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Relationship of ethnicity, age, education, and reading level to speed and executive function among HIV+ and HIV- women: The WIHS Neurocognitive Substudy

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Abstract

Use of neuropsychological tests to identify HIV-associated neurocognitive dysfunction must involve normative standards that are well-suited to the population of interest. Norms should be based on a population of HIV-uninfected individuals as closely matched to the HIV-infected group as possible, and must include examination of the potential effects of demographic factors on test performance. This is the first study to determine the normal range of scores on measures of psychomotor speed and executive function among a large group of ethnically and educationally diverse HIV-uninfected, high risk women, as well as their HIV-infected counterparts. Participants (n = 1653) were administered the Trailmaking Test Parts A and B (Trails A and Trails B), the Symbol Digit Modalities Test (SDMT), and the Wide Range Achievement Test-3 (WRAT-3). Among HIV-uninfected women, race/ethnicity accounted for almost 5% of the variance in cognitive test performance. The proportion of variance in cognitive test performance accounted for by age (13.8%), years of school (4.1%) and WRAT-3 score (11.5%) were each significant, but did not completely account for the effect of race (3%). HIV-infected women obtained lower scores than HIV-uninfected women on time to complete Trails A and B, SDMT total correct, and SDMT incidental recall score, but after adjustment for age, years of education, racial/ethnic classification, and reading level, only the difference on SDMT total correct remained significant. Results highlight the need to adjust for demographic variables when diagnosing cognitive impairment in HIV-infected women. Advantages of demographically adjusted regression equations developed using data from HIV-uninfected women are discussed.

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Introduction

HIV infection is associated with increased risks for impairment in neurocognitive function (Grant & Martin, 1994; Heaton et al., 1995). Impairment in speed of information processing is a cardinal feature of HIV associated brain dysfunction (Heaton et al., 1995). The pattern of cognitive deficits found in HIV-infected individuals can be broadly described as a “subcortical” pattern of cognitive dysfunction. Like other patients with neurological conditions that primarily affect the functions of the basal ganglia and their cortical connections, HIV+ individuals have slowed mentation, increased choice reaction times, and memory loss more characteristic of a retrieval defect than a storage loss (Becker et al., 1995; Martin, Sorensen, Edelstein, & Robertson, 1992). Slowed mentation is common even in the early stages of infection (Villa et al., 1996), and is a predictor of subsequent cognitive and physical decline (Sacktor et al., 1996). According to the Northeastern AIDS Dementia Cohort and the AIDS Clinical Trials Group (ACTG), the prevalence of Minor Cognitive-Motor Disorder (MCMD) is approximately 30%, whereas other data from recent cohort studies of persons with advanced HIV/AIDS put the prevalence at 37% (Sacktor et al., 2002).

Although accurate assessment of cognitive function among people with HIV is critical to determine the effects of the virus on the brain (Carey et al., 2004; Butters et al., 1990; Heaton et al., 1995; Miller, 1990), everyday function, and health variables such as medication adherence, validation of neuropsychological instruments for use among ethnic minorities with HIV has only recently begun (Heaton, Taylor, & Manly J., 2001; Heaton, Miller, Taylor, & Grant, 2004). There is increasing interest in collecting comprehensive normative information on neuropsychological test performance of ethnic minorities (Heaton et al., 2004; Lucas et al., 2005; Ponton et al., 1996). However, the use of these norms to detect cognitive impairment that is related specifically to HIV infection has been questioned (Heaton et al., 1995; Levine et al., 2007), since these normative samples exclude many seronegative people at high risk for HIV-infection. Since history of IV drug use, alcohol and drug dependence, and psychiatric disorders are typical exclusion criteria for normative studies of neuropsychological test performance, the use of these norms to identify HIV-specific cognitive dysfunction is problematic. For example, cognitive impairment is prevalent in substance abusers who are HIV negative (Martin, Pitrak, Pursell, Mullane, & Novak, 1995), and there is evidence of decreases in overall brain volume among high risk group controls as compared to low-risk controls (Jernigan et al., 1993). Highlighting the importance of these high risk behaviors in HIV research, when HIV seropositive and seronegative women were matched on demographics and substance use history, there were no significant differences in cognitive test performance between the groups (Stern et al., 1998).

