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Performance by South African Adults on Semantic Fluency Tests:
Effects of home language, educational attainment, and HIV infection

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Abstract

Research emerging from the global north suggests that semantic fluency test performance (a) is influenced by level of educational attainment and by the language in which the test is administered, and (b) discriminates reliably between HIV-infected individuals and healthy controls. Given that the South African population is marked by wide disparities in educational attainment, that the country has 11 official languages, and that it houses the world's largest number of HIV-infected individuals, local research on the use of semantic fluency tests is imperative. The current investigation sought to meet this imperative. Study 1 ($N = 114$) assessed semantic fluency performance in two groups of healthy adults (those administered tests in English ($n = 54$), and those administered tests in Xhosa ($n = 60$)). Independent-sample t -tests detected no significant between-group differences. Hierarchical regression analyses indicated that education was a significant predictor of performance on both animal and fruit-and-vegetable category tests, and that sex was a significant (but weaker) predictor of performance on the fruit-and-vegetable test. Based on these findings, we used regression-based techniques to produce preliminary normative data, stratified by the appropriate demographic variables, for South African adults on semantic fluency tests. Study 2 investigated whether performance on these tests discriminated between HIV-infected individuals ($n = 102$) and healthy matched controls (the Study 1 sample, $n = 114$). Independent-sample t -tests detected no significant between-group differences. Together, these results suggest that, in South African adults, (a) educational attainment, but not language of administration, affects semantic fluency performance, and (b) semantic fluency tests do not discriminate HIV-infected individuals from healthy controls. The first result is consistent with those from in previous research conducted in the global North, and highlights the importance of considering educational level as a factor influencing semantic fluency scores. This factor is particularly relevant in South Africa, where educational levels vary substantially across age cohorts and regions. The data also indicate that semantic fluency tests should not be included in batteries seeking to detect the presence of HIV-related cognitive impairment in South Africa adults. Given the high rates of infection in the country, this result is of great practical significance.

Keywords: education; HIV; normative data; semantic fluency; South Africa; HIV-associated neurocognitive impairment.

Performance by South African Adults on Semantic Fluency Tests:
Effects of home language, educational attainment, and HIV infection

Since their development and introduction into literature more than 70 years ago, verbal fluency tests have become one of the most important forms of cognitive assessment within both clinical neuropsychological practice and experimental neuropsychological research (Rosselli et al., 2002). These tests include those measuring semantic (or category) fluency (e.g., the number of animals, fruits and vegetables, or girls' names the test-taker can name within a given time limit) and action fluency (i.e., the number of verbs the test-taker can name within a given time limit; Strauss, Sherman, & Spreen, 2006).

Poor performance on verbal fluency tests can be attributed to either disease-related (i.e., HIV, Alzheimer's, or Parkinson's) or non-disease-related factors. Because of the former, these tests are used frequently in the assessment of neurodegeneration associated with, for instance, Alzheimer's pathology or HIV infection (Shao, Janse, Visser, & Meyer, 2014; Snitz et al., 2009). It is only relatively recently, however, that the psychological literature has begun to examine whether performance differences on verbal fluency tests might be attributable to non-disease-related factors (e.g., age, sex, education, or language of test administration)).

The balance of impairment attributable to disease-related versus non-disease-related factors might vary from person to person, and hence it is imperative for research to distinguish clearly (a) the roles of each of those factors in performance, and (b) which non-disease-related factors might play particular roles in the performance of specific individuals. The current study used South African samples to (a) examine the influence of four non-disease-related factors (age, sex, educational attainment, and language of test administration) on semantic fluency performance, (b) generate locally appropriate normative data for semantic fluency tests, and (c) examine the influence of a disease-related factor, HIV infection, semantic fluency test performance.

Non-disease-related Influences on Semantic Fluency Performance

A relatively consistent finding in this literature is that age is significantly negatively associated, and level of educational attainment is significantly positively associated, with performance on semantic fluency tests (see, e.g., Brickman et al., 2005; Esteves et al., 2015; Fichman et al., 2009; Strauss et al., 2006; Troyer, 2000). For instance, in a large normative study ($N = 1300$) using cognitively intact individuals aged 16-95 years with 0-21 years of education, Tombaugh, Kozak, and Rees (1999) showed that both age (23.4%) and education

(13.6%) accounted for a significant proportion of the variance in number of words generated to the category cue of animals. Similarly, Crossley, D'Arcy, and Rawson (1997) reported that older adults (aged 65 years and older) who had completed 13 or more years of formal education generated more than double the amount of words compared to those who had completed 6 or fewer years. More recently, Zimmermann, Parente, Joannette & Fonseca (2014) found, using a Brazilian sample of healthy individuals aged 19-75 years, that (a) older adults (60-75 years) performed more poorly than middle-aged (40-59) and young adults (19-39), (b) those with higher levels of education (7 years or more) performed better than those with lower levels (2-6 years), and (c) there was an age x education interaction suggesting that, among older adults, level of education was less predictive of performance than among younger adults.

The effects of biological sex on semantic fluency performance are not as clear-cut, however. In the Tombaugh et al. (1999) normative study, there were sex differences in overall semantic fluency performance, but the variable contributed a small amount (1%) to variance in outcomes. More recently, Esteves et al. (2015) found, using a Brazilian sample ($N = 265$) of adults older than 60 years, no effect of sex on animal category fluency.

Regarding language of test administration, knowing the language history of the test-taker is crucial to understanding variations in performance on cognitive tasks, including verbal fluency tests (Soh, 2014; Whiteside et al., 2015). Although the test-taker's language history is of obvious importance in all assessment contexts and for all neuropsychologists, most of the literature on this topic has emerged from the global north. Specifically, due to the rapidly increasing Spanish-speaking population in the United States, a large literature has developed around neuropsychological assessment of Latino individuals in the United States because of the need for such assessment to be structured appropriately for these individuals (see, e.g., Rosselli et al., 2000; Mack et al., 2005).

