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The association between neuropsychological scores and ethnicity, language, and acculturation variables in a large patient population

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Abstract

The relationship between ethnicity and cognitive test performance was examined in a sample of 161 patients referred for evaluation at a public hospital-affiliated neuropsychology clinic; 83 patients were Caucasian (non-Hispanic), 31 were African-American, 30 were Hispanic, and 17 were Asian. Significant group differences were present on some measures of language (Boston Naming Test), attention (Digit Span ACSS), constructional ability (Rey-Osterrieth [RO] copy), nonverbal processing speed (Trails A), and executive skills (Wisconsin Card Sorting Test [WCST]). Comparison of those who spoke English as a first language (or who learned English concurrently with a second language) versus those who spoke English as a second language (ESL) revealed significantly higher performance in the non-ESL group for Digit Span, Boston Naming Test, and FAS, and a higher score in the ESL group for RO copy. Boston Naming Test scores were significantly related to years educated in the United States; Boston Naming Test and Digit Span scores were significantly correlated with age at which conversational English was first learned and number of years in the United States; and finally, FAS scores were also significantly related to number of years in the United States. These findings are consistent with data from published literature on ethnic differences and the effects of acculturation on cognitive test performance in nonpatients, and also indicate that these observations are not attenuated by the presence of psychiatric or neurologic illness. The results further caution that normative data derived on Caucasian samples may not be appropriate for use with other ethnic groups.

Keywords: Neuropsychological scores; Ethnicity; Acculturation

Various studies in normal populations have shown an effect of culture/ethnicity on cognitive test performance. Lowered performance in African-Americans relative to Caucasians has been observed for the RBANS (Patton et al., 2003), California Verbal Learning Test (Norman, Evans, Miller, & Heaton, 2000), Boston Naming Test (Whitfield et al., 2000), verbal fluency (Gladsjo et al., 1999; Johnson-Selfridge, Zalewski & Aboudarham, 1998; Schwartz et al., 2004), and the PASAT (Diehr, Heaton, Miller, & Grant, 1998). Manly and colleagues (Byrd, Touradji, Tang, & Manly, 2004; Manly et al., 1998a) reported that older African-Americans obtained significantly lower scores as compared to Whites on Benton Visual Retention Test recognition and matching, WAIS-R Similarities, category fluency, Rosen Drawings Test, and visual cancellation; however, years of education, acculturation level, and reading ability accounted for a significant amount of test score variance (Manly, Byrd, Touradji, & Stern, 2004). Similarly, Mehta et al. (2004) reported

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significantly lowered scores in older African-Americans compared to Caucasians on Digit Symbol and a modified mini-mental state examination, and Schwartz et al. (2004) documented significantly poorer scores on the Stroop Test, Rey Auditory Verbal Learning Test (RAVLT), Rey-Osterrieth (RO), Symbol Digit, Colored Progressive Matrices, Boston Naming Test, and Trailmaking in African-Americans, but differences substantially decreased after adjustments were made for demographic, socioeconomic (e.g., literacy, financial adequacy, household assets, occupational status), and/or health (i.e., blood lead, diabetes, hypertension, tobacco use, etc.) characteristics.

Lowered performances have also been observed in Hispanic nonpatients relative to Caucasians on Halstead-Reitan measures (Arnold, Montgomery, Castaneda, & Longoria, 1994), the Wechsler Memory Scale–Revised (WMS-R) (Demsky, Mittenberg, Quintar, Katell, & Golden, 1998) and the Wisconsin Card Sorting Test (WCST) (Coffey, Marmol, Schock, & Adams, 2005), although differences were attenuated when the effects of acculturation were considered. Comparison of an ethnically diverse sample (Hispanic, Asian, Middle-Eastern) with Anglo-Americans revealed that the latter group performed significantly better on the verbal, but not the nonverbal, subtests of the Wechsler Abbreviated Scale of Intelligence (WASI), and that acculturation measures were significant predictors of Vocabulary and Similarities performance in the non-Anglo group (Razani, Murcia, Tabares, & Wong, in press).

