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Effects of acculturation on tests of attention and information processing in an ethnically diverse group☆

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Abstract

The objective of this study was to examine differences between fluent English-speaking ethnically diverse (ED) individuals (from Hispanic, Asian and Middle-Eastern descent) and monolingual English-speaking Anglo-Americans (MEAA) on commonly used tests of information processing and attention. A sample of 123 (84 ED and 39 MEAA) healthy individuals participated. The results revealed that the MEAA group outperformed the ED group on Trail Making Test Part B, Stroop B and C, and Auditory Consonant Trigrams (18 s delay condition). Additionally, a host of acculturation variables such as score on a formal acculturation scale, amount of time educated outside of the U.S., and the amount of English spoken when growing up correlated with these various neuropsychological tests. The findings from this study highlight the importance of taking acculturation into account for fluent English-speaking ED individuals when administering and interpreting neuropsychological tests.

Keywords: Multicultural; Acculturation; Attention; Information processing; Ethnic diversity

1. Introduction

Neuropsychological tests are tremendously helpful in the detection of brain dysfunction, treatment planning, and rehabilitation. Tests of attention and information processing are of particular use when assessing a variety of neurological deficits including the effects of head injury (Lezak, Howieson, & Loring, 2004; Ruff, Evans, & Marshall, 1986; Stuss et al., 1985), dementia (Pachana, Boone, Miller, Cummings, & Berman, 1996; Trenerry, Crosson, DeBoe, & Leber, 1989), and chronic medical illnesses (Boone, 1999; Grant et al., 1987) on cognition. These tests are typically included in most neuropsychological assessment batteries. While a number of tests used to assess these domains in clinical settings do not require extensive verbal involvement, it would be wrong to assume that individuals from diverse ethnic backgrounds perform similarly to the published reference norms. For example, it may be tempting to assume that ethnically diverse individuals with intact attention and information processing systems would be able to repeat the same amount of information on the test of Digit Span or would connect a set of numbers in sequence at the same rapid rate on the Trail Making Test (TMT) as those in the published norms. Similarly, it may be incorrect to assume that individuals who appear to be balanced in the use of their native language and English will perform similarly

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to native English speakers on cognitive tests. While language proficiency is certainly associated with acculturation and familiarity with the American culture, it most likely does not equate foreign-born individuals and native English speakers on their test-taking abilities and overall performance.

There may be a host of cultural factors, such as level of acculturation, that account for test performance that an examiner needs to take into account. Unfortunately, very few studies have systematically investigated the effects of acculturation on cognitive tasks in ethnically and linguistically diverse individuals. Even fewer studies have actually inspected what specific aspects of acculturation might affect test performance.

The majority of neuropsychological tests have been developed and normed for White, monolingual English-speaking individuals within the United States or Canada. Therefore, the suitability of their use with ethnically and linguistically diverse individuals is questionable (Harris, Tulsky, & Schultheis, 2003). It is estimated that approximately 50% of the U.S. population will be from a non-Anglo background by the year 2050 (United States Census, 1990). Yet, the field of neuropsychology has paid relatively limited attention to how issues of acculturation may affect cognitive test performance (Harris et al., 2003; Manly, Byrd, & Touradji, 2004; Manly et al., 1998).

To date, only a few studies have considered the role of acculturation and other such factors in the neuropsychological test performance of individuals from non-White backgrounds (Arnold & Orozco, 1989; Harris, Cullum, & Peunte, 1995; Manly et al., 1998, 2004). Of the studies conducted, most have included neuropsychological measures of language and memory, but very few have explicitly assessed the effects of acculturation on tests of attention and information processing. It is clear that we need systematic studies in order to examine what role acculturation plays in neuropsychological test performance.