There is a relative paucity of literature on the effects of language of test administration in African clinical contexts. More such studies are needed because, across the continent, most individuals are, at least, bilingual, and many are multilingual (Ansaldi, Marcotte, Scherer, & Raboyeau, 2008; Foxcroft, 2011). South Africa has 11 official languages, and according to the South African Schools Act 84 of 1996, all primary and high school students must have formal classes in at least two of those. Hence, most citizens of the country are at least partially multilingual (Government of the Republic of South Africa, 1996).

Code switching is a common phenomenon appearing in those familiar with more than one language. This term refers to an instance of when a speaker alternates between two or more languages within a single conversation. The frequency with which people code switch depends on their proficiency in both the imminent language and the one in which they switch to (Rodriguez-Fornells, Krämer, Lorenzo-Seva, Festman, & Münte, 2012). Although the ability to code switch is associated with mature executive control processes (Yim & Bialystok, 2012), it is sometimes seen in children or in individuals with a limited vocabulary in the imminent language (i.e., those without a fully-fledged lexicon in one language might switch to a different language in order to describe a concept; Genesee, Crago, & Paradis, 2004; Grosjean, 1982).

Those who code switch in the course of ordinary conversation tend to do so with equal frequency during administration of verbal fluency tasks (Rodriguez-Fornells et al., 2012). For instance, Yim and Bialystok (2012) demonstrated that participants ($N = 78$ English-Cantonese speakers) who employed more code-switching during a semi-structured conversation switched between languages more swiftly on a semantic fluency task than those who did not.

Another key language-related problem for cross-cultural neuropsychologists is whether participants deliver better performance if tested in their home language or in the language in which they received most of their education (Kempler et al., 1998; Ardila et al., 2000; Soh, 2014). A South African study assessing reading literacy performance of Grade 4 students showed that students who were administered the test in their home language (e.g., Sesotho, Zulu, Xhosa) achieved lower scores than those who were administered the test in their medium of academic instruction (e.g., English or Afrikaans; Van Staden, Bosker, & Bergbauer, 2016). There are no published studies examining this question with regard to semantic fluency performance, however.

A Disease-related Influence on Semantic Fluency Performance: HIV infection

Semantic fluency tests are often a core component of HIV neuropsychology batteries (Robertson, Liner, & Heaton, 2009; Heaton et al., 2011; Sacktor et al., 2009, 2013), primarily because performance on these tests has, in many previous studies, distinguished HIV-infected from HIV-negative samples (see, e.g., Iudicello, Woods, Parsons, Moran, Carey, & Grant, 2012; Millikin, Trépanier, & Rourke, 2004). For instance, Iudicello, Woods, Deutsch, Grant & HNRG Group (2012), in a US-based study, reported that HIV-infected older adults (age ≥ 50 years) performed more poorly than HIV-infected younger adults (age < 40 years) and than HIV-negative adults of all ages. In contrast, a Master's thesis by van Wyk (2014) reported no

significant differences in performance between HIV-infected and HIV-negative South African participants. This latter study remains unpublished, however, and the finding has yet to be replicated despite the fact that the long-lasting effects of the HIV pandemic mean South African clinical psychologists and neuropsychologists must be particularly conscious of psychometric means to distinguish between infected and uninfected individuals (Albert, & Martin, 2014; Foley, Ettenhofer, Wright, & Hinkin, 2008; Woods, Moore, Weber, & Grant, 2009)

The Current Research

The present research comprised two studies. Study 1 examined the influence of four non-disease-related factors (age, sex, educational attainment, and language of test administration) on semantic fluency performance in healthy South African adults, and, on the basis of those findings, established appropriately stratified preliminary normative data for the local population. Study 2 assessed whether impaired semantic fluency performance distinguished HIV-infected South African adults from their HIV-negative counterparts.

Study 1:

Sociodemographic influences on semantic fluency performance in South Africa

Although a large and robust literature describes the effects of language of test administration on cognitive test performance (see, e.g., Coady, 2010; Gasquoin & Gonzalez, 2012; Lehman Blake, Ott, Villanyi, Kazhuro, & Schatz, 2015), and despite the fact that most South Africans do not have English as a first language, yet often have cognitive tests administered to them in that language (Ferrett et al., 2014; Shuttleworth-Edwards, 2012; Watts & Shuttleworth-Edwards, 2016), very few of those studies have been conducted in this country. Furthermore, no previously published study has directly examined the effects of language of test administration on semantic fluency performance.

The present study aimed to fill that knowledge gap. We used a South African sample of healthy, cognitively intact adults to assess the effects of language of test administration (English or isiXhosa) on semantic fluency performance. We then built regression models to examine the contribution of other non-disease-related factors (viz., age, sex, level of educational attainment) to (a) test performance, and (b) code switching during test completion. Although previous studies (see, e.g., Esteves et al., 2015; Fichman et al., 2009; Strauss et al., 2006) suggest that those sociodemographic variables have important effects on semantic fluency performance, most of those studies were conducted in the industrialized countries of the global north. There are no published studies on the topic emerging from low-

or middle-income countries in the global south. Finally, we used the results of analyses to produce preliminary normative data for South African adults on semantic fluency tests.

In summary, the present study tested the following hypotheses:

1. Those taking the test in English will generate more words on semantic fluency tests than those taking the test in isiXhosa. We made this prediction because (a) it is likely that most participants will have received much of their formal education in English, and so those taking the test in this language might have a larger pool of appropriate words upon which to draw, and (b) it is likely that the English language contains more words describing animals, and fruits and vegetables, than isiXhosa.
2. Participants who are younger, and/or who have higher levels of educational attainment, will (a) perform better on both semantic fluency tests and (b) have more instances of code switching than those who are older and/or have completed fewer years of formal education. We made this prediction because higher levels of education are associated with larger vocabularies, and with more mature executive control processes (Bialystok, Craik, & Luk; 2008), and because younger adults tend to have more robust generativity processes than older adults (Kempner et al., 1998). We predicted no significant sex differences because the literature is equivocal on this matter (see, e.g., Crossley et al., Esteves et al., Tombaugh et al., 1999)

Methods

Design and setting. This cross-sectional study aimed to assess performance of two groups of participants (those administered tests in English, and those administered tests in isiXhosa) on two semantic verbal fluency tests (an animal category test and a fruits-and-vegetables category test). We used data from a larger research programme that investigated the use of mobile technology in the routine screening of HIV-associated cognitive impairments (Gouse et al., 2017; Robbins et al., 2015). Data collection for that parent study ran between May 2014 and April 2016 in Town II Clinic, Khayelitsha, Cape Town (Robbins et al., 2015).

