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Generalizability of demographically corrected Zambian neuropsychological norms to South African women

Christy A. Denckla^a, Georgina Spies^b, Robert Heaton^c, Jennifer Vasterling^d, Donald Franklin^c, Kristina J. Korte^e, Courtney Colgan^e, David C. Henderson^f, Karestan C. Koenen^a, Soraya Seedat^b

^aHarvard T. H. Chan School of Public Health, Boston, MA, USA;

^bNRF/DST South African Research Chairs Initiative, PTSD Program, Stellenbosch University, Cape Town, South Africa;

^cHIV Neurobehavioral Research Center at the University of California, La Jolla, CA, USA;

^dVA Boston Healthcare System, Boston University School of Medicine, Boston, MA, USA;

^eChester M. Pierce Division of Global Psychiatry, Massachusetts General Hospital, Harvard Medical School, Boston, MA, USA;

^fBoston Medical Center, Boston University, Boston, MA, USA

Abstract

Objective: Demographically corrected norms typically account for the effects of age, education, and in some cases, sex and other factors (e.g. race/ethnicity). However, generalizability of normative standards to different countries and ethnic groups is not universal. This study sought to determine whether demographically specific Zambian neuropsychological norms would generalize to a group of South African women.

Method: 212 English-Xhosa bilingual, South African (SA) women were administered a comprehensive neuropsychological (NP) test battery in either English or Xhosa. We examined rates of “impairment” using Global Deficit Scores (GDS) based upon published, demographically corrected norms from a nearby African country (Zambia). Using multiple regression, we examined the extent to which Zambian norms “corrected” for the effects of age and education in this SA sample.

Results: Compared to the normative standards from Zambia, the South African women performed somewhat worse than expected on a few test measures and better than expected on others, but their GDS and associated “impairment” rates were close to what was seen in Zambia. Demographically corrected Zambian norms adequately adjusted for the effects of age and years of education in this sample of SA women, with the exception that Zambian norms appeared to “under correct” for the positive effects of years of education on tests of information processing speed.

CONTACT Christy A. Denckla, cdenckla@hsph.harvard.edu, Harvard T. H. Chan School of Public Health, Boston, MA, USA.

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Conclusions: Demographically corrected norms developed for Zambia may adequately adjust for the effects of age in SA women. Further research is needed to determine whether additional corrections for education are needed in SA, especially for tests of information processing speed.

Keywords

Neuropsychological testing; age; education; women; South Africa

Neuropsychological (NP) test norms facilitate accurate judgment about whether observed test results fall within normal expectations by characterizing individuals' neurocognitive performance relative to healthy people with similar backgrounds and demographic characteristics (Heaton & Marcotte, 2000). Yet, the question of how to best characterize "similar backgrounds" can be complex and poses a significant challenge for contemporary neuropsychologists practicing in diverse populations that are characterized by a complex admixture of language, ethnicity, identity, educational exposure, migration, urbanization, and cultural background (Brickman, Cabo, & Manly, 2006; Manly, 2005; Suchy, 2016). Furthermore, both race (Manly & Echemendia, 2007) and language (Ardila, Roselli, & Puente, 1994) may be proxies for underlying mechanisms that have a more direct impact on health, such as unmeasured differences in education quality and access to lifestyle advantages such as healthy diet and exercise, as well as the composite indicators of socio-economic status that include household assets and financial resources (Kaufman, Cooper, & McGee, 1997; Phillipson, 1996; Williams, 1999).

Prior work has documented the effect of age and educational background on NP test performance in the cross-cultural context. Age is associated with NP performance across racial and cultural groups, but may disproportionately affect some groups over others (Heaton, Miller, Taylor, & Grant, 2004). For example, verbal learning performance tends to worsen with advancing age both among Caucasian samples (Weins, Tindall, & Crossen, 1994) and African American samples (Norman, Evans, Miller, & Heaton, 2000), but larger age effects have been observed for African Americans versus Caucasians on tests of both verbal and visual episodic memory, as well as tests of executive function and information processing speed (Norman et al., 2011). These findings suggest that the effect of racial and cultural group status is an important consideration in interpretation of age effects on NP performance.

Educational background also has been documented to explain significant amounts of variance on NP test scores, and cross-cultural work has shown that the *quality* of education versus the *level* of education can have a profound influence on NP test performance (Chin, Negash, Xie, Arnold, & Hamilton, 2012). A robust body of work has shown that increasing years of education are typically associated with more proficient performance (Ardila, Ostrosky-Solis, Rosselli, & Gómez, 2000; Byrd, Sanchez, & Manly, 2005; Humphreys et al., 2016). Yet, association between educational background and NP performance is firmly embedded in a cultural context because different cultures place different emphases on the acquisition of specific skills (Rosselli & Ardila, 2003). Also, cultural, linguistic, educational, and socio-economic backgrounds are closely linked, and may differentially affect NP test performance in complex ways even among different sites within countries, as was found in

South Africa (Robertson et. al, 2016). For example, though there are 11 official languages spoken in South Africa, many learners in South African public schools are not taught in their home language and instead receive instruction in English (Posel & Zeller, 2015). There is also a relative lack of teaching materials in indigenous African languages such as Xhosa, creating the potential for widely varying educational effects of NP performance in this population.