Acculturation is the complex process by which an individual becomes assimilated into a majority or dominant culture. Level of acculturation represents the degree to which an individual accepts and adopts the language, values, customs, and behaviors of the dominant culture. Arnold, Montgomery, Castaneda, and Longoria (1994) examined the effects of acculturation on selected Halstead-Reitan neuropsychological tests in a group of young Hispanic and Anglo-American adults (mostly college students). They found that when participants were divided into different levels of acculturation, such as primarily Mexican, Mexican-American, and Anglo-American, based on scores on a formal acculturation rating scale, differences emerged between the groups. Those who identified as primarily Mexican performed poorer on the Tactual Performance Test (TPT; dominant, nondominant, and total scores), the Seashore Rhythm Test, and the Halstead Category Test relative to the Anglo-Americans. The performance of those who identified as Mexican-American fell somewhere in between these two groups. Interestingly, the groups did not differ on a test of attention and information processing speed (the Trail Making Test). This may partially be due to the fact that the groups consisted of young, educated college students. Older, less educated individuals may not have performed similarly. Another study with Hispanic adults found a strong relationship between the years of residence in the U.S. (often used as a proxy to level of acculturation) and perseverative responses on the Wisconsin Card Sorting Test (Artiola i Fortuny, Heaton, & Hermosillo, 1998). In a recent study, we found that a host of acculturation factors such as level of acculturation as measured by a formal questionnaire and amount of education obtained outside of the U.S. correlated with subtests of the Wechsler Abbreviated Scale of Intelligence (Razani, Murcia, Tabares, & Wong, in press). We discovered that while these acculturation variables were particularly strongly correlated with the verbal measures, the amount of education obtained outside of the U.S. was related to at least one of the nonverbal measures, Block Design. This would suggest that learning through specific educational systems affect how well one acquires skills or approaches to taking such tests.

In older African-Americans, Manly and colleagues have demonstrated that acculturation and quality of education accounts for neuropsychological test score variability. Using the African American Acculturation Scale, Manly et al. (1998) found that level of acculturation was related to tests of memory, naming, and figure matching in older African Americans. Manly, Jacobs, Touradji, Small, and Stern (2002) used reading level as a proxy for educational experience and found that this variable, not actual level of education attained, attenuated difference between older African Americans and Whites on a large number of neuropsychological tests. These findings suggest that the quality of the education is a more important variable to measure than actual educational attainment in African Americans, and perhaps other ethnic groups. In fact, in a follow-up study, Manly and colleagues found that educational experience (as measured by the WRAT Reading test) was a significant and unique predictor of test performance across most neuropsychological domains (Manly et al., 2004). Unfortunately, commonly used tests of attention and information processing speed were not included in these studies. As a result, we are unable to assess whether educational factors would have had similar effects on attention and information processing speeded tasks in their sample.

In a recent study, Harris et al. (2003) used a varied group of ethnically diverse individuals in order to examine the effects of acculturation on the WAIS-III and the WMS-III. They examined the WAIS-III/WMS-III combined index scores of 151 non-native English speakers from the standardization sample in relation to cultural factors such as language preference, years of residence in the U.S., and length of education within the U.S. They found that all three of these cultural variables accounted for significant portions of variability in the joint WAIS-III – WMS-III Verbal Comprehension Index, Processing Speed Index, Auditory Memory Composite, and Visual Memory test score performance once the effects education had been statistically removed. The only test that did not correlate with the cultural measures was Visual Memory. They found relatively strong relationships between the cultural factors and the Processing Speed Index, but did not report what effects acculturation had on each of the individual subtests, such as Digit Span and Digit Symbol. Additionally, above and beyond the effects of education, language preference appeared to be the strongest predictor of this composite index.

The purpose of the present study was to examine differences in the performance of a group of monolingual, English-speaking Anglo-Americans and a group of non-native, but conversantly fluent, English speakers from ethnically and linguistically diverse backgrounds. Further, the goal was to assess specific relationships between commonly used tests of attention/information processing speed and various acculturation measures in the ethnically diverse group. The domains of attention and information processing speed were of particular interest due to the fact that most clinical tests used to assess these domains require relatively little verbal mediation. It was hypothesized that the ethnically diverse group would differ from the Anglo-American group on some of these measures and that a number of the acculturation variables would correlate with the neuropsychological test.

2. Methods

2.1. Participants

A total of 123 healthy participants were recruited from the greater Los Angeles community. Thirty-nine participants were monolingual English-speaking Anglo-Americans (MEAA) between the ages of 20 and 72 years, with 10–16 years of education. Eighty-four participants were an ethnically diverse (ED) group of participants from Hispanic, Asian, or Middle-Eastern descent between the ages of 18 and 69 years, with 9–20 years of education. The demographic information for participants presented on Table 1 shows that the MEAA group was slightly older than the ED group (F (1,121) = 8.6, p = .004), but there were no differences between education levels (F (1,121) = 2.24, p = .14).