Participants. The final sample for whom data were analyzed consisted of 114 adults (56 men, 58 women). All were recruited from Town II Clinic, where they had just tested negative on a routine HIV test.

To be eligible for participation, these HIV-negative individuals had to be (1) between the ages of 18 and 75 years, (2) either English- or isiXhosa-speaking, (3) willing to participate and give consent, (4) willing to allow access to their medical records by the study nurse, (5) medically healthy (i.e., not have any illnesses that may negatively affect neurocognitive functioning), and (6) willing to undergo a psychiatric and neuropsychological evaluation. Individuals with a current psychotic disorder or significant suicidal ideation, or who showed severe cognitive impairment that would make giving consent and participation impossible, were excluded from participation.

Power analysis. We used G*Power (Faul, Erdfelder, Buchner, & Lang, 2009) to calculate a series of a priori power analyses. The first set of analyses was relevant to the first hypothesis, and so we set the following parameters for a one-tailed independent-samples *t*-test with two equal-sized groups: $\alpha = .05$, desired power = a minimum of .80, and Cohen's *d* = 0.20 (small), 0.50 (medium), or 0.80 (large). The recommended sample sizes were $N = 620$, 102, and 42, respectively. The second set of analyses were relevant to the second hypothesis, and so we set the following parameters for a two-tailed fixed-effects linear multiple regression model: $\alpha = .05$, desired power = a minimum of .80, predictors = 3, and Cohen's *f* = .15, .35, or .50. Here, the recommended sample sizes were $N = 55$, 25, and 19, respectively. Hence, we argue that the study was adequately powered to explore its aims.

Measures. In the parent study, tests of semantic verbal fluency were part of a comprehensive neuropsychological test battery that aimed to assess cognitive impairment across multiple domains. Administration of that test battery took 2-3 hours to complete. Verbal fluency tests were administered as the 7th of 9 tests within the battery. All tests were administered in either English or isiXhosa, with the participant choosing his or her preferred language of administration. Sixty participants were administered the tests in isiXhosa, and 54 in English.

Regarding the current versions of the semantic fluency tests, the test administrator instructed the participant to generate the names of as many animals as possible within 60 seconds. After completing that test, the administrator repeated the same instructions for the semantic category of fruits and vegetables.

For each of these two tasks, the test administrator recorded each word onto a scoring sheet and summed the number of correct words, repetitions/perseverations (the repetition of a

word said previously instead of generating a new word), and intrusions (generating a word unrelated to the category, e.g., generating the word *coffee* on the animal fluency task). The scoring sheet divided each 60-s time frame into four 15-s intervals so that pace of generation could be captured. Subsequently, we reviewed these scoring sheets and recorded each code-switching occurrence.

Procedure. All participants completed an informed consent document and the comprehensive neuropsychological test battery in a private room at the Town II Clinic. At the beginning of the session, participants read and signed the consent form, and were given verbal information as to the nature of the study as well as the activities set to take place during the test session. Thereafter, a fully-trained and bilingual (isiXhosa-English) female psychometrist administered the test battery. If a participant was unable, for any reason, to complete the battery, the psychometrist scheduled a second test session to take place within the next 7 days.

Data Management and statistical analyses. We used SPSS (version 24) for all data analyses, with the threshold for statistical significance set at $\alpha = .05$, unless otherwise stated. The analyses proceeded across four steps. First, we generated a complete set of descriptive statistics that allowed us to examine the normality of data distributions, and to test the assumptions underlying subsequent inferential statistical analyses. Second, to test Hypothesis 1, two independent-sample *t*-tests assessed whether participants who took the semantic fluency tests (animals, fruits and vegetables) in English generated more words than those who took the test in isiXhosa. Third, to test Hypothesis 2a, two separate hierarchical regression models described the influence of age, sex, and level of educational attainment on (i) animals category test total score, and (ii) the fruits and vegetables category test total score. Fourth, to test Hypothesis 2b, two separate hierarchical regression models described the influence of age, sex, and level of educational attainment on (i) code switching during the animals category test, and (ii) code switching during the fruits and vegetables category test. In all of the regression models, we entered sex first, then age, then education.

Results

Sample characteristics. Most participants were aged between 20 and 50 years and had at least some high school education. Of the 144 participants, 113 identified isiXhosa as their home language and 1 identified their home language as isiZulu. Some, however, had received a significant amount of their formal education in English. Analyses detected significant between-group differences in terms of age and education, but no such differences in terms of sex distribution across groups (see Table 1).

Testing Hypothesis 1. Analyses detected no significant between-group differences in performance on either the animals category test or the fruits and vegetables category test (see Table 1). Because of these non-significant results, and because of the types of analyses conducted in testing subsequent hypotheses, we did not run analyses of covariance to examine whether the significant between-group age and education differences had any bearing on the pairwise comparisons.

Table 1

Between-group Differences: Demographic characteristics and test performance (N = 114)

Variable	Group		t / χ^2	p	ESE
	isiXhosa ($n = 60$)	English ($n = 54$)			
Age (years)			-4.01	< .001***	0.75
<i>M (SD)</i>	39.40 (11.81)	30.98 (10.50)			
Range	18-54	18-64			
Sex (M:F)	26:34	30:24	1.69	.19	.12
Education (years)			2.18	.032*	0.41
<i>M (SD)</i>	10.28 (1.48)	10.85 (1.28)			
Range	7-13	8-13			
Semantic Fluency					
Animals			1.85	0.066	0.35
<i>M (SD)</i>	14.54 (3.22)	13.32 (3.81)			
Range	8-23	7-25			
Fruits and Vegetables			1.77	0.080	0.33
<i>M (SD)</i>	13.47 (3.79)	14.65 (3.29)			
Range	6-22	9-23			

Note. Means are presented, with standard deviations in parentheses. ESE = effect size estimate (in this case, Cohen's d for t-tests and Cramer's V for chi-squared tests).