Use of appropriate normative data for detection of HIV-related neurocognitive impairment also involves proper adjustment for educational experience. Prior studies, primarily among older adults, have shown that years of school is an inadequate measure of educational experience among ethnically diverse adults, and that quality of education must also be taken into account (Manly, Byrd, Touradji, & Stern, 2004; Manly, Jacobs, Touradji, Small, & Stern, 2002; Manly, Touradji, Tang, & Stern, 2003), but thus far, limited research has been conducted examining the role of reading level (as an estimate of quality of education) in cognitive test performance among HIV-infected individuals. Research conducted among 200 participants in the Manhattan HIV Brain Bank (Ryan et al., 2005) found that African Americans and Hispanics had lower overall reading levels as compared to non-Hispanic Whites, African Americans were more likely to have reading levels significantly discrepant from their reported years of school, and that discrepancies between years of school and education had a stronger relationship to neuropsychological test performance than racial/

ethnic classification. A study of 113 HIV-infected participants of the National Neurological AIDS Bank (Rohit et al., 2007) found that when cognitive test scores adjusted for reading level were used, they had increased specificity for detection of physician-diagnosed possible or probable minor cognitive and motor disorder (MCMD) or HIV-Associated Dementia by over 20% above that of scores corrected for years of education among African Americans. This increase in specificity of reading-level adjusted scores was accompanied by a decrease in sensitivity as compared to education-adjusted scores (48.4% vs. 61.3%). Among Whites, reading level adjustment did not improve sensitivity or specificity of the measures. Neither of these studies examined the relationship of reading level to test scores among HIV-seronegative individuals.

The primary goal of this study was to determine the normal range of scores on measures of psychomotor speed and executive function among ethnically and educationally diverse HIV-uninfected, high risk women as well as their HIV-infected counterparts. We sought to compare test performance between HIV-infected and HIV-uninfected women, and to determine if adjustment for age, years of education, racial/ethnic classification, and reading level altered differences between HIV-infected and HIV-uninfected women. This study also describes the methodology used to determine cutoffs that define neurocognitive dysfunction after examining the role of cultural, linguistic, and educational experience on test performance.

Method

Population and Study Design

The Women's Interagency HIV Study (WIHS) is a multicenter prospective cohort study of the natural history of HIV type 1 infection in women who were recruited and evaluated at any of six research sites in New York (Bronx and Brooklyn), California (Los Angeles and San Francisco), Washington DC, and Chicago. In 1994/1995, 2,623 women (2,054 HIV+; and 569 HIV-) were enrolled. In 2001/2002, an additional 1,143 women (737 HIV+ and 406 HIV-) were enrolled into the WIHS. Methods for recruitment and the characteristics of the baseline cohort are described elsewhere (Barkan et al., 1998). The recruitment of the HIV-uninfected women is of particular relevance to the current analyses. HIV-negative women were enrolled if they reported one or more of the following behaviors within the past year: injection drug use; having a sexually transmitted disease; having unprotected sex with three or more men or protected sex with more than five men; or having exchanged sex for drugs, money, or shelter). Participants return every 6 months for an interview which includes questions about socio-demographic, medical, obstetric, gynecological and contraceptive history, as well as alcohol, tobacco and other drug use and sexual behaviors. Plasma, serum, lymphocyte, tissue, genital secretion and urine samples are collected and stored. The institutional review boards of each of the participating centers approved the protocol, and informed consent was obtained from every participant. The Neurocognition substudy was initiated in October 2004. Participants who were interviewed in English, and provided complete data on the neurocognitive measures, the reading level measure, and the educational history assessment, were eligible for inclusion in the current study.

Measures

Racial/ethnic group—Ethnic group was determined by self-report using the format of the 2000 US Census (United States Office of Management and Budget, 1997). All individuals were first asked to report their race (i.e., American Indian/Alaska Native, Asian, Native Hawaiian or other Pacific Islander, Black or African American, or White), then, in a second question, were asked whether or not they were Hispanic.

The Wide Range Achievement Test – Version 3 (WRAT-3)(Wilkinson, 1993)— English reading level was measured using the Reading Recognition subtest from the WRAT-3. On this test, participants are asked to name letters and pronounce words out of context.