Some literature suggests that the effect of demographic variables on neuropsychological scores may be reduced in patient groups as compared to control populations due to the predominant effect of illness on cognition (Reitan & Wolfson, 1995, 1997; e.g., Trailmaking: Corrigan & Hinkeldey, 1987; Mitrushina, Boone, & D'Elia, 1999). However, there are few studies examining the relationship between ethnicity/culture and cognitive scores in patient populations. This information is critical because it is unclear whether the same corrections for culture/ethnicity indicated for control populations should be applied when interpreting patient scores.

To the best of our knowledge, there have only been two studies examining the effects of ethnicity/culture on cognitive scores in a clinical sample at risk for cognitive impairment. Manly et al. (1998b) compared the neuropsychological performance of HIV+ African-Americans to that of age, education, and gender matched HIV+ non-Hispanic Whites. They found that the African-Americans scored significantly lower relative to their White counterparts on the Category Test, Trails B, WAIS-R Block Design, WAIS-R Vocabulary, and Story and Figure Memory Test learning components. However, virtually all of these differences were no longer significant when scores were adjusted for level of acculturation. Similarly, Kennepohl et al. (2004) observed that in an African-American traumatic brain injury sample, lower levels of acculturation were associated with poorer performance on the Token Test, Block Design, RAVLT, and Symbol Digit Modalities Test. Although these studies provide important information, they are limited to examination of African-Americans and do not provide data on performance for many common neuropsychological measures.

The purpose of the present study was to compare the performance of African-American, Hispanic, Asian, and Caucasian (non-Hispanic) neuropsychology clinic patients on a battery of common neuropsychological tests, and to examine the separate impact of language/acculturation (i.e., ESL, age learned English, years of education in United States, number of years in United States) on cognitive test performance.

1. Method

1.1. Participants

Permission to access archival data was obtained from the Institutional Review Board at Harbor-UCLA Medical Center. The sample comprised patients referred for outpatient neuropsychological evaluation at this public hospital by the departments of Neurology and Psychiatry and also by nearby community mental health centers. To ensure that only subjects who were applying adequate effort on the cognitive measures were included in the study, patients who were involved in civil litigation or attempting to obtain disability compensation were excluded from the sample. In addition, subjects who failed three or more of the following cognitive effort measures were also excluded: WAIS-III Digit Span Age Corrected Scaled Score (cut-off < 6; Babikian, Boone, Lu, & Arnold, 2006), Dot Counting Test E score (cut-off ≥ 17; Boone, Lu, & Herzberg, 2002a), RAVLT Recognition (cut-off ≤ 7, Greiffenstein, Baker, & Gola, 1996), Rey 15-Item (total free recall + [recognition minus false positives] cut-off < 20; Boone, Salazar, Warner-Chacon, & Razani, 2002), Warrington Recognition Memory Test–Words (cut-off < 33; Iverson & Franzen, 1994), RO Effort Equation (copy + [recognition minus atypical false positives] $\times$ 3; cut-off ≤ 47; Lu, Boone, Cozolino, & Mitchell, 2003), Rey Word Recognition Test (cut-off for males ≤ 5, females ≤ 7; Nitch, Boone, Wen, Arnold, & Warner-Chacon, 2006), and b Test E score (cut-off ≥ 160; Boone, Lu, & Herzberg, 2002b).