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

Testing Hypothesis 2. The first set of regression models suggested that level of educational attainment was a consistently strong predictor of semantic fluency performance, regardless of the category in which the participant was generating words (see Table 2). Age and sex were not significant predictors of performance on the animal category task, but sex was a significant predictor of performance on the fruits-and-vegetables category task, explaining 9.1% of the variance in the outcome. Education explained an additional 12.4% of the variance in this outcome. Table 3 presents the consequent regression equations that can serve to produce preliminary normative data for performance of South African adults on the two semantic fluency tests.

The second set of regression models suggested that none of the sociodemographic variables was a significant predictor of code switching during the animal category task, but

that both sex ($R^2 = .050$) and age ($R^2 = .126$) were significant predictors of code switching during the fruits-and-vegetables category task.

Table 2

Hierarchical Regression Analyses: Predictors of outcomes and performance characteristics on semantic fluency tests (N = 114)

Subtest / Outcome variable	Significant predictor(s)	R^2	F	df	p	β
Animal fluency: Total score		.053	6.27	1, 112	< .014***	
	Education				< .014***	.23
Fruits and vegetables fluency: Total score		.215	17.57	1, 111	< .001***	
	Sex				.001**	.35
	Education				< .001**	.36
Animal fluency: Code switching		.003	.015	1, 110	.961	.012
Fruits and vegetables fluency: Code switching		.013	9.68	1, 111	.001**	
	Sex				.017*	.20
	Age				.001**	.28

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

Table 3

Regression-based Normative Data: Semantic fluency tests (N = 114)

Subtest / Outcome variable	Regression equation
Animal fluency: Total score	$Y = 7.80 + (0.578 * \text{Education})$
Fruits and vegetables fluency: Total score	$Y = 3.238 + (2.476 * \text{Sex}) + (0.903 * \text{Education})$

Note. In the equations, for *Sex* we code the categorical variable as 0 for men and 1 for women, and for *Education* we code the continuous variable as number of years of completed education.

Study 2:

Semantic fluency performance in HIV-infected South African adults

The HIV pandemic has hit South Africa harder than any other country in the world. Recent estimates suggest that about 1 of every 5 HIV-infected people lives in this country, a number that exceeds 7 million people (12% of the country's population). In 2016, 270 000 South Africans were infected with HIV, whilst 110 000 died from HIV/AIDS-related illnesses (UNAIDS, 2017).

A significant proportion of those infected individuals (more than 60%, according to one of the few local prevalence studies) experience at least mild HIV-associated cognitive impairment (Joska et al., 2010). Hence, South African clinical psychologists and neuropsychologists are often required to assess whether, and to what degree, HIV-infected patients experience cognitive impairment, and how that impairment impacts on their ability to complete everyday functional activities (Joska, Fincham, Stein, Paul & Seedat, 2009; Joska et al., 2010; Robbins et al., 2014; Heaton et al., 2004).

Numerous studies suggest that semantic fluency tasks are sensitive to the cognitive impairments present in HIV-infected participants, especially as these relate to changes in frontal circuitry (see, e.g., González-Scarano & Martín-García, 2005; Woods et al., 2009). In South Africa, a study by Joska et al. (2011) showed that there was a statistically significant difference in performance of adults (age range = 18-40) on the both the animal and fruit and vegetable category between the HIV-negative participants ($n = 94$) and the HIV-infected participants ($n = 96$) with the HIV-negative participants performing better on these tests than the HIV-infected group. However, van Wyk (2014) reported that HIV-infected ($n = 30$) and HIV-negative ($n = 70$) South African adolescents (age range = 13-16) did not perform significantly differently on animals and fruit-and-vegetables category fluency tests. Those findings are yet to be replicated in a sample of South African adults, however. Moreover, a significant limitation of that study is that there was no objective verification of participants' HIV status: Those assigned to the HIV-infected group were deemed so because they belonged to a local clinic's HIV programme, whereas those assigned to the HIV-negative group were simply sampled from a local school and reported they were not HIV-infected. There was no blood testing for HIV/AIDS.

Hence, Study 2 aimed to contribute to the extant literature by comparing semantic fluency performance in terms of total words generated on the animal category test, and on the

fruit-and-vegetable category test) in a sample of HIV-infected South African adults to that in a sample of demographically matched HIV-negative controls.

Methods

Design and setting. This study was cross-sectional and quasi-experimental in design, with a primary focus on comparing HIV-infected to HIV-negative participants. The data we analyzed were collected from the same research programme described in Study 1, with the exception that HIV-infected participants were recruited from two different clinics (Town II Clinic in Khayelitsha and Mzamomhle Clinic in Mitchell's Plain) after they completed a 12-month parent-study visit (Gouse et al., 2017; Robbins et al., 2015).

Participants. The final sample for whom data were analysed consisted of 102 HIV-infected adults (19 men and 83 women, all of whom identified their home language as isiXhosa) and 114 HIV-negative adults (56 men, 58 women; the Study 1 sample).

Regarding eligibility criteria for inclusion in the HIV-infected group, individuals had to be (1) HIV-positive, as determined by testing within the parent study, (2) between the ages of 18 and 75 years, (3) either English- or isiXhosa-speaking, (4) willing to participate and give consent, (5) willing to allow access to their medical records by the study nurse, (6) eligible (following South African government guidelines) to initiate ART, (7) willing to undergo a psychiatric and neuropsychological evaluation, (8) ready to initiate mandatory counselling prior to ART initiation, (9) willing to bring a support partner to the intervention, and (10) willing to use Wisepill (Haberer, 2010; Pellowski et al., 2014) to store and dispense HIV medication during the duration of the study. Individuals who had a current psychotic disorder or significant suicidal ideation, or who showed severe cognitive impairment that would make giving consent and participating impossible, were excluded from the study.