The South African education system is additionally characterized by a long history of unequal access to resources. The 1953 Bantu Education Act marked the beginning of apartheid education, creating separate schools for each of South Africa's racial groups, namely Whites, Blacks, Indians, and mixed European and African ancestry groups, with inequalities among the four schooling systems. This act segregated education, and disadvantaged most racial groups, but was particularly devastating for black Africans (Rusznayak, 2014). The Bantu education schools for black South Africans were grossly under-resourced, receiving one-tenth of the funds afforded to white education and struggling with 56:1 student-teacher ratios (Hartshorne, 1992). Even today, adverse conditions such as dilapidated buildings, overcrowded classrooms, inadequate instruction, and poor teacher training continue to exist. Although numerous curriculum changes have been instituted recently, resulting in some improvements in teaching and increases in pass rates, as well as access to advantaged educational possibilities for some, average knowledge and literacy levels remain low for many (Rusznayak, 2014). Together, this unique aspect of South Africa's educational history, and resulting educational conditions, suggest both differences compared to other countries in the region and within the country over time, as well as the need for further research on the effects of educational background on NP performance (Shuttleworth-Edwards et al., 2004).

A recent study conducted in Zambia evaluated the effects of gender, age, and educational background on NP test performance to develop demographically corrected norms (Hestad et al., 2016). The details of the Zambian educational context have been outlined in Hestad et al. (2016) and are briefly summarized here. Though English has been the primary language of instruction since the British colonial era, 10 major languages are spoken in Zambia and most people speak at least two local languages in addition to English. The educational system, like that in South Africa, suffers from a legacy of segregation and under-resourced schools, inadequate training and teacher compensation, and overcrowding. Even though both Zambia and South Africa have some similarities in institutional educational history, it is not clear that norms developed in one African country generalize to other countries, or even within regions (Van Wijk, 2013). For example, literacy rates in South Africa (92.88% in 2010) are higher than in Zambia (83.01%) (World Bank, 2010), potentially reflecting underlying differences between educational settings in these two countries. The question of generalizability of demographically-adjusted NP norms between different groups with varying educational backgrounds is an important one given the lack of adequately corrected norms to estimate impairment in settings where norms have not yet been calculated and the time and resource costs associated with conducting norming studies. Data assessing the generalizability of existing norms could substantially enhance clinical care and research, especially if adequate generalizability is identified.

The current study aimed to investigate the degree to which demographically corrected Zambian NP norms previously calculated (Hestad et al., 2016) generalized to a South African sample. We approached this question by (1) estimating the effects of age and years of education on NP performance in the South African sample, and (2) investigating the change in variance explained by age and years of education among the South African group when using Zambian adjusted T-scores, and (3) estimating the percent of the South African sample classified as “impaired” when using demo-graphically corrected Zambian norms following methods used previously (Heaton et al., 2004). Given the lack of prior research and the very different cultural context and education systems of Zambia and South Africa, we did not make hypotheses about generalizability of corrections on specific tests or ability domains.

Methods

Participants

Data for the current analyses were drawn from the demographic, clinical, and neuropsychological assessment results in a sample of HIV negative women. The participant sample in the present report included $N = 212$, HIV negative, black, South African women who speak Xhosa in the home and are English bilingual (assessed by self-report of English language fluency). Half completed NP tests in English ($n = 104$) and half in Xhosa ($n = 108$) (see Table 1). The language in which tests were administered to each participant reflected the exigencies of the larger health-related study. Specifically, testing was initially performed in English at the study start, and later conducted in Xhosa as translated instruments became available. In the later stages of the study, additional participants were tested in English to balance the sample. All participants had obtained a minimum 5th-grade education, assessed by self-report.

In addition to English language proficiency, inclusion criteria for participation in the study were being between the ages of 18 and 65 years, having the capacity to provide written consent, never having taken psychotropic medication (including anti-depressants), and being medically well enough to undergo psychological testing and magnetic resonance imaging scanning. Exclusion criteria consisted of (1) a medical or neurological condition such as traumatic brain injury or hepatitis positive status, as assessed by self-report, that could interfere with the ability to perform study evaluations and MR scanning (including pregnancy), (2) a history of schizophrenia, bipolar disorder or other psychotic disorder as assessed by the Mini-International Neuropsychiatric Interview-Plus (MINI; Sheehan et al., 1998), (3) current (12 months) history of substance or alcohol abuse or dependence assessed by clinical interview, and (4) demonstrated cognitive impairment on the International HIV Dementia Scale (IHDS) ($IHDS < 10$; Sacktor et al., 2005).