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Table 1
Frequency (percentage) of diagnosis by ethnicity

Diagnosis	Caucasian ($N = 83$)	Hispanic ($N = 30$)	Asian ($N = 17$)	African-American ($N = 31$)
Depression	15 (18.1%)	3 (10.0%)	2 (11.8%)	2 (6.5%)
Severe head injury	10 (12.0%)	3 (10.0%)	3 (17.6%)	2 (6.5%)
Drugs/alcohol	8 (9.6%)	4 (13.3%)	0	3 (9.7%)
HIV	6 (7.2%)	0	0	0
Seizures	6 (7.2%)	0	1 (5.9%)	0
Psychosis	5 (6.0%)	5 (16.7%)	2 (11.8%)	5 (16.1%)
Bipolar disorder	3 (4.8%)	1 (3.3%)	1 (5.9%)	2 (6.5%)
Multiple sclerosis	3 (3.6%)	0	0	0
Stroke/aneurysm	3 (3.6%)	4 (13.3%)	1 (5.9%)	4 (12.9%)
Brain tumor/cyst	3 (3.6%)	2 (6.7%)	0	0
Mild cognitive impairment	3 (3.6%)	0	2 (11.8%)	2 (6.5%)
Dementia	3 (3.6%)	0	0	2 (6.5%)
Attention deficit disorder	2 (2.4%)	0	0	0
Moderate head injury	2 (2.4%)	0	0	0
Anxiety/panic	2 (2.4%)	1 (3.3%)	0	1 (3.2%)
Anoxia	1 (1.2%)	1 (3.3%)	1 (5.9%)	0
Hepatitis	1 (1.2%)	0	0	0
Immune disorder	1 (1.2%)	1 (3.3%)	0	0
Learning disability	1 (1.2%)	1 (3.3%)	0	5 (16.1%)
Personality disorder	1 (1.2%)	0	0	0
Mild mental retardation	1 (1.2%)	0	0	0
Frontotemporal dementia	1 (1.2%)	0	0	1 (3.2%)
Encephalitis	1 (1.2%)	0	0	0
Asbergers	1 (1.2%)	0	0	0
Somatoform	0	2 (6.7%)	1 (5.9%)	1 (3.2%)
Carotid stenosis	0	1 (3.3%)	0	0
Tourettes	0	1 (3.3%)	0	0
Mild head injury	0	0	1 (5.9%)	0
Amnestic disorder	0	0	1 (5.9%)	0
Rule out cognitive disorder	0	0	1 (5.9%)	0
Hydrocephalus	0	0	0	1

In the final sample of 161 patients, 83 were Caucasian (non-Hispanic), 31 were African-American, 30 were Hispanic, and 17 were Asian. All participants were fluent in English and were able to understand test instructions.

As shown in Table 1, the distribution of diagnoses was generally comparable across groups.

1.2. Neuropsychological measures

A neuropsychological battery was administered to all patients as part of a clinical neurocognitive evaluation. Scores used for analysis included (1) total correct on the Boston Naming Test (out of 60 possible); (2) total correct, nonredundant words generated on FAS; (3) RO Complex Figure Test copy and 3-min recall scores; (4) number of categories completed on the WCST; (5) number of words recalled for Trial 5, Trial 7 (after interference), and Trial 8 (long delay), and recognized on a paragraph format recognition trial for the RAVLT; (6) time scores for the Trailmaking Test (Parts A and B); (7) time scores for the Comalli Stroop Test (Parts A, B, and C); (8) age-corrected scaled scores (ACSS) for WAIS-R or WAIS-III Digit Span; and (9) age-corrected percentiles for WMS-R or Wechsler Memory Scale-III (WMS-III) Logical Memory I and II and Visual Reproduction I and II.

1.3. Language/acculturation variables

The following language and acculturation data were extracted from the patient files: (1) whether subjects learned English as a first language (or concurrent with another language) versus English learned as a second language (ESL); (2) age at which English was first learned; (3) number of years resided in the United States (subtracted from total age); and finally, (4) number of years educated in the United States (subtracted from total years of education completed).

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2. Results

As shown in Table 2, one-way analysis of variance (ANOVA) revealed ethnic groups significantly differed in age ($F(3,157) = 3.018$, $p = .032$) and years of education ($F(3,157) = 18.732$, $p = .0001$). With respect to age, Tukey's post-hoc analyses failed to reveal significant pairwise group differences. However, with regards to education, Tukey's post-hoc analyses revealed that Hispanics had significantly less education than Caucasians ($p = .0001$), Asians ($p = .0001$), and African-Americans ($p = .005$), and African-Americans had significantly less education than Asians ($p = .004$).