Measures and procedure. The semantic fluency tests were administered and scored using the same procedures as described in Study 1. Among the HIV-infected participants, 97 were administered the tests in isiXhosa and 5 in English. Given Study 1's non-significant findings regarding effects of language of test administration on semantic fluency performance, we simply combined the data from these individuals into a single HIV-infected group.

Data management and statistical analyses. As in Study 1, we used SPSS (version 24) for all data analyses, and set the threshold for statistical significance at $\alpha = .05$, unless otherwise stated. We began our analysis by creating standardized data that was stratified by the appropriate demographic variables. This was done through the use of the regression equations derived from the regression analysis in study 1 (Table 3). First, we ran the

regression equation analysis for all participants in order to get their expected scores. Second, we deducted the expected score from the participants actual score and divided that by the residual standard deviation in order to arrive at the standardized data (Z-scores) that would be used in study 2. As in Study 1, we generated a complete set of descriptive statistics for the outcome variables. These descriptive statistics allowed us to examine the normality of data distributions, and to test the assumptions underlying subsequent inferential statistical analyses. Thereafter, two separate independent-sample *t*-tests assessed whether, on average, the group of HIV-infected participants generated significantly fewer words on the semantic fluency tests (animals, fruits and vegetables) than the group of HIV-negative participants.

Results

Sample characteristics. Analyses detected no significant between-group differences in terms of age and education (see Table 4). Most participants in both groups were aged between 25 and 45 years and had at least some high school education. Regarding sex distribution, analyses detected a significant between-group difference, with a much larger proportion of women in the HIV-infected group. We did not run an ANCOVA with sex as a covariate because we used regression equations to generate standardized outcome variables. Finally, although all participants had a home language of Xhosa, the ratio of those administered the test in Xhosa to those administered the test in English was much higher in the HIV-infected group. Again, however, because Study 1 results indicated no significant effects of language of test administration, we did not use this variable as a factor in subsequent analyses.

Between-group comparisons. Analyses detected no significant between-group differences in performance on either the animal category test or the fruits-and-vegetables category test (see Table 4).

Table 4
Sample Characteristics (N = 216)

Variable	Group		t / χ^2	p	ESE
	HIV-negative ($n = 114$)	HIV-infected ($n = 102$)			
Age (years)			1.90	.059	.23
<i>M (SD)</i>	35.41 (11.93)	32.80 (7.46)			
Range	18-64	18-56			
Education (years)			1.32	.188	.22
<i>M (SD)</i>	10.55 (1.42)	10.25 (1.99)			
Range	7-13	2-13			
Sex			22.09	< .001***	.32
Female	58 (50.88%)	83 (81.37%)			
Male	56 (49.12%)	19 (18.63%)			
Language of test administration			49.9	< .001***	.48
Xhosa	60 (52.63%)	97 (95.01%)			
Other	54 (47.37%)	5 (4.9%)			
Semantic Fluency					
Animals			-0.31	.173	.04
<i>M (SD)</i>	-.001(1.0)	-.04(.86)			
Range	-1.91-2.97	-2.36-1.78			
Fruits and Vegetables			-0.24	.661	-.03
<i>M (SD)</i>	-.0001(1.0)	.03(.99)			
Range	-2.99-2.25	-2.37-2.84			

Note. For the variables *Sex* and *Language of Test Administration*, counts are presented with percentages in parentheses. ESE = effect size estimate (in this case, Cohen's d for t -tests, Cramer's V for chi-squared tests).

*** $p < .001$.

General Discussion

Performance on semantic fluency tests (i.e., tests that require oral generation of words to a category cue) is susceptible to the influence of variation in non-disease-related factors (e.g., age, education, home language) and to the presence of disease-related impairment (e.g., HIV infection). Because South Africa is a demographically heterogeneous society, with regionally specific language variation and great disparities in educational attainment and socioeconomic power, and because the country is home to the world's largest population of HIV-infected individuals, research on semantic fluency performance is particularly relevant for local clinical purposes. Hence, the current study used South African samples to (a) examine the influence of four non-disease-related factors (age, sex, educational attainment, and language of test administration) on semantic fluency performance, (b) generate locally appropriate normative data for semantic fluency tests, and (c) examine the influence of HIV infection on semantic fluency test performance.

Results from Study 1 suggested that, in a sample of participants who were isiXhosa home-language speakers, and most of whom had some high school education, those who were administered the semantic fluency tests in English performed no differently than those who were administered the tests in isiXhosa. Vast differences on performance between tests administered in different languages may speak to the validity of the test; that is whether it measures verbal fluency or lexicon of words belonging to a category (animals or fruit and vegetables) in a specific language. These results are of particular importance in multilingual South Africa because there is need of culturally corrected tests that do not have a language bias. Moreover, this suggests that clinicians can administer these tests in different South African languages without concern that it may negatively influence the test-takers performance. This is consistent with Pekkala et al. (2009) who found that English-speaking group ($n=30$, $M (SD)$ 19.9 (3.8)) performed no differently than the Finnish-speaking group ($n=30$, $M (SD)$ 18.9, (4.7) on the semantic fluency task (animals), $p=.423$.

Study 1's results further suggested that level of educational attainment was a strong predictor of performance on both the animal and fruits-and-vegetables category tasks. This finding is consistent with previous research suggesting that education is positively associated with performance on semantic fluency tests (i.e., the higher level of education one attains, the better one will perform on the tests; see, e.g., Bento-Torres et al., 2017; Brickman et al., 2005; Esteves et al., 2015; Fichman et al., 2009; Parisi et al., 2012; Schneeweis, Skirbekk, & Winter-Ebmer, 2014; Strauss et al., 2006; Troyer, 2000). One account of this association is that more years of exposure to formal education provides individuals with a greater foundation of the necessary knowledge and skills to engage in and successfully complete cognitive processes (e.g., the retrieval of memory traces required in verbal fluency tasks), and with a larger and more diverse vocabulary.