Procedure

The primary study was approved by the ethics committee of Stellenbosch University (ethics reference number: N07/07/153). Details regarding study procedures and sample characteristics have been previously reported (Spies, Fennema-Notestine, Cherner, & Seedat, 2017; Spies & Seedat, 2014). Participants were recruited through community health care

facilities in and around the Cape metropole of South Africa from 2008 to 2015 by a research assistant, research nurse, or with the help of a physician or counselor. Recruitment procedures did not differ between participants tested in either English or Xhosa. Participants who consented for participation in the study were screened for eligibility, either in person or by telephone. Those who met initial screening criteria came to the Department of Psychiatry at Stellenbosch University to undergo further assessment including: screening by a physician, completing a battery of self-report measures, a neuropsychiatric interview, collecting a blood sample, and completing a comprehensive series of neuropsychological tests that were originally developed in the US and have been widely used in HIV research in the US and inter-nationally (de Almeida et al., 2013; Gupta et al., 2011, 2014; Heaton, Clifford, & Franklin, 2008, 2010; Heaton, Ryan & Grant, 2009; Hestad et al., 2016; Kamat et al., 2012; Kanmogne et al., 2010). Demographic characteristics such as years of education and language spoken at home was assessed via self-report. English language proficiency was established by asking participants if they could speak English fluently. The neuropsychological test battery was administered by a trained research psychologist or research nurse. Tests were individually administered following a structured instruction manual to ensure consistency across all assessments. All participants were administered NP instruments in a private, quiet testing laboratory setting free of distraction. Participants were reimbursed a total of ZAR250/20\$USD for their transport costs to the University.

Measures

Neurocognitive Assessment—Neuropsychological (NP) functioning was assessed using a comprehensive battery consisting of 17 tests that cover seven cognitive domains: attention/working memory (Paced Auditory Serial Addition Test [PASAT; Gronwall, 1977] and the Wechsler Memory Scale-III Spatial Span task [Wechsler, 1997]); verbal episodic memory (Hopkins Verbal Learning Test, Revised [HVLTR; Benedict, Schretlen, Groninger, & Brandt, 1998]); visual episodic memory (Brief Visuospatial Memory Test, Revised [BVMTR; Benedict, Schretlen, Groninger, Dobraski, & Shpritz, 1996]); executive function (Wisconsin Card Sorting Test—Computer version [WCST; Heaton, 1999], Color Trails 2 [Mario et al., 1993], Halstead Category Test—computer version [Choca & Morris, 1992]); verbal fluency (Controlled Oral Word Association Test of phonemic fluency [letter/FAS, COWAT; Benton, Hamsher, & Sivan, 1994], Animal/Action Test of semantic fluency [Rosen, 1980]); information processing speed (Color Trails 1 [Mario et al., 1993], Stroop Color and Word naming speed [Golden, 1978], Wechsler Adult Intelligence Scale, Third Edition Digit-Symbol and Symbol Search subtests [WAIS-III; Wechsler, 1997], Trail Making Test—A [TMT-A; Reitan & Wolfson, 1985]); and fine motor functioning (Grooved Pegboard [Matthews & Klove, 1964]).

Test instructions and stimuli were translated into Xhosa using standard techniques (forward and backward translation) and adapted to fit the cultural context of South Africa. For example, specific modifications were made to the HVLTR to include replacing the precious stone (emerald, sapphire, opal and pearl) category with vegetables (bean, lettuce, potato and corn) because precious stones as named in the HVLTR are unfamiliar in the South African context. Also, for verbal fluency tests, the letters “F”, “A”, and “S” were replaced by “T”, “B”, and “S” for Xhosa speakers. Replacement letters were selected by rank ordering

frequency of words in both an English and a Xhosa dictionary, and selecting words in Xhosa with a similar rank order to that of the English words that began with the letters “F”, “A”, and “S”. Similar NP test adaptation procedures have also been used in other African contexts (Kitsao-Wekulo, Holding, Taylor, Abubakar, & Connolly, 2013).

Analytic approach—First, we confirmed that there were no missing data on any of the NP test variables and then compared raw NP test scores across the English and Xhosa language groups. To evaluate whether demographic effects were significantly reduced or fully eliminated when using the Zambian norms, and to estimate whether the rates of impairment classifications when using *T*-scores with Zambian demographic corrections was acceptable, we first converted raw NP test scores to demographically corrected *T*-scores based on published Zambian norms (Hestad et al., 2016). We then examined the percentages of variance in the raw versus Zambian *T*-scores that can be accounted for by the basic demographic variables of age and years of education. Finally, to estimate the percent of the South African sample that would be classified as “impaired” we computed Deficit Scores (DS). These scores were based on the demographically corrected *T*-scores calculated for a sample of Zambian adults (Hestad et al., 2016) and computed following procedures described previously (Carey et al., 2004; Heaton et al., 2004). To briefly restate the calculation procedures here, each NP test *T*-score was converted to a deficit score (DS) ranging from 0 to 5: DS 0, *T* = 40, “normal”; DS 1, *T* = 35–39, “mild impairment”; DS 2, *T* = 30–34, “mild to moderate”; DS 3, *T* = 25–29, “moderate”; DS 4, *T* = 20–24, “moderate to severe”; DS 5, *T* < 20, “severe.” The GDS is the average of all deficit scores, and reflects the number and severity of deficits on the total NP battery. The Domain Deficit Score (DDS) is the average DS within a neurocognitive domain. The standard cutoff for GDS to classify individual participants’ NP impairment is 0.50 (Carey et al., 2004; Heaton et al., 2004).