Subsequent analysis of covariance (ANCOVA) examining group differences (i.e., ethnicity as the between-subjects factor) on neuropsychological test scores included age and education as covariates (with the exception that age was not used as a covariate for WMS subtest percentiles or WAIS-R/WAIS-III Digit Span ACSS because these scores were already age corrected). As shown in Table 2, ANCOVA revealed significant group differences on measures of attention (Digit Span ACSS), nonverbal processing speed (Trails A), language (Boston Naming Test), constructional ability (RO copy), and executive skills (WCST); no significant differences were found in verbal processing speed (Stroop A and B), verbal memory (WMS-R or WMS-III LM, RAVLT), visual memory (WMS-R or WMS-III VR; RO delay), or executive skills involving word generation (FAS), rapid response inhibition (Stroop C), or alternation between tasks (Trails B).

Bonferroni contrasts revealed that Caucasians scored significantly higher than (1) African-Americans on Digit Span, Trails A, Boston Naming Test, RO copy, and WCST categories; (2) Hispanics on Digit Span and Boston Naming Test; and finally, (3) Asians on Boston Naming Test. In addition, Hispanics scored significantly higher than African-Americans on WCST categories, and Asians scored higher than African-Americans on RO copy.

As shown in Table 3, additional analyses were computed between those who spoke English as a second language ($n = 25$) versus native English speakers ($n = 136$). ANOVA revealed these two subgroups did not significantly differ in age but did differ in mean years of education. Subsequent ANCOVA analyses (covarying for education only) showed that native English speakers outperformed ESL patients on Digit Span, Boston Naming Test, and FAS, whereas the ESL group scored significantly higher on RO copy. In a subsample of Hispanics only (i.e., the ethnic group with the largest number of ESL speakers), ESL ($n = 12$) and non-ESL ($n = 18$) subjects also differed in years of education ($F(1,28) = 12.568$, $p = .001$), but not in age. Subsequent ANCOVA analyses (covarying for education) showed that although the ESL superiority on RO copy continued to be observed (non-ESL $= 27.7 \pm 1.2$, ESL $= 32.4 \pm 1.5$, $F(1,27) = 4.916$, $p = .035$), no significant differences were noted on Digit Span (non-ESL $= 7.5 \pm 0.3$, ESL $= 6.7 \pm 0.4$, $F(1,27) = 2.367$, $p = .136$), Boston Naming Test (non-ESL $= 42.2 \pm 2.2$, ESL $= 38.7 \pm 2.9$, $F(1,26) = .692$, $p = .413$), and FAS (non-ESL $= 26.9 \pm 3.0$, ESL $= 20.2 \pm 3.8$, $F(1,27) = 1.676$, $p = .206$). ESL and non-ESL Asians could not be compared due to small sample sizes (10 vs. 7).

Regarding acculturation variables, Boston Naming Test performance was significantly and negatively related to the age at which conversational English was first learned (Spearman $r = -.258$, $p = .001$), number of years educated in the United States (subtracted from total education completed; Spearman $r = -.272$, $p = .001$), and number of years in the United States (subtracted from total age; Spearman $r = -.346$, $p = .0001$). Digit Span score was significantly and negatively related to age at which English was first learned (Spearman $r = -.258$, $p = .001$) and number of years in the United States (subtracted from total age; Spearman $r = -.193$, $p = .016$), whereas FAS was significantly and negatively correlated only with number of years in the United States (subtracted from total age; Spearman $r = -.184$, $p = .022$). No other significant relationships were observed between acculturation measures and cognitive scores.