Within the ED group, 43 were of Hispanic descent from Mexico, Central America (El Salvador, Guatemala, and Honduras), or South America (Paraguay and Columbia); 20 were of Asian descent from the Philippines, Indonesia, China, Vietnam, or Korea; and 21 were of Middle-Eastern descent from Iran, Turkey, or Lebanon. In this ED group, 22 were born in and 62 were born outside of the U.S., and English was the first language learned for 15 and the second language for 69. Additionally, 32 of the ED participants obtained all of their education inside of the U.S., 25 obtained all of their education outside of the U.S., and 27 obtained a portion of their education in their native country and a

Table 1
Means and standard deviations (in parenthesis) for demographic information by group

Measures	ED Group	MEAA Group
N	84	39
Male/female ratio	32/52	16/23
Age**	34.87 (±13.78)	42.79 (±14.32)
Years of education	13.57 (±2.13)	13.00 (±1.56)
Years of education outside U.S.	6.97 (±6.31)	–
Years of residence in U.S.	18.72 (±11.06)	–
Age at which entered the U.S.	15.64 (±15.47)	–
Acculturation	51.80 (±12.09)	–
% English growing up	38.86 (±34.53)	–
% English currently	58.85 (±34.19)	–

ED = ethnically diverse; MEAA = monolingual English-speaking Anglo-American.
** $p < .01$.

portion within the U.S. Unfortunately, we do not have data regarding whether any of the participants who obtained any portion of their education outside of the U.S. attended English-speaking schools. However, closer examination of data regarding the age at which they entered the U.S., years of education obtained outside of the U.S., and age at which they learned English indicates that at least 21 participants had some (ranging from 1 to 31 years, but most had less than 10 years) exposure to the English language prior to entering the United States. It is unclear whether this was within an educational context.

All participants were carefully screened with an examiner-administered health questionnaire for the following factors known to affect cognitive functioning: history of neurological or psychiatric illness, head injury resulting in ≥5 min of loss of consciousness, learning disability, and chronic untreated medical illness (e.g., diabetes, hypertension). All participants who met the health criteria and who were from Middle-Eastern, Hispanic (other than European), and Asian descent were eligible to participate in the current study. The MEAA were eligible to participate if they were Anglo-American and monolingual English speaking. Given that all testing was conducted in English, to participate in the study, all participants were required to be fluently conversant in English. They were considered fluently conversant if they were able to communicate clearly with the examiner, understand test instructions, and carryout the tasks.

2.2. Instruments

2.2.1. Acculturation and other related measures

Since specific acculturation measures are unavailable for each specific ethnic group used in the current study, the Acculturation Rating Scale for Mexican Americans (ARSMA; Cuellar, Harris, & Jasso, 1980) was adapted and administered to the ethnic participants. At least one study has demonstrated that the ARSMA can be reliably and validly adapted for Asian groups (Suinn, Rickard-Figueroa, Lew, & Vigil, 1987). Using similar methods to that of Suinn et al. (1987), wordings such as “Mexican” and “Spanish” were changed to the nationality and the language of origin that was applicable to the participant.

As an example of the type of adaptations made, below are two sample items from the original ARSMA and those adapted for a Korean individual:

Original ARSMA		Adapted for Korean	
What language do you speak?		What language do you speak?	
1.	Spanish only	1.	Korean only
2.	Mostly Spanish, some English	2.	Mostly Korean, some English
3.	Spanish and English about equally	3.	Korean and English about equally
4.	Mostly English, some Spanish	4.	Mostly English, some Korean
5.	English only	5.	English only
How would you rate yourself?		How would you rate yourself?	
1.	Very Mexican	1.	Very Korean
2.	Mostly Mexican	2.	Mostly Korean
3.	Bicultural	3.	Bicultural
4.	Mostly Anglicized	4.	Mostly Anglicized
5.	Very Anglicized	5.	Very Anglicized

The ARSMA is a 20-item scale that requires the participant to rate each question on a 5-point Likert scale ranging from original heritage/language (1) to Anglo/English (5). The ARSMA assesses four acculturation domains: (1) language familiarity, usage, and preference; (2) ethnic identity and generation; (3) reading, writing, and cultural exposure; (4) ethnic interaction. In adapting this instrument for a broader range of ethnic groups, three of the items had to be limited to a 3-point Likert scale, since distinctions such as “Mexican” versus “Chicano” were not relevant for these other ethnic groups. All other items were rated on the original 5-point Likert scale. The ARSMA also has two questions regarding culture and language that are also rated on a 5-point scale but that are not included in the overall score. Thus, individuals could receive a score of 20 (lowest level of acculturation) to 94 (highest level of acculturation) on this adapted acculturation measure.