Results

The average age of the 212 participants was 28.85 (SD = 8.97, range 18–54). The majority of the sample (89.2%) reported their average combined annual household income was very low in an absolute sense (<R20,000/781USD annually), and far below the South African 2017 average household net-adjusted disposable income of 10,872USD (OECD, 2017). About one-fifth of the participants (20.3%) reported that they were the primary breadwinner in the household. All participants reported that Xhosa was the primary language they spoke at home, and all participants reported black ethnicity. Among this sample of women, 9.4% reported less than 10 years of education, 82.1% had 10–12 years of education, and 8.0% had a diploma or greater level of education. Marital status consisted of 71.7% self-described as single, 24.5% married, 1.9% living with their partner, and 1.9% as separated. Finally, the average number of children was 1.29 (SD = 1.31).

First, we explored between group differences in raw NP test performance scores by estimating marginal mean differences between English and Xhosa groups, controlling for years of education, marital status, and average number of children given that there were significant between group differences among the English and the Xhosa test groups in years of education, marital status, and average number of children. Results are reported in Table 1. Significant between group differences in the performance on individual tests of verbal

fluency (Action fluency, $\eta^2 = .10$), executive function (Category test, $\eta^2 = .03$), and working memory (PASAT 50, $\eta^2 = .07$) were identified, but the direction of these differences varied. The English group performed more proficiently on the Category Test, but the Xhosa group performed more proficiently on Action Fluency and PASAT 50. All other domains, including visual episodic memory, motor function, and information processing speed, showed no significant differences between groups.

Given that there were few significant differences in NP test performance between the two language groups and the lack of consistent pattern, we opted to combine the two language groups in subsequent analyses to increase our power, and results are summarized in Table 2. Generally, we found that using Zambian corrected norms among this sample of South African women adequately detected expected base rates of impairment (GDS mean = 0.32 [SD = 0.35]) such that the standard GDS cutoff of 0.50 occurred in 17.9% of women in the South African sample; this compares to 15.6% expected for a 1 SD cutoff, which the standard GDS cutoff is intended to match (Heaton et al., 2004). Mean Domain Deficit Scores (DDS) are also reported in Table 2; taking into consideration that domains have fewer tests scores, the DDS cutoff for domain impairment is > 0.50. The percentage of the sample classified as impaired varied by domain: verbal fluency (27.4%), executive function (18.4%), information processing speed (22.2%) and working memory (24.1%) exceeded the 15.6% expected for a 1 SD cutoff, whereas verbal and visual learning (14.2%), verbal and visual recall (11.3%), and especially fine motor function (2.8%) were below the 15.6% cutoff.

We next conducted several simultaneous multiple regressions with age and years of education predicting NP test performance among South African women using Zambian norm-adjusted *T*-scores (Table 3). Generally, we found that across all tests, use of Zambian norms adequately corrected for the effects of age. We also found a similar pattern for years of education, except that most tests in the information processing speed domain, as well as the WCST-64 test, continued to be significantly influenced by years of education, even after applying Zambian demographic corrections. Although the effect of years of education was reduced when using Zambian norms, years of education continued to be significantly and positively associated with the *T*-scores on some tests. In other words, Zambian norms tended to “under correct” for the effect of years of education in this South African sample in some tests. The final column of Table 3 displays the difference in percent variance explained by age and years of education effects when using raw scores vs. Zambian demographically corrected scores.

Discussion

A substantial body of work has investigated the effects of age, educational back-ground, and race on neuropsychological (NP) test performance, and additional studies have been conducted to understand the influences of socioeconomic disadvantage and negative stereotypes (McKay, Doverspike, Bowen-Hilton, & McKay, 2003), multilingualism (Ardila, Rosselli, et al., 2000; Flores et al., 2017), and resource attainment (Ostrosky-Solis, Canseco, Quintanar, Meneses, & Ardila, 1985) on neurocognitive functioning. South Africa has a history of neuropsychological research and assessment focused on the application of cross-

cultural norms (Suchy, 2016), yet gaps still exist due to the many challenges associated with developing clinically useful norms for the complex cultural/racial/ethnic admixture of groups in this country (Nell, 1994; Watts, 2008; Watts & Shuttleworth-Edwards, 2016). Given the cost and resources necessary to develop norms, determining the generalizability of norms developed elsewhere could have a significant clinical impact. This is particularly true for the battery of tests we have examined here, because this battery is widely used for its sensitivity to neuroAIDS across multiple international contexts, and Sub-Saharan Africa continues to be especially burdened by the HIV/AIDS epidemic. Our primary aim therefore was to investigate how well demographically corrected Zambian norms functioned in this SA sample.