3. Discussion

In the present study, the association of ethnicity and cognitive test performance was examined in a large archival data set of patients referred to a public hospital-affiliated outpatient neuropsychology clinic. Comparisons of Caucasians (non-Hispanic), African-Americans, Hispanics, and Asians revealed significant group differences on a third of the scores from the neuropsychological battery. Specifically, group differences were observed in language (i.e., Boston Naming Test), visuoconstruction (i.e., RO copy), verbal repetition/attention span (i.e., Digit Span), nonverbal processing speed (i.e., Trails A), and an executive task (i.e., WCST total number of categories). These differences emerged despite

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Table 2
Sample characteristics and neuropsychological performances by ethnicity

	Caucasian	Hispanic	Asian	African-American	*F*	*p*	Group differences[a]
Sample characteristics							
Total sample size	83	30	17	31	–	–	
Gender (% female)	57	67	41	68	–	–	
Age	49.0 (14.3)	41.0 (15.2)	43.8 (17.6)	41.7 (17.1)	3.018	.032	
Education	13.6 (2.6)	10.1 (3.1)	14.8 (1.9)	12.3 (1.6)	18.732	.000	
Attention							
WAIS-III Digit Span	9.7 (0.3)	8.0 (0.5)	8.5 (0.6)	8.2 (0.4)	4.913	.003	C > H, AA
n	81	30	17	30			
Processing speed							
Trailmaking Part A	38.6 (2.2)	39.8 (4.0)	43.6 (4.9)	51.1 (3.8)	2.875	.038	C > AA
n	82	30	17	28			
Stroop A	54.7 (1.7)	55.8 (3.0)	59.1 (3.7)	54.1 (2.9)	.485	.693	
n	76	29	17	26			
Stroop B	76.7 (2.5)	77.5 (4.4)	82.2 (5.5)	77.9 (4.2)	.283	.838	
n	76	29	16	26			
Language							
Boston Naming Test	52.4 (1.0)	42.9 (1.8)	42.4 (2.3)	42.5 (1.7)	13.817	.000	C > H, A, AA
n	80	29	15	28			
Verbal Fluency (FAS)	33.2 (1.3)	26.7 (2.3)	28.1 (2.9)	30.6 (2.1)		2.408	.069
n	82	30	17	29			
Visuospatial							
RO copy	31.7 (0.6)	30.3 (1.1)	32.5 (1.3)	26.9 (1.0)	6.575	.000	C, A > AA
n	81	30	17	31			
Visual memory							
Visual Reproduction I	39.0 (3.8)	26.9 (6.7)	36.5 (8.0)	31.1 (6.0)	0.912	.437	
n	74	27	17	28			
Visual Reproduction II	26.4 (2.9)	27.4 (5.2)	24.5 (6.1)	19.0 (4.6)	.737	.532	
n	73	27	17	28			
Rey-O 3-min Delay	15.2 (0.9)	15.0 (1.5)	16.1 (1.9)	12.7 (1.4)	.941	.423	
n	80	30	17	29			
Verbal memory							
Logical Memory I	36.6 (3.2)	30.0 (5.6)	20.2 (6.7)	25.6 (5.1)	2.383	.072	
n	72	28	17	28			
Logical Memory II	37.9 (3.2)	35.3 (5.5)	28.8 (6.7)	25.8 (5.0)	1.635	.184	
n	73	28	17	28			
RAVLT Trial 5	8.3 (0.4)	8.1 (0.7)	6.8 (0.8)	7.2 (0.6)	1.674	.175	
n	78	30	17	29			
RAVLT Short Delay	8.3 (0.4)	8.1 (0.7)	6.8 (0.8)	7.2 (0.6)	1.674	.175	
n	78	30	17	29			
RAVLT long delay	7.6 (0.4)	6.9 (0.8)	6.5 (1.0)	6.0 (0.7)	1.318	.271	
n	77	30	17	9			
RAVLT recognition	12.8 (0.3)	13.1 (0.6)	12.3 (0.7)	11.9 (0.5)	1.313	.273	
n	78	27	17	29			
Executive function							
Stroop C	147.6 (5.2)	144.9 (9.2)	146.9 (11.4)	159.4 (9.0)	.565	.639	
n	75	28	16	24			
Trailmaking Part B	101.7 (6.6)	114.4 (11.7)	110.6 (14.3)	126.8 (11.4)	1.203	.311	
n	80	29	17	26			
WCST categories	4.2 (0.2)	4.4 (0.4)	3.9 (0.6)	2.8 (0.4)	3.579	.016	C, H > AA
n	75	27	13	27			