In contrast, age was not a significant predictor of performance on either semantic fluency test. This is inconsistent with previous literature that describes a strong negative correlation of age with performance-the younger you are the better you should perform on the semantic fluency test (see, e.g., Brickman et al., 2005; Esteves et al., 2015; Fichman et al., 2009; Strauss et al., 2006; Troyer, 2000) as well as Tombaugh et al (1999) who found age to be the strongest predictors of performance, accounting for a variance of 23.4% in the semantic fluency tests. However, it can be attributed to our age range (18-64) which in comparison to Tombaugh et al. (1999) (age range = 16-95) and other studies (see, e.g., Cavaco et al., 2013; Elgamal, Roy and Sharratt, 2011; Gladsjo et al., 1999; Kavé, 2005;

Zimmermann et al., 2014, is considerably small. This means that age is more likely to be a significant predictor in studies that have a larger age range.

Moreover, sex was not a significant predictor of performance on the animal category task, but was a significant (albeit minor, compared to education) predictor of performance on the fruits-and-vegetables category task (women performed better than men). This result is partially consistent with Tombaugh et al. (1999), who found small sex differences (in favour of men) in performance on a semantic fluency task. This can be attributed to the large sample size in the Tombaugh et al. (1999) as well as the large number of participants with higher levels of education of up to 21 years of educational attainment. Of the 734 participants who took part in their study, 29.5% had educational levels ranging from 13-21 years and this had a great influence because education accounts for a bigger variance in performance than sex. Both the current data and those reported by Tombaugh et al. (1999) are not, however, consistent with Esteves et al. (2015), who reported no effects of sex on semantic fluency performance. Inconsistency with the Esteves et al. (2015) study could be directed at the fact that they had an uneven distribution between sexes in their study (men = 101 (38%); women = 164 (62%)) whereas our study had a more even distribution of 56 (49%) and 58 (51%), respectively.

Regression modelling further suggested that none of the sociodemographic variables was a significant predictor of code switching during the animal category task, but that both sex and age were significant predictors of code switching during the fruits-and-vegetables category task. These results disconfirm our hypothesis that higher educational attainment (because of a consequent larger vocabulary) would be associated with more instances of code-switching. These results are particularly important because most people are bilingual, if not multilingual and receive most of their education in English which will likely result in them code-switching. Therefore, it is important to have psychometrists know the language history of the test-taker as well as understand these language so as to avoid incorrect scoring of the participant and making the semantic fluency test a test of language instead. No studies have examined educational attainment as a predictor for code-switching in semantic fluency tests, however one study by Yim and Bialystok (2012) argued that those who code-switched during conversations were more likely to code switch in semantic fluency tasks. In South Africa, fruits and vegetables are largely referred to in English despite the language spoken by individuals at that given time and this can be a result of age and sex being predictors for code-switching in that it is expected that younger adults will have greater exposure to societal

constructs (language) and our study found that females perform better which gives reason to why these two are predictors to code-switching.

Tests assessing semantic verbal fluency tap into neural processes and circuits centred on the frontal and temporal lobes (see, e.g., Baldo et al., 2006; Meinzer et al., 2009; Shao et al., 2014). Because damage to this circuitry appears to underlie HIV-associated cognitive impairment (González-Scarano & Martín-García, 2005; Woods et al., 2009), research exploring the sensitivity of semantic fluency to HIV infection, and to the trajectory of cognitive decline following infection, is critical. Because South African research is equivocal on the ability of semantic fluency tests to detect HIV-associated cognitive impairment (see, e.g., Joska et al. (2009); van Wijk, 2013). Study 2 of the current research compared semantic fluency performance in a sample of HIV-infected South African adults to that of demographically matched HIV-negative controls.

Analyses detected no significant between-group differences in performance on either of the semantic fluency tests. Most people in the world (including South Africa) are infected with the HIV-1 virus (Hemelaar, Gouws, Ghys, & Osmanov., 2011). HIV-1 comprises of three groups (Robertson, 2000), with 90% of infections globally being attributable to Group M (M for major), which is comprised of different clades (A-K). Clade B accounts for approximately 10% of all infections worldwide, and is prominent in North and Central America, Western and Central Europe, and Australia, whereas, Clade C is prominent in Southern and Eastern Africa and South Easter Asia (Hemelaar et al., 2006; Liner, Hall, & Robertson, 2007; Osmanov Pattou, Walker, Schwardländer, & Esparza, 2002; Smith, Kuiken & Korber, 2003) and accounts for up to 50% of global infections. For the significance of HIV neuropsychology, several studies suggest that HIV-associated neurocognitive deficits are more evident in Clade B than in Clade C (Tyor, Fritz-French & Nath, 2013). Our study was based on participants with HIV Clade C, whereas previous studies that found a significant difference conducted the study on HIV Clade B which is more neurovirulent (Langford, Letendre, Larrea & Masliah, 2006; Sacktor et al., 2001), therefore accounting for the inconsistencies in comparison to our results.

Limitations and Directions for Future Research

The conclusions one might draw from this research are limited by two sample-related factors. First, although our sample was large enough to power the study adequately, we only recruited participants from the Western Cape, and therefore the languages we considered in the first part of Study 1 were limited to a small proportion of the languages spoken in South

Africa as a whole. Future research should extend participant recruitment to other parts of South Africa, and/or to participants who have other home languages.

Second, in Study 2 there was a much larger number of women than men in the HIV-infected group. Future research should therefore attempt to include equal numbers of men and women to ensure that data is equally distributed according to sex.

Third, although South Africa generally has a lower life expectancy (men = 59.7; women = 65.1 yoe) (Statistics South Africa, 2016) compared to the US (men = 77; women = 82) (WHO, 2015), it is important to have a wider age range in order to account for performance among the oldest and the youngest participants. Our study, unfortunately, fell short of this, however it is important for future research to consider getting older or younger participants than what we had.