We found that demographically corrected Zambian norms demonstrated acceptable rates of classification of “impairment” in this SA sample. Expected performance would ideally classify about 15.6% of a healthy population as “impaired,” consistent with use of a one standard deviation cutoff. In the current study, we found the standard GDS cutoff of .50 classified “impairment” in 17.9% of the women in our South African sample, which is only slightly higher than the 14% reported for the Zambian normative sample (Hestad et al., 2016). GDS were similar for South African women tested in either English or Xhosa, with no significant differences between the two groups.

However, when examining the effect of using Zambian *T*-scores to adjust for demographic characteristics, we found a mixed pattern. First, the effects of age on NP test performance were eliminated among the SA women when applying the Zambian norms. Second, although the use of Zambian norms reduced the effect of years of education on NP test performance among SA women, significant effects of years of education persisted, primarily on NP tests of information processing speed. This is consistent with findings among a different sample of Xhosa-speaking South Africans (Andrews, Shuttleworth-Edwards, & Radloff, 2012), suggesting that additional differences in educational background in this highly heterogeneous area may reduce generalizability between settings.

Taken together, the pattern of findings regarding the persisting effects of years of education among SA women, even when applying corrected Zambian norms, could reflect educational differences between the Zambian and South African groups. Although average numbers of education years completed were similar for the Zambian and South African samples (approximately 11 years), there could be unmeasured, qualitative education differences that may explain greater education effects among South African women. Modest differences in base impairment rates between the South African and Zambian groups could also reflect other background differences between the two groups not measured in the current study. Finally, differences between the two groups might also be explained by lower literacy rates in this specific South African sample of women (even with commensurate years of schooling compared to the Zambian sample). Given that South Africa on average reports higher literacy rates (92.88% of all people 15 years or older) compared to Zambia (83.01%) (World Bank, 2010), the implication is that the specific sample of SA women considered in the present report could represent a sub-population with less access to education relative to other South Africans. Adjustments based upon measured literacy are available for the “fully corrected” Zambian norms. Unfortunately, however, we did not measure academic

achievement and therefore were unable to adjust for literacy or other indicators of academic achievement. It could be that if we had been able to adjust for such indicators of qualitative education effects, generalizability of the fully-corrected Zambian norms may have been different.

A second unexpected pattern of findings included lower base rates of “impairment” and consistently higher performance in the SA sample on the test of complex motor function (Grooved Pegboard). It could be that minor practice differences in test administration would explain improved performance in the South African sample, though test administrators were closely supervised and trained not to offer additional assistance or modify test administration procedures. These differences could amount to variability in background characteristics, such as work history, of the South African and Zambian samples. For example, amongst South African communities of similar socio-economic status to the one considered in the present study, employment in the textile industry is quite common. Alternatively, higher motor function in the South African sample could reflect sex differences given that the South African sample was composed entirely of women, whereas the Zambian study included both sexes. This is consistent with prior work demonstrating that grooved pegboard performance is influenced by sex, which has also been reported for a South African sample (Schmidt, Oliveira, Rocha, & Abreu-Villaca, 2000; Van Wijk & Meintjes, 2015). Finally, it may be that differences between South African and Zambian educational systems can explain these patterns if there is variable focus on motor skills between educational settings.

The current study adds to the existing cross-cultural neuropsychological literature in the South African setting exploring the use of population-based norms among diverse racial/ethnic/cultural groups (Suchy, 2016), and is consistent with prior work suggesting that educational background warrants further consideration (Shuttleworth-Edwards et al., 2004). Education effects especially may be a proxy for underlying differences in SES, access to educational resources, ethnic identity, and language background (Manly & Echemendia, 2007), all of which widely vary in the South African setting. Our findings underscore caution against uncritical use of comparative data from other developing countries on the African continent (Van Wijk, 2013) and additionally point to the importance of investigating the effects of educational background (quality as well as number of years completed) on performance between cross-cultural groups.

Several limitations should be considered when interpreting the findings of this study. Most importantly, education was assessed by years of schooling, and does not reflect the quality of educational experiences, especially in an educational setting such as South Africa where wide disparities exist in educational structures. Furthermore, self-reported education may not correspond reliably to true educational attainment (O’Bryant et al., 2007). Other studies have found that when reading level is formally assessed, it is possible to explain variability in NP performance beyond effects of years of education (Manly, Jacobs, Touradji, Small, & Stern, 2002; Hestad et al., 2016). However, we were unable to test this potential association in this study due to a lack of measured variables. Even though we found that self-reported level of education (number of years completed) was significantly associated with NP performance on most tests, we could not control for quality of education in our analyses. Future studies should incorporate a test of educational attainment, such as the Zambia