Note. Values are adjusted means (*SE*) controlling for age and/or education.
[a] C, Caucasians; H, Hispanics; A, Asians; AA, African-Americans.

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Table 3
Neuropsychological performances by ESL group

	English	ESL	*F*	*p*	Group differences[a]
Sample demographics					
Total sample size	136	25	–	–	
Gender (% female)	61	48	–	–	
Age	45.3 (15.7)	46.8 (16.0)	.199	.656	
Education	13.0 (2.4)	11.5 (4.5)	6.142	.014	
Attention					
WAIS-III Digit Span	9.2 (0.2)	7.9 (0.5)	5.149	.025	English > ESL
n	134	24			
Processing speed					
Trailmaking Part A	42.1 (1.9)	39.1 (4.3)	.395	.531	
n	132	25			
Stroop A	56.1 (1.3)	51.0 (3.1)	2.367	.126	
n	125	23			
Stroop B	78.0 (1.9)	75.9 (4.6)	.173	.678	
n	125	22			
Language					
Boston Naming Test	48.9 (0.8)	41.0 (2.1)	12.515	.001	English > ESL
n	130	22			
Verbal Fluency (FAS)	31.7 (1.0)	26.6 (2.4)	3.839	.052	English > ESL
n	134	24			
Visuospatial					
RO copy	30.2 (0.5)	32.8 (1.1)	4.685	.032	ESL > English
n	134	25			
Visual memory					
Visual reproduction I	34.6 (2.9)	36.8 (6.9)	.088	.767	
n	124	22			
Visual reproduction II	23.9 (2.2)	30.8 (5.2)	1.468	.228	
n	123	22			
Rey-O 3-min delay	14.5 (0.7)	16.2 (1.5)	.962	.328	
n	131	25			
Verbal memory					
Logical Memory I	31.4 (2.5)	30.5 (5.9)	.023	.881	
n	123	22			
Logical Memory II	33.0 (2.4)	40.0 (5.7)	1.270	.262	
n	124	22			
RAVLT Trial 5	10.3 (0.3)	10.6 (0.6)	.384	.537	
n	130	24			
RAVLT short delay	7.9 (0.3)	8.1 (0.7)	.055	.815	
n	130	24			
RAVLT long delay	6.9 (0.4)	7.7 (0.8)	.690	.408	
n	129	24			
RAVLT recognition	12.5 (0.2)	13.2 (0.6)	1.223	.271	
n	129	22			
Executive function					
Stroop C	149.5 (4.1)	145.6 (9.8)	.134	.714	
n	121	22			
Trailmaking Part B	109.8 (5.3)	107.3 (12.5)	.035	.852	
n	128	24			
WCST categories	4.0 (0.2)	3.9 (0.5)	.004	.950	
n	121	21			

Note. Values are adjusted means (*SE*).
[a] ESL, English as a second language.

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the fact that the groups appeared to be fairly equivalent in terms of frequency of clinical diagnoses, indicating that the group differences were not due to discrepancies in nature of the presenting illness.

Examination of group means adjusted for age and education revealed that African-American, Hispanics, and Asians scored on average 9–10 points below Caucasians on the Boston Naming Test, and African-Americans and Hispanics scored on average 1½ scaled score points below Caucasians on Digit Span. In addition, African-Americans averaged >1 fewer category on the WCST as compared to Caucasians and Hispanics; 5–6 fewer points in copy of the RO figure in comparison to Caucasians and Asians; and required 12 seconds more than Caucasians on Trails A.