We were also interested in collecting additional information regarding language usage and greater detail about educational experience from the ED sample. For language, participants were asked to estimate the percentage of

English they spoke when they were growing up and the percentage of English they use currently. Additionally, the length of time the participant was educated outside of the U.S. was calculated for each individual based on a ratio of years educated outside of the U.S. to the total number of years of education attained. Similarly, an individual's years of residence in the U.S. was calculated as a ratio of years the individual has been in the U.S. to the total age. It should be noted that all of the Anglo-American participants were monolingual English-speaking and obtained all of their education within the United States. Table 1 presents means and standard deviations for the acculturation, language, and education factors for the ED group.

2.2.2. Neuropsychological tests of attention and information processing speed

2.2.2.1. WAIS-III Digit Span and Digit Symbol. While both tasks assess attention, Digit Symbol also involves psychomotor skills, and Digit Span also involves immediate verbal recall (Lezak et al., 2004). Standard test procedures were used to administer both conditions (i.e., digits forward and backward) of the Digit Span subtest of the WAIS-III (Wechsler, 2002). The raw scores (number of trials accurately recalled) were recorded for each condition. Similarly, the standard procedures used to administer the Digit Symbol subtest of the WAIS-III were used and raw scores were used as the outcome measure.

2.2.2.2. Trail Making Test (TMT). In addition to attention, both parts of this test also involve psychomotor speed (Lezak et al., 2004). Part B has also been considered an executive function test (Mitrushina, Boone, Razani, & D'Elia, 2005). Both parts of this test were administered following standard procedures (Mitrushina et al., 2005). In Part A, the numbers 1 through 25 were scattered within circles on a page of an 8 in. × 11 in. page and the participant was instructed to draw lines connecting the numbers in order as quickly as possible. In Part B, the numbers 1 through 13 and letters A through L within circles were scattered within circles on a page of an 8 in. × 11 in. page and the participant was instructed to draw lines connecting the numbers and letters in sequence (e.g., 1-A-2-B, etc.) as quickly as possible. For each part, time (in seconds) taken to complete the task was used as the outcome measure.

2.2.2.3. Stroop Test. In addition to information processing speed, Stroop C also assesses executive functioning (Mitrushina et al., 2005). The Comalli version of the Stroop Test (Boone, Lesser, Hill-Gutierrez, Berman, & D'Elia, 1993) was administered. For this version of the Stroop Test, three cards of $9\frac{1}{4}$ in. × $9\frac{1}{4}$ in. with 100 stimuli per card are arranged in a 10 × 10 grid against a white background. The reading condition requires that the participant read color words (*red, blue, green*) printed in black ink and presented in random order as quickly as possible. The color-naming condition consists of rectangles (5/16 in. × 2/16 in.) of colors (red, blue, green) arranged in random order and requires that the participant name the color blocks as quickly as possible. For the color-reading interference condition (Stroop C), the words "red", "green", and "blue" were printed in different color ink and the participants were required to name the color of the ink in which the word was printed and not read the word. For each condition, time (in seconds) taken to complete the task was used as the outcome measure.

2.2.2.4. Auditory Consonant Trigrams (ACT). In addition to attention, this task involves skills of working memory (Mitrushina et al., 2005). Using the Boone (1999) procedure, three consonant trigrams are presented in an auditory fashion and are followed by a number. The participant is instructed to subtract by 3s from the number for varying intervals (in seconds), after which time he/she is asked to recall the letters. For the first five trials, there is no delay in recalling the letters. There are five trials for each of the delay (3-, 9-, and 18-s) intervals. The number of accurately recalled letters for each delay condition served as the outcome measures.

2.2.3. Procedure

Participants were recruited via newspaper advertisements, flyers posted in public agencies and buildings, and word of mouth. The tests of attention and information processing speed were administered as part of a larger neuropsychological test battery, which took approximately 2½ h to complete. All participants were administered a health questionnaire as part of the screening procedure, and the ED group was administered an additional questionnaire which contained more detailed questions regarding language usage, acculturation factors, and educational experience, as well as a formal acculturation instrument. All participants were paid $50 for their participation.

It should be noted that for various reasons there are some missing data points (e.g., a few participants were not able to complete testing or a given test was not included in the battery that was administered in the early stages of the study). For the ED participants, 2 were missing ACT, 10 were missing TMT, and 1 was missing Stroop data. For the MEAA group, 1 was missing Digit Span and 9 were missing TMT data.