Achievement Test (ZAT), a formal English reading test developed for use in Zambia (Stemler et al., 2009). Relatedly, English language proficiency was also assessed via self-report, and therefore we did not have measures of performance-based proficiency. Also, our sample consisted only of women; therefore, we have no way of comparing gender effects or assessing if the findings we note equally apply to men, or to any of the other widely diverse socioeconomic and sociocultural groups in South Africa. A further limitation is that women were not randomly assigned to language testing group; however, given the relative lack of differences between language testing groups in NP test performance, the present data do not suggest that this lack of random assignment introduced systematic bias. Finally, there are additional potential confounds that we did not measure, such as lifetime trauma exposure, that could influence NP test performance. Although participant exclusion criteria included screening for schizophrenia, bipolar disorder, and affective disorders, posttraumatic stress disorder (PTSD) was not an exclusion criterion. PTSD is a significant factor in South African communities and can significantly influence neuropsychological test performance (Scott et al., 2015); future studies should consider this potentially confounding variable. Additionally, some tests used in this battery have been shown to raise anxiety levels among some examinees, and assessment of subjective anxiety state test such as the State-Trait Anxiety Inventory (STAI; Spielberger, Gorsuch, and Lushene) would have allowed us to investigate anxiety effects, especially among samples with lower education levels such as that considered in the present report (Leininger & Skeel, 2012).

In summary, our findings contribute to the current evidence base on background effects of NP test performance in multicultural and multilingual settings. With the increase in global mobility, urban populations increasingly reflect greater ethnic, linguistic, and cultural diversity, and contemporary neuropsychologists practicing in both domestic and international settings are confronted with serious challenges in identifying and classifying neurocognitive impairments. Considering the effects of age, educational setting, ethnicity, and culture will remain important in the development of normative standards. For example, even though this study found few differences in specific NP test performance between SA language groups, future research might investigate differential performance between separate language groups in NP tests such as Action Fluency, Category Test, and PASAT 50. Yet, best practices may go further, consistent with the 2017 American Psychological Association Task Force on Re-envisioning the Multicultural Guidelines for the twenty-first century (American Psychological Association [APA], 2017), by considering the potential effects of other factors such as quality of education and educational background, even among ethnically and culturally similar groups, on NP test performance.

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Table 1.

Estimated marginal mean differences in raw neuropsychological test scores (M, SD) between English and Xhosa speaking South African women, controlling for years of education, marital status, and number of children ($N=212$).

	Marginal means (<i>std. error</i>)		
Neuropsychological test	Xhosa (<i>n</i> = 108)	English (<i>n</i> = 104)	<i>F</i> (df) (<i>p</i> -value)
Verbal fluency			
Letter fluency	26.38 (.86)	24.82 (.88)	1.51 (1, 207) (.22)
Animal fluency	13.06 (.27)	12.29 (.28)	3.65 (1, 207) (.06)
Action fluency	11.52 (.32)	9.26 (.32)	23.37 (1,207) (.00)***
Executive functions			
Category Test	83.98 (2.32)	75.89 (2.37)	5.61 (1, 207) (.02)*
WCST-64	28.24 (1.06)	28.10 (1.08)	.01 (1, 207) (.93)
Color Trails 2	115.29 (4.17)	120.13 (4.25)	.62 (1, 207) (.43)
Stroop-CW	31.87 (.90)	30.65 (.91)	.84 (1, 207) (.36)
Information processing speed			
TMT-A	51.65 (2.29)	50.37 (2.33)	.15 (1, 207) (.70)
WAIS-III DS	52.55 (1.16)	52.29 (1.18)	.02 (1, 207) (.88)
WAIS-III SS	19.03 (.70)	19.87 (.71)	.66 (1, 207) (.42)
Stroop Word	75.69 (1.65)	76.55 (1.67)	.13 (1, 207) (.72)
Stroop Color	55.16 (1.17)	52.05 (1.19)	3.29 (1, 207) (.07)
Color Trails 1	57.21 (2.47)	52.03 (2.52)	2.03 (1, 207) (.16)
Verbal episodic memory			
HVLT-R, L	22.60 (.41)	22.85 (.41)	.18 (1,207) (.68)
HVLT-R, DR	7.79 (.21)	8.35 (.21)	3.47 (1, 207) (.06)
Visual episodic memory			
BVMT-R, L	19.88 (.74)	18.27 (.75)	2.37 (1,207) (.13)
BVMT-R, DR	8.05 (.31)	7.57 (.32)	1.13 (1,207) (.29)
Working memory			
PASAT 50	25.00 (1.00)	19.44 (1.02)	14.39 (1, 207) (.00)***
WMS-III Spatial Span	12.09 (.29)	11.55 (.30)	1.54 (1,207) (.22)
Motor Function			
Pegboard DH	69.19 (1.59)	68.86 (1.60)	.00 (1, 207) (.96)
Pegboard NDH	76.98 (1.93)	75.73 (1.20)	.19 (1, 207) (.66)

Note: WCST = Wisconsin Card Sorting Test; Stroop-CW = Stroop Color-Word Incongruence; TMT-A = Trail Making Test, Version A; WAIS-III DS = WAIS-III Digit Symbol; WAIS-III S-S = WAIS-III Symbol Search; HVLT-R, L = Hopkins Verbal Learning Test, Revised, Learning; HVLT-R, DR = Hopkins Verbal Learning Test, Revised, Delayed Recall; BVMT-R, L = Brief Visuospatial Memory Test, Revised, Learning; BVMT-R, DR = Brief Visuospatial Memory Test, Revised, Delayed Recall; PASAT = Paced Auditory Serial Addition Task; WMS-III S-Span = WMS-III Spatial Span; Pegboard DH = Grooved Pegboard Dominant Hand; Pegboard NDH = Grooved Pegboard Non-Dominant Hand.