In contrast, group differences were not documented on measures of verbal processing speed (Stroop A and B), verbal memory (WMS-R and WMS-III LM, RAVLT), visual memory (WMS-R or WMS-III VR, RO delay), and most executive skills (Trails B, FAS, Stroop C).

Comparison of those who spoke English as a native versus second language revealed significantly better performance on the Boston Naming Test, FAS, and Digit Span in the former group, and better RO figure copy in the latter group. However, within the Hispanic group specifically, although comparisons of those who spoke English as a first versus second language continued to show a superiority in RO figure copy in the ESL group, no other significant differences were detected. In fact, examination of adjusted means revealed that native-English-speaking Hispanics were still averaging 10 points less on the Boston Naming Test than Caucasians, more than 6 points less on FAS, and over 2 scaled score points lower on Digit Span. These data contradict the assumption that adjustments in interpretation of neuropsychological scores are only necessary for Hispanics who are nonnative English speakers. Our findings are similar to those of Razani and colleagues (in press) who observed that an ethnically diverse sample of nonpatient volunteers (Hispanic, Asian, and Middle-Eastern) who spoke English as a first versus second language performed comparably to each other and worse than Anglo-Americans on verbal measures of the WASI.

Associations between available measures of acculturation (years in United States, years educated in United States, age at which English was first learned) and cognitive scores were limited to select verbal skills involving word-retrieval (Boston Naming Test), word generation (FAS), and verbal repetition/attention span (Digit Span). However, these acculturation variables are only applicable to foreign-born individuals and/or those who speak English as a second language. We did not have data available to assess the relationship between formal acculturation measures and cognitive scores in ethnic minorities born in this county and who spoke English as native language. The data we do have, however, suggest that language skills measured in English in an immigrant population will be inversely related to age at which English was learned and positively associated with number of years resided and educated in the United States. These findings are in line with previous research conducted with healthy, ethnically diverse adults (Harris, Tulsky, & Schultheis, 2003; Razani et al., in press).

Results from the present study suggest that ethnic differences in test performance are not attenuated by presence of psychiatric or neurologic illness. The findings further caution that normative data derived on Caucasian samples may not be appropriate for use for with other ethnic groups, particularly for measures of language, attention, processing speed, constructional skill, and select executive skills; application of Caucasian-derived norms will result in overpathologizing of cognitive disorder in ethnic minorities. Additionally, the fact that all non-Caucasian groups performed consistently lower on the Boston Naming Test suggests that the test stimuli themselves may be systematically biased against those groups. In a multicultural society, the development of appropriate norms may be insufficient in and of themselves unless specific tests/test-items that are reflective of a diverse cultural experience are developed simultaneously with normative data.

Some authors have questioned the use of race-based norms (Gasquoine, 1999; Manly, 2005; Manly et al., 2004; Manly, Jacobs, Touradji, Small, & Stern, 2002) given that variables such as level of acculturation, quality of education, length of residence in the United States, years educated outside of the United States, and extent of English language use when growing up and currently, appear to be the factors responsible for the observed ethnic differences in cognition (Arnold & Orozco, 1989; Gasquoine, 1999; Gonzalez & Roll, 1985; Harris et al., 2003; Manly et al., 1998a,b, 2002; Razani et al., in press; Shuttleworth-Edwards et al., 2004; Touradji, Manly, Jacobs, & Stern, 2001). Ideally, future normative studies should stratify data according to cultural factors, rather than race. However, in the interim, clinicians attempting to interpret test scores of ethnic minorities are limited to use of incomplete race-based norms (see Table 4) and norms primarily derived on non-Hispanic Caucasians; use of the latter will require appropriate adjustments of interpretations, informed by the available literature, so as to avoid mischaracterization of the cognitive abilities of ethnic minorities. In addition, clinical and forensic decisions based on such data must include prominent caveats about sources of measurement error (Pontón, 2001; Pontón & Corona-LoMonaco, in press).