Summary and Conclusion

Our research aimed to examine the influence of language of test administration, age, sex, level of education, and HIV infection on semantic verbal fluency performance. We found no differences in performance on the semantic fluency tasks between those who took the tests in English and those who took the tests in isiXhosa. Furthermore, education was a consistently strong predictor of performance across both semantic fluency tests (animals and fruits-and-vegetables) These results are particularly relevant for South African clinicians and researchers, who operate in an assessment context where educational levels vary substantially across age cohorts and regions. The data from Study 2 suggest that semantic fluency tests should not be a core component of neuropsychological test batteries seeking to detect the presence of HIV-related cognitive impairment in South Africa adults. Given the high rates of infection in the country, this result is of great practical significance. Overall, this study is important, especially in the South African context of diverse languages, varying educational levels and high HIV-infection because it examines how these factors affect performance on this important cognitive assessment- something that has not been done before in Africa.

References

- Ansaldo, A., Marcotte, K., Scherer, L., & Raboyeau, G. (2008). Language therapy and bilingual aphasia: Clinical implications of psycholinguistic and neuroimaging research. *Journal of Neurolinguistics*, *21*, 539-557. doi: 10.1016/j.jneuroling.2008.02.001
- Ardila, A., Rosselli, M., Ostrosky-Solís, F., Marcos, J., Granda, G., & Soto, M. (2000). Syntactic comprehension, verbal memory, and calculation abilities in Spanish-English bilinguals. *Applied Neuropsychology*, *7*, 3-16. doi:10.1207/s15324826an0701_2
- Bento-Torres, N., Bento-Torres, J., Tomás, A., Costa, V., Corrêa, P., & Costa, C., et al. (2017). Influence of schooling and age on cognitive performance in healthy older adults. *Brazilian Journal of Medical and Biological Research*, *50*. doi :10.1590/1414-431x20165892
- Bialystok, E., Craik, F. I., & Luk, G. (2008). Lexical access in bilinguals: Effects of vocabulary size and executive control. *Journal of Neurolinguistics*, *21*, 522-538. doi: 10.1016/j.jneuroling.2007.07.001
- Brickman, A., Paul, R., Cohen, R., Williams, L., Macgregor, K., & Jefferson, A.,, & Gordon, E. (2005). Category and letter verbal fluency across the adult lifespan: relationship to EEG theta power. *Archives of Clinical Neuropsychology*, *20*, 561-573. doi: 10.1016/j.acn.2004.12.006
- Cavaco, S., Gonçalves, A., Pinto, C., Almeida, E., Gomes, F., Moreira, I., ... & Teixeira-Pinto, A. (2013). Semantic fluency and phonemic fluency: regression-based norms for the Portuguese population. *Archives of Clinical Neuropsychology*, *28*, 262-271. doi:10.1093/arclin/act001
- Crossley, M., D'Arcy, C., & Rawson, N. S. B. (1997). Letter and category fluency in community-dwelling Canadian seniors: A comparison of normal participants to those with dementia of the Alzheimer or vascular Type. *Journal of Clinical and Experimental Neuropsychology*, *19*, 52-62. doi: 10.1080/01688639708403836
- Elgamal, S., Roy, E., & Sharratt, M. (2011). Age and Verbal Fluency: The mediating effect of speed of processing. *Canadian Geriatrics Journal*, *14*. doi:10.5770/cgj.v14i3.17
- Esteves, C. S., Oliveira, C. R., Moret-Tatay, C., Navarro-Pardo, E., De Carli, G. A., Silva, I. G., ... , & Argimon. I. I. L. (2015). Phonemic and semantic verbal fluency tasks: Normative data for elderly Brazilians. *Psychology/Psicologia Refl exão e Crítica*, *28*, 350-355. doi: 10.1590/1678-7153.201528215ISSN

- Faul, F., Erdfelder, E., Buchner, A., & Lang, A. G. (2009). Statistical power analyses using G* Power 3.1: Tests for correlation and regression analyses. *Behavior research methods, 41*, 1149-1160. doi: 10.3758/BRM.41.4.1149
- Ferrett, H. L., Carey, P. D., Baufeldt, A. L., Cuzen, N. L., Conradie, S., Dowling, T., ... & Thomas, K. G. (2014). Assessing phonemic fluency in multilingual contexts: Letter selection methodology and demographically stratified norms for three South African language groups. *International Journal of Testing, 14*, 143-167. doi:10.1080/15305058.2013.865623
- Fichman, H., Fernandes, C., Nitrini, R., Lourenço, R., Paradela, E., Carthery-Goulart, M., & Caramelli, P. (2009). Age and educational level effects on the performance of normal elderly on category verbal fluency tasks. *Dementia & Neuropsychologia, 3*, 49-54. doi: 10.1590/s1980-57642009dn30100010
- Foley, J., Ettenhofer, M., Wright, M., & Hinkin, C. H. (2008). Emerging issues in the neuropsychology of HIV infection. *Current HIV/AIDS Reports, 5*(4), 204. doi: 10.1007%2Fs11904-008-0029-x
- Foxcroft, C. (2011). Ethical issues related to psychological testing in Africa: What I have learned (so far). *Online Readings in Psychology and Culture, 2*. doi:10.9707/2307-0919.1022
- Gasquoine, P., & Gonzalez, C. (2012). Using monolingual neuropsychological test norms with bilingual Hispanic Americans: Application of an individual comparison standard. *Archives of Clinical Neuropsychology, 27*, 268-276. doi:10.1093/arclin/acs004
- Genesee, F., Crago, M., & Paradis, J. (2004). *Dual Language Development and Disorders* (1st ed.). Baltimore, MD: Paul H. Brookes Publishing.
- Gladsjo, J. A., Schuman, C. C., Evans, J. D., Miller, S. W., & Heaton, R. K. (1999). Norms of letter and category fluency: Demographic correlations for age, education and ethnicity. *Psychological Assessment, 6*, 147-178. doi: 10.1177/107319119900600204
- Gouse, H., Henry, M., Robbins, R. N., Lopez-Rios, J., Mellins, C. A., Remien, R. H., & Joska, J. A. (2017). Psychosocial aspects of ART counselling: A comparison of HIV beliefs and knowledge in PMTCT and ART-naïve women. *Journal of the Association of Nurses in AIDS Care, 28*, 504-517. doi: 10.1016/j.jana.2017.03.002
- Government of the Republic of South Africa. (1996). No. 86 of 1996: South African Schools Act, 1996.
- Grosjean, F. (1982). *Life with Two Languages* (1st ed.). Cambridge, MA: Harvard University Press.