3. Results

3.1. Group comparisons

Given that there were age differences present between the ED and MEAA groups, a multivariate analysis of covariance, using age as the covariate, was performed in order to compare the MEAA group to the ED group on the tests of attention and information processing speed. The analysis revealed a significant difference between the groups on the neuropsychological measures, Wilk's Lambda $F\ (11, 80) = 2.61$, $p = .007$.

Means and standard deviations for the groups, on each neuropsychological measure, are presented in Table 2. Follow-up ANCOVAs were performed, again using age as the covariate. The MEAA group outperformed the ED group on Digit Span, $F\ (1, 122) = 21.45$, $p < .0001$; Digit Symbol, $F\ (1, 118) = 4.21$, $p = .045$; TMT Part B, $F\ (1, 96) = 10.61$, $p = .002$; Stroop B, $F\ (1, 119) = 12.55$, $p = .001$; Stroop C, $F\ (1, 119) = 5.04$, $p = .01$; and ACT 18-s delay, $F\ (1, 119) = 5.82$, $p = .01$.

No differences were found between the groups on TMT Part A, $F\ (1, 107) = 1.36$, $p = .29$; Stroop A, $F\ (1, 119) = 2.95$, $p = .09$; ACT 0-s delay, $F\ (1, 119) = 0.92$, $p = .34$; ACT 3-s delay, $F\ (1, 119) = .01$, $p = .99$; or ACT 9-s delay, $F\ (1, 119) = 3.52$, $p = .06$.

In order to better understand these group differences and the impact of acculturation on neuropsychological scores, the ED group was divided into high and low acculturated groups using the adapted ARSMA scores. Due to the fact that we did not have perfect high scorers on the ARSMA, we were not able to use a method previously used by Arnold et al. (1994). Instead, a median acculturation score of 50 was obtained for the ED group and participants who scored above this score were classified as high acculturated and those who scored below the median were classified as low acculturated. Four individuals who scored a 50 were not included in the analysis. The two groups were then compared to the MEAA group. A series of ANCOVAs, using age as the covariate, was performed, and Tukey post-hoc analyses were examined when group differences were obtained. The results of these analyses were found to be quite similar to those reported above. The MEAA group outperformed both the high- and low-acculturated groups on Digit Span, $F\ (2, 110) = 11.45$, $p = .0001$; TMT Part B, $F\ (2, 83) = 6.05$, $p = .003$; Stroop B, $F\ (2, 107) = 7.47$, $p = .001$; Stroop C, $F\ (2, 107) = 4.13$, $p = .019$; and ACT 18-s delay, $F\ (2, 109) = 4.62$, $p = .012$. It should be noted that there were no statistical differences between the high- and low-acculturated groups on these neuropsychological variables.

Table 2
Means and standard deviations (in parentheses) for neuropsychological measures by group

Measures	ED Group	MEAA Group
Digit Symbol (raw score)	53.41 (±10.56)	54.54 (±10.56)
Digit Span (raw score)***	15.67 (±4.05)	18.55 (±4.11)
Trails A	31.19 (±12.36)	31.28 (±11.23)
Trails B**	81.09 (±33.63)	67.50 (±21.31)
Stroop A	46.93 (±8.64)	44.56 (±8.14)
Stroop B***	66.72 (±12.83)	61.79 (±9.03)
Stroop C**	117.64 (±25.93)	109.23 (±25.71)
ACT 0 s delay	14.88 (±.40)	14.92 (±.35)
ACT 3 s delay	11.69 (±2.69)	11.56 (±2.72)
ACT 9 s delay	9.16 (±3.31)	9.90 (±3.64)
ACT 18 s delay*	7.70 (±3.52)	9.13 (±3.61)

ED = ethnically diverse; MEAA = monolingual English-speaking Anglo-American.
* $p < .05$.
** $p < .01$.
*** $p < .001$.

Table 3
Pearson's *r* correlation coefficients between neuropsychological measures, demographic and cultural/language factors