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Table 4
Available normative for African-Americans, Hispanics, and Asians

Ethnic group	Test	References
African-Americans		
	Boston Naming Test	Henderson, Frank, Pigatt, Abramson, & Houston (1998); Lucas et al. (2005)
	Benton Visual Retention Test	Manly et al. (2002)
	California Verbal Learning Test	Norman et al. (2000)
	COWAT/FAS	Gladsjo et al. (1999); Johnson-Selfridge et al. (1998); Lucas et al. (2005)
	Halstead-Reitan Battery	Heaton, Miller, Taylor, and Grant (2004)
	Hopkins Verbal Learning Test	Friedman, Schinka, Mortimer, and Graves (2002)
	Grip Strength	Heaton et al. (2004)
	Grooved Pegboard	Heaton et al. (2004)
	Judgment of Line Orientation	Lucas et al. (2005)
	PASAT	Diehr et al. (1998)
	RBANS	Patton et al. (2003)
	Stroop Test	Lucas et al. (2005); Moering, Schinka, Mortimer, and Graves (2004); Strickland, D'Elia, James, and Stein, (1997)
	Token Test	Lucas et al. (2005)
	Trailmaking	Lucas et al. (2005)
	WAIS-III and WMS-III	Psychological Corporation (2001)
	WRAT-3 Reading	Lucas et al. (2005)
Hispanics		
Tested in English		
	Boston Naming Test	Kohnert, Hernandez, and Bates, (1998); Roberts, Garcia, Desrochers, and Hernandez (2002); Rosselli et al. (2002)
	FAS	Johnson-Selfridge et al. (1998)
	Stroop Test	Rosselli et al. (2002)
	WAIS-III and WMS-III	Psychological Corporation (2001)
Tested in Spanish		
	Bateria Neuropsicologica en Espanol	Artiola-i-Fortuny, Hermosillo Romo, Heaton, and Pardee (1999)
	Benton Visual Retention Test	Jacobs et al. (1997)
	Boston Naming Test	Pontón et al. (1996)
	Color Trails	Pontón et al. (1996)
	FAS	Pontón et al. (1996)
	NEUROPSI	Ostrosky-Solis, Ardila, and Rosselli (1997)
	Neuropsychological Screening Battery for Hispanics	Pontón et al. (1996)
	Raven's Standard Progressive Matrices	Pontón et al. (1996)
	Rey figure copy	Ardila, Rosselli, and Rosas (1989); Ostrosky-Solis et al. (1998); Pontón et al. (1996)
	Spanish English Verbal Learning	Gonzalez, Mungas, and Haan (2002)
	Stroop Test	Lopez-Carlos, Salazar, Villasenor, Saucedo, and Pena (2003)
	Visual Form Discrimination	Campo and Morales (2003)
	WMS-R	Demsky et al. (1998)
	WHO-UCLA AVLT	Pontón et al. (1996)
	Wisconsin Card Sorting Test	Artiola-i-Fortuny and Heaton (1996); Artiola-i-Fortuny and Mullaney (1998); Lopez-Carlos et al. (2003); Mejia, Pineda, Alvarez, and Ardila, (1998); Rey, Feldman, Rivas-Vazquez, Levin, and Benton, (1999); Rosselli and Ardila (1996)
Asians		
Vietnamese	Stroop Test	Doan and Swerdlow (1999)
Chinese	Trailmaking	Lu and Bigler (2002)
Korean	Western Aphasia Battery	Kim and Na (2004)
Japanese	Trailmaking	McCurry et al. (2001); Abe et al. (2004)
	Verbal Fluency	Abe et al. (2004)
	Wisconsin Card Sorting Test	Abe et al. (2004)
	Finger Tapping	McCurry et al. (2001)

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