<tr>
<th>NP Variable</th>
<th>Farsi-Speaking</th>
<th>English-Speaking</th>
<th>Caucasian</th>
<th>Group Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>TMT-A</td>
<td>$M = 51.56$</td>
<td>$M = 35.32$</td>
<td>$M = 27.72$</td>
<td><strong>$F &gt; E = C$</strong></td>
</tr>
<tr>
<td></td>
<td>SE = 3.39</td>
<td>SE = 3.04</td>
<td>SE = 2.92</td>
<td></td>
</tr>
<tr>
<td>TMT-B</td>
<td>$M = 143.76$</td>
<td>$M = 80.47$</td>
<td>$M = 69.75$</td>
<td><strong>$F &gt; E = C$</strong></td>
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<tr>
<td></td>
<td>SE = 9.79</td>
<td>SE = 8.79</td>
<td>SE = 8.43</td>
<td></td>
</tr>
<tr>
<td>CTT-1</td>
<td>$M = 56.83$</td>
<td>$M = 48.56$</td>
<td>$M = 42.03$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SE = 4.52</td>
<td>SE = 4.06</td>
<td>SE = 3.90</td>
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<tr>
<td>CTT-2</td>
<td>$M = 110.47$</td>
<td>$M = 96.54$</td>
<td>$M = 98.05$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SE = 8.83</td>
<td>SE = 7.93</td>
<td>SE = 7.60</td>
<td></td>
</tr>
<tr>
<td>WCST Total Errors</td>
<td>$M = 19.58$</td>
<td>$M = 17.40$</td>
<td>$M = 17.75$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SE = 1.92</td>
<td>SE = 1.73</td>
<td>SE = 1.66</td>
<td></td>
</tr>
<tr>
<td>WCST Perseverative Responses</td>
<td>$M = 12.99$</td>
<td>$M = 10.19$</td>
<td>$M = 10.47$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SE = 1.63</td>
<td>SE = 1.46</td>
<td>SE = 1.40</td>
<td></td>
</tr>
<tr>
<td>WCST Set Failure</td>
<td>$M = 0.12$</td>
<td>$M = 0.15$</td>
<td>$M = 0.36$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SE = 0.11</td>
<td>SE = 0.09</td>
<td>SE = 0.09</td>
<td></td>
</tr>
<tr>
<td>WCST % Conceptual Level</td>
<td>$M = 49.72$</td>
<td>$M = 66.68$</td>
<td>$M = 65.07$</td>
<td>*$F &lt; E = C$</td>
</tr>
<tr>
<td>Level Response</td>
<td>SE = 3.71</td>
<td>SE = 3.33</td>
<td>SE = 3.20</td>
<td></td>
</tr>
<tr>
<td>WCST Categories Completed</td>
<td>$M = 3.20$</td>
<td>$M = 3.60$</td>
<td>$M = 3.37$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SE = 0.25</td>
<td>SE = 0.23</td>
<td>SE = 0.22</td>
<td></td>
</tr>
</tbody>
</table>

TMT = Trail Making Test; CTT = Color Trails Test; WCST = Wisconsin Card Sorting Test.
F = Farsi-Speaking Iranians; E = English-Speaking Iranians; C = Caucasian.
For TMT-A and TMT-B, “$>$“ represents lower performance
* $p < .01$.
** $p < .001$. 
APPENDIX D

Table 4. Pearson’s $r$ correlation coefficients between neuropsychological measures, level of acculturation, and percentage of education obtained in the US for the Iranian group (Farsi- and English-speakers).

<table>
<thead>
<tr>
<th>NP Variable</th>
<th>Acculturation Level</th>
<th>% Education in the US</th>
</tr>
</thead>
<tbody>
<tr>
<td>TMT-A</td>
<td>-.258*</td>
<td>-.164</td>
</tr>
<tr>
<td>TMT-B</td>
<td>-.379**</td>
<td>-.274*</td>
</tr>
<tr>
<td>CTT-1</td>
<td>-.211</td>
<td>-.079</td>
</tr>
<tr>
<td>CTT-2</td>
<td>-.309*</td>
<td>-.272*</td>
</tr>
<tr>
<td>WCST Total Errors</td>
<td>-.224</td>
<td>-.037</td>
</tr>
<tr>
<td>WCST Perseverative Responses</td>
<td>-.175</td>
<td>.038</td>
</tr>
<tr>
<td>WCST Set Failure</td>
<td>-.302*</td>
<td>-.117</td>
</tr>
<tr>
<td>WCST % Conceptual Level Response</td>
<td>.350**</td>
<td>.164</td>
</tr>
<tr>
<td>WCST Categories Completed</td>
<td>.342**</td>
<td>.114</td>
</tr>
</tbody>
</table>

TMT = Trail Making Test; CTT = Color Trails Test; WCST = Wisconsin Card Sorting Test.

* $p < .05$.

** $p < .01$. 