Educational experience—A detailed assessment of educational experience was administered, which provides information about educational attainment and clarification of the setting in which education was completed. The following variables were assessed separately for elementary, high school, and post-high school phases of education: years completed, age or date of first year attended, location (country, state, rural vs. urban), setting (public vs. private, class size (one-room school or multi-room school), and estimated ethnic composition of student body and teachers). Total years of education is the sum of years completed in elementary, high school, and post-high school phases of education, with a minimum of 0 and a maximum of 20. In addition, participants were asked whether they were ever “left back or had to repeat a grade”. Those who did not attain a high school degree were asked why they left school. As is standard in many normative samples (Heaton & Miller, 2004; Strauss, Sherman, & Spreen, 2006), women who obtained a GED as a terminal degree were assigned the number of actual years of formal schooling (as opposed to 12 years).

Neuropsychological measures

All participants received neuropsychological tests administered by trained psychometrists using standardized procedures. The Trailmaking Test (Parts A and B) (Reitan, 1978; Heaton, Grant, & Matthews, 1991) was administered to assess processing speed and cognitive flexibility. Participants were allowed 5 minutes to complete Trails A and 54 minutes to complete Trails B before the tasks were discontinued. Total time to complete the tests, as well as number of errors, was recorded. If either test was discontinued at 5 minutes, the correct number of connections made was recorded. The Symbol Digit Modalities Test (Smith, 1968) was administered to assess speed of information processing and perceptual motor ability. Score was the total number of boxes that were correctly filled within the time limit of 90 seconds. An incidental recall condition was added, in which the code table and previous answers were hidden, the nine symbols were shown, and participants were asked to recall the digits that matched the symbols (Demakis, Sawyer, Fritz, & Sweet, 2001; Shuttleworth-Jordan & Bode, 1995; Joy, Fein, & Kaplan, 2003).

Data analyses

The distributions of time to complete Parts A and B of the Trailmaking Test were somewhat skewed to the right and were therefore log transformed. Errors on the Trailmaking task were quite rare, and the distributions of these scores could not be brought to near-normal or normal. Pearson correlation coefficients were calculated for all continuous variables (Spearman's rho was used to examine Trailmaking error totals) in the entire sample, and then separately among HIV negative women and among HIV positive women. The relationships of other demographic variables and cognitive test scores were compared across the four ethnic groups in the entire sample and two serostatus groups using ANOVAs, and post-hoc Tukey's tests were used to follow-up significant overall findings. Trails A and B errors were compared across all 4 ethnic groups using a Kruskal-Wallis one-way analysis of variance, and Mann-Whitney U tests were used to compare individual ethnic groups in the case of a significant overall test.

A MANOVA was performed in which the normally distributed, raw cognitive test scores (time to complete Trails A and Trails B (log transformed), total correct on the Symbol Digit Modalities test, and incidental recall score) were dependent variables and race/ethnicity was the independent variable. We then repeated this analysis controlling for age, years of school, and WRAT-3 score. We compared the F value and significance of the overall effect of race/ethnicity between these two analyses. Logistic regression models were conducted to test the effect of demographic predictors on presence or absence of errors on Trails A and Trails B.

A MANCOVA was performed to test the effect of serostatus on the four normally distributed test scores after controlling for age, years of school, reading level, and ethnicity. In the case of a significant overall effect, post-hoc univariate F tests were used to determine which group means differed. Logistic regression models were constructed to determine whether HIV-uninfected and HIV-infected women differed on the presence or absence of errors on 1) Trails A and 2) Trails B after accounting for age, years of school, WRAT-3 scores, and ethnicity.

Finally, we describe the development of normative standards for these cognitive measures in this cohort. All HIV-negative participants were included in the normative sample. Demographically corrected T-scores were developed based on the Heaton, Grant, and Matthews (1991) regression method (Heaton et al., 1991). We developed the norms using two approaches, both using multiple linear regression analyses to obtain normative values. In the first method, we adjusted scores for the influences of age, years of education, reading level, and ethnicity. We designed this first approach to take advantage of all of the measured background variables that may assist in determining “premorbid” level of function. The four cognitive test variables were included as dependent variables in a regression, with age, years of education, WRAT-3 reading subtest total, and ethnicity as predictors. For each of the four regression analyses, we initially included all four predictors in the model, but the final model retained only those variables that significantly contributed to prediction of cognitive test score. The unstandardized beta weights of each of the predictors in the final model, the constant, as well as the standard error, were used to calculate predicted scores on each test. These predicted scores were subtracted from each participant's actual composite score to calculate residual scores, and Z-scores were derived according to the formulas:

$$\text{Predicted Score}=\left(\text{Constant}+\left(\text{age}\times\beta_{\text{age}}\right)+(\text{WRAT}\times\beta_{\text{wrat}})+\left(\text{Years of education}\times\beta_{\text{yeduc}}\right)\right.$$
$$\left.+(\text{African American status}\times\beta_{\text{AA}})+\left(\text{Hispanic status}\times\beta_{\text{Hispanic}}\right)\right)$$

$$\text{Z score}=\text{Predicted score}-\text{Actual Score}/\text{standard error of the estimate}$$

The signs of the Z-scores for time to complete Trails A and Trails B were reversed, since higher values on these tasks reflect worse performance.

Results

Sample characteristics

A total of 613 HIV-uninfected women and 1497 HIV-infected women completed at least one cognitive test from the Neurocognitive Substudy. Among these potential participants, 324 were excluded from the current sample because information about years of education could not be derived from the educational history questionnaire. Of the remaining women, 133 were evaluated in Spanish and were excluded from the current sample. The final sample of 1653 participants included 511 HIV negative women and 1142 HIV+ women. Although most of the women completed the initial evaluation in visit 21 of the WIHS study (n = 1282, 77%), because the IRB at two sites did not approve the protocol before the beginning of visit 21, 363 (22%) did not enter until visit 22 (04/01/05 - 09/30/05). An additional 6 (<1%)

participants did not enter until visit 23 (dates), and 2 (<1%) entered in visit 24 (dates). Among the women in the final sample, 72 were not administered the English reading level measure; they were not excluded from the sample but their data could not contribute to our planned analyses involving reading level.

The mean age of final sample was 41.0 years (SD = 9.2 years), and they had an average of 12.0 (SD = 3.0) years of education. The cohort was 63.1% non-Hispanic Black, 21.5% Hispanic, 11.9% non-Hispanic White, and 3.5% “other race”. Table 1 details the demographic characteristics of the sample by HIV status.

Educational experience

All but 4 women (99.8%) reported completing at least one year of school. Of these participants, 88% attended elementary school in the United States. The other 12% of the cohort reported attending elementary school in primarily Caribbean countries (such as Puerto Rico, Jamaica, Trinidad, and Guyana), Mexico and Central America, and Canada, and some in African and European nations. A small proportion of women reported that they could not recall information about the racial composition of the students and teachers in their schools; however, among those who did report this information, most attended elementary and high schools in which most of their peers were African American and most of the teachers were White.

The most common reasons for discontinuing school reported by women who did not attaining a high school degree were “not liking school”, “had children”, “difficulty learning in school” and “family problems”. Of the women who attended any school, 17.7% reported that they were left back or failed a grade at least once. Women who reported failing a grade attained approximately one less year of school than women who reported that they never failed a grade (11.0 years vs 12.3 years; $t(1610) = 7.1$, $p < .001$). Twenty-one percent of the participants reported that they attained a GED.

Relationship of demographics to raw cognitive test scores

Among the entire sample (HIV positive and HIV negative women), the demographic variables had strong relationships with most of the cognitive test scores. Overall, the cognitive test scores were significantly correlated with each other, except that Trails A errors was unrelated to Trails B time and incidental recall. Women who described themselves as White or “other race” obtained higher scores on the WRAT-3 and the cognitive measures as compared to African Americans and Hispanics. African Americans and Hispanics rarely differed from each other, with the exception of the SDMT total, where Hispanics obtained higher scores than African Americans. There were no ethnic differences on number of errors on Trails A. These relationships in the entire group were also present in the HIV-infected subgroup; with the exception of Trails A errors, Whites and “other race” obtained higher scores on the cognitive measures as compared to African Americans and Hispanics.