Variable/measure	Age	Years of education	Acculturation score	Years resided in the U.S.	Years of education outside the U.S.	% English spoken growing up	% English spoken currently
Digit Symbol (raw score)	**−.536*****	**.418*****	**.270***	.125	**−.231***	.156	−.012
Digit Span (raw score)	**−.381*****	**.237***	**.254***	.173	**−.293****	.208	.105
Trails A	**.352****	−.157	**−.254***	−.210	**.374*****	**−.309****	−.223
Trails B	**.455*****	−.052	−.226	**−.306***	**.457*****	**−.377*****	.046
Stroop A	.168	−.097	.005	−.022	−.126	.051	−.032
Stroop B	**.549*****	**−.266***	**−.353****	**−.305****	**.375*****	**−.409*****	−.169
Stroop C	**.357*****	**−.257***	−.124	−.144	.142	−.162	.013
ACT 0 s delay	−.123	.013	−.122	.114	−.133	.113	−.107
ACT 3 s delay	−.138	**.309****	.055	−.047	.001	−.104	.019
ACT 9 s delay	**−.268****	**.224***	.179	.105	−.206	.133	.035
ACT 18 s delay	−.137	**.269****	−.137	−.148	.024	−.075	−.028

* $p < .05$.
** $p < .01$.
*** $p < .001$.

3.2. *Correlation analyses*

Pearson's *r* correlation analyses were performed for the ED group in order to assess the relationship between the demographic, cultural, and the neuropsychological variables. The results are presented in Table 3. As expected, most of the neuropsychological variables correlated with age. A number of the measures also correlated with education. The acculturation measure correlated significantly with a number of the neuropsychological measures. It appears that as level of acculturation increased, so did performance on the Digit Symbol, Digit Span, TMT Part A, and Stroop B performance for the ED group. Other acculturation variables such as the greater the percentage of time English was spoken by the participant when growing up appeared to lessen the time required to complete TMT Part B and Stroop B. Interestingly, the amount of English *currently* spoken by the ED participants did not affect performance on any of the test.

For the acculturation factors, the amount of education obtained *outside* of the U.S. appeared to produce the greatest number of correlations with the neuropsychological measures. The longer one was educated outside of the U.S., the poorer they performed on Digit Symbol and Digit Span, and the longer time they required for completing TMT Parts A and B and Stroop B. The amount of time spent in the U.S. appeared to produce the fewest significant correlations with the neuropsychological measures (i.e., correlated only with TMT Part B and Stroop B).

4. Discussion

The present study examined differences between a group of MEAA and ED on commonly used tests of attention and information processing speed. It also examined the relationship between these neuropsychological measures and acculturation. The results show that the MEAA consistently outperformed the ED group on a number of these tests, especially those that required greater verbal mediation. The MEAA group was able to recall a greater number of digits and connected numbers and letters in sequence with faster speed than the ED group. The MEAA were able to name color blocks more rapidly and performed a color-reading (inhibition) test with greater speed than the ED group. They also outperformed the ED group on recall of number of letters after an 18-s delay on the ACT.

These findings are quite intriguing given that both groups were fluent English speakers and that these particular tests do not require a substantial amount of language skills. These findings underscore the importance of not simply assuming that normative reference data are appropriate for all fluent English speakers. Language proficiency is certainly one indication of how one has acculturated or assimilated into the majority culture; however, there are a number of other factors that contribute to optimal performance on these tests. For example, cultural familiarity with the testing format and the culture-specific test items may lead to better test performance. Other cultural factors such as test-taking approach, attitude of the participant toward test taking, and participants' comfort with lengthy testing sessions may also influence performance.

These findings are consistent with previous research demonstrating differences between Whites and other cultural groups (Harris et al., 2003; Manly et al., 2002; Razani et al., in press). Interestingly, Arnold et al. (1994), one of the only studies to include a measure of attention and information processing speed, did not find differences between Mexican-Americans with varying levels of acculturation. This may, however, have been due to the fact that they included a group of young college students. Perhaps college students are familiar with speeded tasks, and perhaps discrepancies in performance are more apparent in older groups with heterogeneous education levels.

The current results from the correlation analyses further confirmed the influence of acculturation and linguistic factors on the performance of the ED group. Specifically, acculturation level, as measured by the ARSMA, was found to be a strong predictor of test of attention. This implies that as one becomes more familiar with and adopts the dominant Euro-American culture, neuropsychological test scores tend to increase. This is most likely due to the fact that familiarity with the dominant culture and customs brings with it familiarity with test-taking formats and approaches.