* $p < .05$,

** $p < 0.1$,

*** $p < .001$.

Table 2.

Xhosa-speaking South African healthy adults' ($N=212$) neuropsychological test T-scores, Domain Deficit scores, percentage classified as "impaired," and basic demographic effects in raw vs. Zambian norms using demographically corrected Zambian norms (T-score < 40, DDS > 0.50).

Neuropsychological Test	Zambian T-Score, M (Std. Err)	% Impaired by Zambian Norms	Domain Deficit scores (DDS), M (Std. Err)	% Impaired by DDS
Verbal fluency			0.47 (.05)	27.4
Letter fluency	43.90 (.80)	33.5		
Animal fluency	50.42 (.63)	10.4		
Action fluency	45.12 (.70)	31.1		
Executive functions			0.24 (.03)	18.4
Category Test	45.66 (.55)	20.3		
WCST-64	63.01 (.82)	18.9		
Color Trails 2	52.08 (.65)	11.3		
Stroop-CW	48.75 (.75)	18.5		
Information processing speed			0.33 (.04)	22.2
TMT-A	51.42 (.72)	11.8		
WAIS-III DS	47.71 (.57)	14.6		
WAIS-III SS	46.98 (.73)	22.6		
Stroop Word	49.45 (.82)	19.0		
Stroop Color	44.27 (.79)	30.3		
Color Trails 1	54.67 (.72)	8.0		
Verbal episodic memory				
HVLTL-R, L	49.88 (.69)	13.2	0.28 (.04) ^a	14.2
HVLTL-R, DR	51.56 (.70)	11.3		11.3
Visual episodic memory				
BVMT-R, L	47.96 (.69)	17.9		
BVMT-R, DR	48.77 (.74)	19.8	0.27 (.04) ^b	
Working memory			0.46 (.06)	24.1
PASAT 50	49.04 (.89)	17.0		
WMS-III Spatial Span	47.00 (.69)	22.2		
Motor function			0.06 (.02)	2.8
Peg board DH	57.51 (.63)	3.3		
Pegboard NDH	58.77 (.71)	3.3		

Note: WCST = Wisconsin Card Sorting Test; Stroop-CW = Stroop Color-Word Incongruence; TMT-A = Trail Making Test, Version A; WAIS-III DS = WAIS-III Digit Symbol; WAIS-III S-S = WAIS-III Symbol Search; HVLTL-R, L = Hopkins Verbal Learning Test, Revised, Learning; HVLTL-R, DR = Hopkins Verbal Learning Test, Revised, Delayed Recall; BVMT-R, L = Brief Visuospatial Memory Test, Revised, Learning; BVMT-R, DR = Brief Visuospatial Memory Test, Revised, Delayed Recall; PASAT = Paced Auditory Serial Addition Task; WMS-III S-Span = WMS-III Spatial Span; Pegboard DH = Grooved Pegboard Dominant Hand; Pegboard NDH = Grooved Pegboard Non-Dominant Hand. Percent impaired for Zambian norms for each test is based on T-score cutoff of <40. Percent impaired for Zambian norms by domain is based on Domain Deficit Score cutoff of > 0.50.

^a domain deficit score for verbal and visual learning,

^b domain deficit score for verbal and visual delayed recall.

*
 $p < .05$,

**
 $p < 0.1$,

 $p < .001$.

Table 3.

Simultaneous multiple regression with age and years of education predicting NP test performance among South African Women using Zambian norm-adjusted T-scores (N = 212).