The relationships between demographics to raw test scores among HIV negative women are detailed in Tables 2 and 3, since these relationships serve as the basis of the normative standards for this study. Table 2 shows that, as expected, older women completed the Trailmaking task slower and made more errors on the Trails B, and got fewer items correct on the SDMT and the incidental recall task than younger women. Women with more education and with higher reading level obtained better scores on the cognitive measures than women with lower education and reading level. White and “Other race” participants had more years of school, higher WRAT-3 scores, faster performance on the Trailmaking tasks with fewer errors, and more correct items on the SDMT than African American and

Hispanic women. Finally, Whites recalled more items on the incidental recall task than African Americans and Hispanics (who did not differ from each other). Based on these findings, we grouped Whites with “Other race” for the remainder of the analyses and for the development of the normative data.

As expected based on the individual mean comparisons, a MANOVA revealed a significant overall effect of race/ethnicity on performance on Trails A and B time, Symbol Digit total correct, and incidental recall among HIV-negative women (Wilks' $\lambda = .906$, df = 8, $p < .001$). Race/ethnicity accounted for almost 5% of the variance in cognitive test performance (Eta squared = .047). Using a MANCOVA model and entering age, years of school, and WRAT-3 as covariates, the effect of race on cognitive test score was still significant (Wilks' $\lambda = .944$, df = 8, $p = .001$), although the effect size of race was reduced (Eta squared = .029). The proportion of variance in cognitive test performance accounted for by age (13.8%), years of school (4.1%) and WRAT-3 score (11.5%) were each significant in this model.

The effect of race/ethnicity on presence of errors on the Trailmaking tests was examined separately using logistic regression models, since errors were not normally distributed. Race/ethnicity was not related to presence of Trails A errors. However, African Americans were about 3 times as likely (OR = 3.18, 95% CI = 1.72 – 5.90) and Hispanics were about 2 times as likely (OR = 2.54, 95% CI = 1.29 – 4.99) to make errors on the Trails B test as compared to women who identified as White or “other race”. When the demographic variables were entered as covariates, age and WRAT-3 score were significant predictors of presence of Trails B errors. Furthermore, the effect of Hispanic status was no longer significant after adjusting for age, years of school, and WRAT-3 (OR = 1.72, 95% CI = 0.85 – 3.52). African Americans were still more likely to make Trails B errors adjusting for age, years of school, and WRAT-3 (OR = 2.18, 95% CI = 1.14 – 4.16).

Effect of HIV serostatus on neuropsychological measures of speed and executive function

A MANOVA revealed that overall, HIV-infected women obtained worse scores than HIV-uninfected women on time to complete Trails A and Trails B (log transformed), total correct on the Symbol Digit Modalities test, and incidental recall score, without correcting for differences in background variables (Wilks' $\lambda = .981$, df = 4, $p < .001$). HIV status accounted for only 1.9% of the overall variance in overall cognitive test score. Table 4 shows the results of univariate ANOVAs which revealed significant effects of HIV status on each of the individual cognitive tests. HIV status was unrelated to number of errors on the Trailmaking tasks.

After age, years of school, WRAT-3 score, and race/ethnicity were accounted for in a MANCOVA model, the effect of HIV status on overall cognitive test performance remained significant (Wilks' $\lambda = .994$, df = 4, $p < .05$), even though HIV status accounted for a very small amount (0.6%) of the overall variance. The relative contributions of the demographic variables was much higher than HIV serostatus in this overall model: age accounted for 10.2% of the variance, while years of school (2.8%), reading level (12.2%), African American race (4.3%), and Hispanic origin (2.9%) all accounted for significant variance in cognitive test performance.

Table 4 shows the F values and effect sizes of HIV status on the individual tests after accounting for the covariates; the effect of HIV infection on time to complete Trails A and Trails B (both log transformed) and incidental recall score was no longer significant after accounting for age, years of school, WRAT-3 score, and race/ethnicity, while the effect on SDMT total remained significant.

Development of Normative data

Four regression models were performed using the four continuous neuropsychological variables as outcomes, and the demographic predictors (age, years of education, WRAT-3 score, and reference-coded race/ethnicity) as predictors among the HIV-uninfected women. The supplemental Table 5a shows the beta weights and significance levels for each of the predictor variables when all of the demographic predictors were entered into the models. The final models used to develop normative data, however, retained only those predictors that significantly contributed to prediction of cognitive test score. The final models for Trailmaking A and B times and SDMT score all included age, years of education, WRAT-3 score, and African American status as predictors. For SDMT incidental recall, years of education was not a significant predictor but Hispanic status entered into the model. Supplemental Table 5b shows the beta weights (and significance of those betas), constants and standard error of estimates for the regression equations, and the overall R^2 for each final model, using each of the cognitive variables as outcomes. These values were used to derive Z scores, also shown in supplemental Table 5b.