The amount of education obtained outside of the U.S. was another strong predictor of test performance. Manly and colleagues have repeatedly demonstrated that the quality of education or the educational experience are important predictors of cognitive testing performance (Manly et al., 2004). Our findings are also in agreement with Harris et al.'s (2003) study, in which they found that the amount of time education was obtained within the U.S. to be an important predictor of WAIS-III/WMS-III performance. In fact, in a group of non-native English speakers, the years of education obtained within the U.S. was a more significant predictor of performance than actual formal years of education. The current results combined with the previous literature (Manly et al., 1998, 2004) indicate that the role of education is far more complicated than we had previously assumed. It appears that simply accounting for one's level of educational attainment is not adequate for explaining test performance. Educational experience, whether measured in terms of skill level (Manly et al., 1998) or where (e.g., in what country) the skills are attained, seems to strongly influence neuropsychological test performance. It may be that through the educational system one learns subtle skills and test-taking approaches needed for optimal neuropsychological performance. It is clear that to truly adjust for the influence of education we need to find innovative ways to capture its distinctive aspects. Perhaps, some computational formula of educational attainment, number of years the education was attained within the U.S. school system, and the actual skill level would be a better indictor of educational influence.

In the current study, the percentage of English spoken when growing up (as estimated by the participant) appeared to correlate significantly with several of the timed measures. This again suggests that subtle aspects of language fluency and familiarity may affect optimal test performance in ED individuals. It further indicates that bilingual individuals, particularly those who have not fully mastered the English language, may be at a disadvantage when being assessed with neuropsychological tests. These findings are in line with that of Harris et al. (1995), who found that "balanced" bilinguals (those who were similarly familiar with Spanish and English) performed worse on a learning and memory task relative to those who were monolingual English- or monolingual Spanish-speaking. This is also consistent with Harris et al.'s (2003) finding that language preference was a strong, unique predictor of test performance, particularly for tests of information processing. It is interesting that, in the current study, the ED groups' estimate of how much English they currently speak does not appear to predict any of the neuropsychological measures. This indicates that early exposure to and mastery of English are better indicators of test performance than current use. Finally, among all of the tests administered, the ACT Test seems to be the least influenced by acculturation. Level of education correlated significantly with most ACT delay conditions; however, acculturation scores and the amount of education obtained outside of the U.S. did not appear to influence scores on this test, nor did estimated English usage.

The findings of the present study have serious implications for the professional practice of neuropsychology. Clinicians often confidently administer tests to fluent English-speaking ethnic groups and interpret such findings using standard normative tables. They assume that this group is well acculturated to U.S. customs and thus using published norms is not problematic. However, as can be seen from the current results, ED individuals differ from the MAEE group and a host of acculturation factors affect the test performance of the ED group. It is clear that understanding the impact of acculturation and other cultural factors on test performance needs to begin early in the professional training. Fastenau, Evans, Johnson, and Bond (2002) discuss ways in which multicultural training can be infused into clinical neuropsychology training programs. Multiculturalism and its impact on test performance need to be integrated into general psychological assessment, neuropsychological assessment, and counseling courses. Additionally, multicultural concepts need to be integrated into the curriculum and practicum training whenever possible.

Perhaps, adjustments for acculturation can be made in much the same way that they are made for demographic factors such as age, education, and gender. Unfortunately, due to the small sample size and the heterogeneity of the ethnic groups in the current study, we cannot make any specific recommendations for adjusting test scores at this time based on our data. However, until such formal adjustments can be made, we are in full agreement with the recommendations made by Harris et al. (2003). These authors suggest that patients need to be queried regarding various cultural variables. These variables include not just level of education but also where the education was obtained (e.g., within or outside of the U.S.), language fluency and preference, and their level of adaptation to the mainstream culture. These factors may help guide professionals to determine whether specific tests are appropriate for administration with certain ethnically diverse individuals and may assist with interpretation of the test results.

References

Arnold, B. R., Montgomery, G. T., Castaneda, I., & Longoria, R. (1994). Acculturation and performance of Hispanics on selected Halstead-Reitan neuropsychological tests. *Assessment*, *3*, 239–248.S.

Arnold, B. R., & Orozco, S. (1989). Acculturation and evaluation of Mexican Americans with disabilities. *Journal of Rehabilitation*, *55*, 53–57.

Artiola i Fortuny, L., Heaton, R. K., & Hermosillo, D. (1998). Neuropsychological comparisons of Spanish-speaking participants from the U.S.–Mexico border region versus Spain. *Journal of the International Neuropsychological Society*, *4*, 363–379.

Boone, K. B. (1999). Neuropsychological assessment of executive functions: Impact of age, education, gender, intellectual level, and vascular status on executive test scores. In B. L. Miller & J. L. Cummings (Eds.), *The human frontal lobes: Functions and disorders. The science and practice of neuropsychology series* (pp. 247–260). New York: Guilford Press.