Neuropsychological Test demographic effects: Raw/Zambian norms	Variable	<i>B</i>	Std. Er. <i>B</i>	Std. β	<i>t</i>	95% C.I.	<i>R</i> ²	Basic
Verbal fluency								
Letter fluency	Age	.05	.09	.04	.51	-.13, .22		
	Education	-.06	.56	-.01	-.01	-1.16, 1.05	.00	.04 [*] /.00
Animal fluency	Age	-.02	.07	-.02	-.28	-.16, .12		
	Education	-.60	.44	-.09	-1.37	-1.46, .26	.00	.05 ^{**} /.00
Action fluency	Age	.01	.08	.01	.12	-.15, .16		
	Education	.02	.49	.00	.04	-.94, .98	.00	.06 ^{**} 7.00
Executive functions								
Category Test	Age	-.08	.06	-.09	-1.32	-.20, .04		
	Education	.66	.38	.12	1.74	-.09, 1.42	.02	.14 ^{***} /.02
WCST-64	Age	.03	.08	.03	.38	-.12, .18		
	Education	1.64	.48	.23	3.47 ^{**}	.71, 2.58	.06 ^{**}	.02/.06 ^{**}
Color Trails 2	Age	-.09	.07	-.09	-1.34	-.24, .05		
	Education	.83	.45	.13	1.86	-.05, 1.71	.03	.12 ^{***} /.03
Stroop-CW	Age	-.12	.08	-.10	-1.48	-.29, .04		
	Education	.42	.52	.06	.79	-.62, 1.45	.01	.06 ^{**} /.01
Information processing speed								
TMT-A	Age	-.03	.08	-.02	-.32	-.18, .13		
	Education	1.41	.50	.19	2.84	.43, 2.39	.04 [*]	.20 ^{***} /.04 [*]
WAIS-III DS	Age	-.12	.06	-.13	-1.97	-.24, .00		
	Education	1.71	.38	.30	4.56 ^{***}	.97, 2.45	.11 ^{***}	.42 ^{***} /.11 ^{***}
WAIS-III SS	Age	-.06	.08	-.05	-.77	-.22, .10		
	Education	1.91	.50	.26	3.85 ^{***}	.93, 2.89	.07 ^{**}	.23 ^{***} /.07 ^{**}
Stroop Word	Age	-.13	.09	-.10	-.49	-.31, .04		
	Education	1.96	.56	.24	3.54 ^{***}	.87, 3.06	.07 ^{**}	.16 ^{***} /.07 ^{**}
Stroop Color	Age	-.06	.09	-.05	-.73	-.23, .11		
	Education	2.01	.53	.26	3.91 ^{***}	1.03, 3.12	.07 ^{***}	.13 ^{***} /.07 ^{***}
Color Trails 1	Age	-.14	.08	-.12	-1.72	-.29, .02		
	Education	1.08	.49	.15	2.19 [*]	.11, 2.05	.04 [*]	.15 ^{***} /.04 [*]
Verbal episodic memory								
HVLT-R, L	Age	.01	.08	.01	.18	-.14, .17		
	Education	-.05	.48	-.01	-.10	-1.0, .91	.00	.06 ^{**} /.00
HVLT-R, DR	Age	-.11	.08	-.10	-1.45	-.27, .04		
	Education	.46	.49	.07	.94	-.51, 1.43	.01	.10 ^{***} /.01
Visual episodic memory								

Neuropsychological Test demographic effects: Raw/Zambian norms	Variable	<i>B</i>	Std. Er. <i>B</i>	Std. β	<i>t</i>	95% C.I.	<i>R</i> ²	Basic
BVMT-R, L	Age	.01	.08	.01	.09	-.15, .16		
	Education	.39	.49	.06	.80	-.57, 1.35	.00	.13***/.00
BVMT-R, DR	Age	-.06	.08	-.05	-.68	-.22, .11		
	Education	.22	.51	.03	.42	-.80, 1.23	.00	.10***/.00
Working memory								
PASAT 50	Age	-.07	.10	-.05	-.75	-.27, .12		
	Education	-.84	.62	-.09	-1.37	-2.06, .37	.01	.03/.01
WMS-III Spatial Span	Age	-.11	.08	-.10	-1.46	-.26, .04		
	Education	.70	.48	.10	1.48	-.24, 1.65	.02	.08***/.02
Motor function								
Pegboard DH	Age	-.12	.07	-.12	-1.69	-.26, .02		
	Education	.62	.44	.10	1.41	-.25, 1.48	.02	.15***/.02
Pegboard NDH	Age	-.05	.08	-.04	-.57	-.20, .11		
	Education	-.06	.50	-.01	-.11	-1.04, .93	.00	.06**/.00

Note; WCST = Wisconsin Card Sorting Test; Stroop-CW Stroop Color-Word Incongruence; TMT-A = Trail Making Test, Version WAIS-III DS = WAIS-III Digit Symbol; WAIS-III S-S = WAIS-III Symbol Search; HVL-R, L = Hopkins Verbal Learning Test, Revised, Learning; HVL-R, DR = Hopkins Verbal Learning Test, Revised, Delayed Recall; BVMT-R, L = Brief Visuospatial Memory Test, Revised, Learning; BVMT-R, DR = Brief Visuospatial Memory Test, Revised, Delayed Recall; PASAT = Paced Auditory Serial Addition Task; WMS-III S-Span = WMS-III Spatial Span; Pegboard DH = Grooved Pegboard Dominant Hand; Pegboard NDH = Grooved Pegboard Non-Dominant Hand. Basic Demographic effects represented by percentages of variance in the raw vs. Zambian *T*-scores that can be accounted for by the basic demographic effects of age and education.

*
 $p < .05$,

**
 $p < .01$,

 $p < .001$.