Discussion

This is the first large scale study to describe demographic influences on two widely used measures of psychomotor speed and executive function among HIV-infected and HIV-uninfected women. Similar to prior studies, we found that demographic factors account for a large amount of variance in cognitive test performance. This work joins the growing number of studies that have found influences of ethnic group (Bohnstedt, Fox, & Kohatsu, 1994; Unverzagt, Hall, Torke, & Rediger, 1996; Mast, Fitzgerald, Steinberg, MacNeill, & Lichtenberg, 2001; Teresi, Albert, Holmes, & Mayeux, 1999; Fillenbaum, Hughes, Heyman, George, & Blazer, 1988; Escobar et al., 1986; Welsh et al., 1995; Kuller et al., 1998; Salmon et al., 1989; Overall & Levin, 1978; Adams, Boake, & Crain, 1982; Roberts & Hamsher, 1984; Welsh et al., 1995; Ross, Lichtenberg, & Christensen, 1995; Carlson, Brandt, Carson, & Kawas, 1998; Fillenbaum, Heyman, Huber, Ganguli, & Unverzagt, 2001; Manly et al., 1998a; Jacobs et al., 1997) and quality of education (Weiss et al., 1995; Manly et al., 1999; 1981; Lecours et al., 1987 Lecours et al., 1994; Ardila, Rosselli, & Rosas, 1989; Rosselli, Ardila, & Rosas, 1990; 1997) on cognitive test performance among ethnic minorities. The impact of cultural and educational background on neuropsychological test performance is an important consideration in the diagnosis of disease-related cognitive impairment, where it has been shown that ethnic minorities are more likely to be misdiagnosed as impaired in studies of HIV-related cognitive impairment (Rohit et al., 2007; Miller, Heaton, Kirson, & Grant, 1997; Manly et al., 1998c) and dementia (Manly et al., 1998a).

We found that the SDMT was sensitive to HIV-related differences after adjusting for demographic variables; this is significant since the SDMT and other measures of psychomotor speed are very sensitive to HIV-related cognitive impairment (Carey et al., 2004), are associated with poor cognitive outcomes and mortality among HIV infected individuals (Sacktor et al., 1996), and are sensitive to age-related differences among HIV-infected participants (Sacktor et al., 2007).

The results of this study suggest that assessment of cognition and determination of rates of cognitive impairment among HIV-infected and high-risk HIV-uninfected women requires appreciation of the relationships between cognitive test performance and factors such as racial/ethnic identification, educational experience, and age. Reading level, as an estimate of quality of education, had the strongest relationship to cognitive test scores, accounting for more variance in cognitive test score than HIV status, years of education, and in some cases, more than years of age. Although ethnic differences in test scores were not completely accounted for by measures of educational experience, adjustment for these factors did significantly reduce the effect size of race.

The current results regarding reading level are consistent with prior studies in other primarily male cohorts (Rohit et al., 2007; Ryan et al., 2005). The advantage of the current study over this prior work is the availability of a large, risk-factor-matched group of HIV-uninfected women in which to examine the relationships of demographic factors such as reading level to cognitive test performance in order to establish normative standards. One limitation of the current study is that unlike the National Neurological AIDS Bank study (Rohit et al., 2007), a physician-determined cognitive diagnosis independent of the neuropsychological evaluation was unavailable, and thus sensitivity and specificity of our measures could not be established.