Boone, K. B., Lesser, I. M., Hill-Gutierrez, E. H., Berman, N. G., & D'Elia, L. F. (1993). Rey-Osterrieth complex figure performance in healthy, older adults: Relationship to age, education, sex and IQ. *The Clinical Neuropsychologist*, *7*(1), 22–28.

Census of Population. (1990). *Current population reports*. Washington, D.C.: U.S. Department of Commerce, Bureau of the Census.

Cuellar, I., Harris, L. C., & Jasso, R. (1980). An acculturation scale for Mexican American normal and clinical populations. *Hispanic Journal of Behavioral Sciences*, *2*(3), 199–217.

Fastenau, P. S., Evans, J. D., Johnson, K. E., & Bond, G. R. (2002). Multicultural training in clinical neuropsychology. In F. R. Ferraro (Ed.), *Minority and cross-cultural aspects of neuropsychological assessment* (pp. 345–373). Lisse, The Netherlands: Swets & Zeitlinger Publishers.

Grant, I., Prigatano, G. P., Heaton, R. K., McSweeny, A. J., Wright, E. C., & Adams, K. M. (1987). Progressive neuropsychologic impairment and hypoxemia: Relationship in chronic obstructive pulmonary disease. *Archives of General Psychiatry*, *44*(11), 999–1006.

Harris, J. G., Cullum, C. M., & Peunte, A. E. (1995). Effects of bilingualism on verbal learning and memory in Hispanic adults. *Journal of the International Neuropsychology*, *1*, 10–16.

Harris, J. G., Tulsky, D. S., & Schultheis, M. T. (2003). Assessment of the non-native English speaker: Assimilating history and research findings to guide clinical practice. In S. D. Tulsky, D. H. Saklofske, G. J. Chelune, R. K. Heaton, R. J. Ivnik, R. Bornstein, A. Prifitera, & M. F. Ledbetter (Eds.), *Clinical interpretation of the WAIS-II and WMS-II* (pp. 343–390). San Diego, CA: Academic Press.

Lezak, M. D., Howieson, D. B., & Loring, D. W. (2004). *Neuropsychological assessment* (4th ed.). New York: Oxford University Press.

Manly, J. J., Byrd, D. A., & Pegah, T. (2004). Acculturation, reading level, and neuropsychological test performance among African American elders. *Applied Neuropsychology*, *11*, 37–46.

Manly, J. J., Jacobs, D. M., Sano, M., Bell, K., Merchant, C. A., Small, S. A., et al. (1998). Cognitive test performance among nondemented elderly African-Americans and whites. *American Academy of Neurology*, *50*, 1238–1245.

Manly, J. J., Jacobs, D. M., Touradji, P., Small, S. A., & Stern, Y. (2002). Reading level attenuates differences in neuropsychological test performance between African American and White elders. *Journal of the International Neuropsychological Society*, *8*, 341–348.

Mitrushina, M., Boone, K. B., Razani, J., & D'Elia, L. Fl. (2005). *Handbook of normative data for neuropsychological assessment* (2nd ed.). New York: Oxford University Press.

Pachana, N. A., Boone, K. B., Miller, B. L., Cummings, J. L., & Berman, N. (1996). Comparison of neuropsychological functioning in Alzheimer's disease and frontotemporal dementia. *Journal of the International Neuropsychological Society*, *2*, 505–510.

Razani, J., Murcia, G., Tabares, J., Wong, J. (in press). The effects of culture on WASI test performance in ethnically diverse individuals. *The Clinical Neuropsychologist*.

Ruff, R. M., Evans, R., & Marshall, L. F. (1986). Impaired verbal and figural fluency after head injury. *Archives of Clinical Neuropsychology*, *1*(2), 87–101.

Stuss, D. T., Ely, P., Hugenholtz, H., Richard, M. T., LaRochelle, S., Poirier, C. A., et al. (1985). Subtle neuropsychological deficits in patients with good recovery after closed head injury. *Neurosurgery*, *17*(1), 41–47.

Suinn, R. M., Rickard-Figueroa, K., Lew, S., & Vigil, P. (1987). The Sunn-Lew Asian Self-Identity Acculturation Scale: An initial report. *Educational and Psychological Measurement*, *47*, 401–443.

Trenerry, M. R., Crosson, B., DeBoe, J., & Leber, W. R. (1989). *Stroop Neuropsychological Screening Test Manual*. Odessa, FL: Psychological Assessment Resources.

Wechsler, D. (2002). *WAIS-III, WMS-III technical manual – updated*. San Antonio, TX: The Psychological Corporation.