Although there were very few neuropsychological measures administered in this introduction of cognitive measures to the WIHS project, these analyses highlight the clear need to correct for demographic variables when developing norms for cognitive impairment in HIV. The norms that were developed in this study will allow for comparisons across time and allow for evaluation of additional risks for cognitive impairment associated with other HIV-related conditions.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

Sample demographics and reading test scores

	HIV-		HIV+					
	mean	**SD**	**mean**	**SD**	**T, χ^2, or U**	**p**	**min**	**max**
N	511		1142					
Age	37.7	9.9	42.4	8.5	9.6	<.001	21	66
Years of education	12.3	3.0	11.9	3.0	2.3	.020	0	20
% White	9.4		13.0		4.5	.035		
% African American	62.6		63.3		0.1	NS		
% Hispanic	24.1		20.4		2.7	NS		
% “Other race”	3.9		3.3		0.4	NS		
WRAT reading*	43.6	7.7	43.8	8.0	0.1	NS	15	57

*The total N for analyses involving the WRAT is 495 HIV-uninfected and 1086 HIV-infected participants.

Table 2

Correlations between demographic variables and neuropsychological measures among HIV-negative women.

	Age	Years of education	WRAT	Trails A time	Trails A errors	Trails B time	Trails B errors	SDMT correct
Age	1							
Years of education	-0.12**	1						
WRAT-3 reading	-0.13**	0.37***	1					
Trails A time	0.20***	-0.21***	-0.22**	1				
Trails A errors	-0.02	-0.06	-0.06	0.17***	1			
Trails B time	0.27***	-0.29***	-0.41***	0.57***	0.05	1		
Trails B errors	0.16***	-0.17***	-0.28***	0.21***	0.15***	0.55***	1	
SDMT correct	-0.38***	0.33***	0.38***	-0.49***	-0.08	-0.56***	-0.28***	1
Incidental Recall	-0.31***	0.16***	0.19***	-0.21***	0.06	-0.31***	-0.17***	0.40***

Note.

* $p < .05$;

** $p < .01$;

*** $p < .001$

Trails A and B times and errors are log transformed for this analysis

Spearman's rho correlations are used for Trailmaking errors

Table 3

Relationship of background variables and neuropsychological test scores to race/ethnicity in HIV negative participants

	White		African American		Hispanic		Other race	
N	**48**		**320**		**123**		**20**	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Age [a]	36.0	9.2	38.8	10.2	36.4	9.6	34.0	6.8
Years education [b]	14.2	3.4	12.3***	2.8	11.5***	2.9	12.4	3.5
WRAT reading [c]	49.0	5.5	42.7***	7.4	43.8***	8.2	47.7	6.9
Trails A time [d]	3.4	0.3	3.6***	0.4	3.5*	0.4	3.4	0.4
Trails A errors	0.1	0.4	0.2	0.5	0.2	0.4	0.1	0.3
Trails B time [e]	4.1	0.4	4.4***	0.4	4.3**	0.4	4.2	0.4
Trails B errors [f]	0.2	0.5	1.0***	1.5	0.7**	1.2	0.5	0.7
Symbol Digit total [g]	52.2	13.4	43.4***	10.8	46.2**	11.4	48.9	7.9
Incidental learning [h]	6.2	2.5	4.4***	2.7	4.4**	2.8	4.9	2.6

Note: Trails A and B times were log transformed for this analysis. Significance is marked (* $p < .05$; ** $p < .01$; *** $p < .001$) when group mean differed from that of Whites using a Tukey's HSD post-hoc test with the exception of Trails A and B errors where follow-up Mann-Whitney U tests were conducted.

Table 4

Raw neuropsychological test score means and statistical comparisons by HIV status

	HIV-		HIV+		Without covariates		With covariates [b]	
	mean	**SD**	**mean**	**SD**	**F**	**Eta Sq**	**F**	**Eta Sq**
Trails A time [a]	37.3	15.7	40.6	19.2	11.8**	.008	2.6	.002
Trails B time [a]	86.0	40.7	93.0	45.6	8.2**	.005	1.4	.001
Symbol Digit total	45.1	11.4	41.5	12.3	26.9***	.017	8.8**	.006
Incidental recall	4.6	2.8	4.1	2.7	8.7**	.006	2.3	.002
					U		OR	CI
Trails A errors	0.2	0.5	0.2	0.6	289271.0		1.0	0.8 – 1.4
Trails B errors	0.8	1.4	0.9	1.7	272324.5		0.9	0.7 – 1.1

[a] Unadjusted means are displayed, but log transformed scores were used in the statistical comparisons

[b] Covariates were age, years of school, WRAT-3 reading score, and race/ethnicity

** $p < .01$;

*** $p < .001$