- Haberer, J. E., Kahane, J., Kigozi, I., Emenyonu, N., Hunt, P., Martin, J., & Bangsberg, D. R. (2010). Real-time adherence monitoring for HIV antiretroviral therapy. *AIDS and Behavior, 14*, 1340-1346. doi: 10.1007/s10461-010-9799-4.
- Heaton, R. K., Franklin, D. R., Ellis, R. J., McCutchan, J. A., Letendre, S. L., LeBlanc, S., ... & Collier, A. C. (2011). HIV-associated neurocognitive disorders before and during the era of combination antiretroviral therapy: differences in rates, nature, and predictors. *Journal of neurovirology, 17*(1), 3-16. doi:10.1007/s13365-010-0006-1
- Heaton, R. K., Marcotte, T. D., Mindt, M. R., Sadek, J., Moore, D. J., Bentley, H., ... & HNRC GROUP. (2004). The impact of HIV-associated neuropsychological impairment on everyday functioning. *Journal of the international neuropsychological society, 10*, 317-331. doi: 10.1017/S1355617704102130
- Hemelaar, J., Gouws, E., Ghys, P. D., & Osmanov, S. (2006). Global and regional distribution of HIV-1 genetic subtypes and recombinants in 2004. *AIDS, 20*, W13-W23. doi: 10.1097/01.aids.0000247564.73009.bc
- Hemelaar, J., Gouws, E., Ghys, P., & Osmanov, S. (2011). Global trends in molecular epidemiology of HIV-1 during 2000–2007. *AIDS, 25*, 679-689. doi: 10.1097/qad.0b013e328342ff93
- Iudicello, J. E., Woods, S. P., Deutsch, R., Grant, I., & HIV Neurobehavioral Research Program (HNRP) Group. (2012). Combined effects of aging and HIV infection on semantic verbal fluency: a view of the cortical hypothesis through the lens of clustering and switching. *Journal of Clinical and Experimental Neuropsychology, 34*, 476-488. doi: 10.1080/13803395.2011.651103
- Iudicello, J., Kellogg, E., Weber, E., Smith, C., Grant, I., Drane, D., & Woods, S. (2012). Semantic cueing improves category verbal fluency in persons living with HIV Infection. *The Journal of Neuropsychiatry and Clinical Neurosciences, 24*, 183-190. doi:10.1176/appi.neuropsych.11100301
- Joska, J., Fincham, D., Stein, D., Paul, R., & Seedat, S. (2009). Clinical correlates of HIV-associated neurocognitive disorders in South Africa. *AIDS And Behavior, 14*, 371-378. doi:10.1007/s10461-009-9538-x
- Joska, J. A., Westgarth-Taylor, J., Hoare, J., Thomas, K. G., Paul, R., Myer, L., & Stein, D. J. (2011). Validity of the international HIV dementia scale in South Africa. *AIDS patient care and STDs, 25*, 95-101. doi: 10.1089/apc.2010.0292
- Joska, J. A., Westgarth-Taylor, J., Myer, L., Hoare, J., Thomas, K. G., Combrinck, M., ... & Flisher, A. J. (2010). Characterization of HIV-associated neurocognitive disorders among

- individuals starting antiretroviral therapy in South Africa. *AIDS and Behavior*, *15*(6), 1197-1203. doi:10.1007/s10461-010-9744-6
- Kavé, G. (2005). Phonemic fluency, semantic fluency, and difference scores: Normative data for adult Hebrew speakers. *Journal of Clinical and Experimental Neuropsychology*, *27*, 690-699. doi:10.1080/13803390490918499
- Kempler, D., Teng, E. L., Dick, M., Taussig, I. M., & Davis, A. (1998). The effects of age, education, and ethnicity on verbal fluency. *Journal of the International Neuropsychological Society*, *4*, 531-538. doi: 10.1017%2FS1355617798466013
- Langford, T., Letendre, S., Larrea, G., & Masliah, E. (2006). Changing Patterns in the Neuropathogenesis of HIV During the HAART Era. *Brain Pathology*, *13*, 195-210. doi:10.1111/j.1750-3639.2003.tb00019.x
- Lehman Blake, M., Ott, S., Villanyi, E., Kazhuro, K., & Schatz, P. (2015). Influence of language of administration on ImpACT performance by bilingual Spanish-English college students. *Archives of Clinical Neuropsychology*, *30*, 302-309. doi:10.1093/arclin/acv021
- Liner, K., Hall, C., & Robertson, K. (2007). Impact of human immunodeficiency virus (HIV) subtypes on HIV-associated neurological disease. *Journal of Neurovirology*, *13*, 291-304. doi: 10.1080/13550280701422383
- Mack, W., Teng, E., Zheng, L., Paz, S., Chui, H., & Varma, R. (2005). Category fluency in a Latino sample: Associations with age, education, gender, and language. *Journal of Clinical and Experimental Neuropsychology*, *27*, 591-598. doi:10.1080/13803390490918417
- Millikin, C., Trépanier, L., & Rourke, S. (2004). Verbal fluency component analysis in adults with HIV/AIDS. *Journal of Clinical and Experimental Neuropsychology*, *26*, 933-942. doi:10.1080/13803390490510842
- Osmanov, S., Pattou, C., Walker, N., Schwardländer, B., & Esparza, J. (2002). Estimated global distribution and regional spread of HIV-1 genetic subtypes in the year 2000. *JAIDS Journal of Acquired Immune Deficiency Syndromes*, *29*(2), 184-190. <http://dx.doi.org/10.1097/00042560-200202010-00013>
- Parisi, J., Rebok, G., Xue, Q., Fried, L., Seeman, T., & Tanner, E. et al. (2012). The role of education and intellectual activity on cognition. *Journal of Aging Research*, *2012*, 1-9. doi: 10.1155/2012/416132

- Pekkala, S., Goral, M., Hyun, J., Obler, L., Erkinjuntti, T., & Albert, M. (2009). Semantic verbal fluency in two contrasting languages. *Clinical Linguistics & Phonetics*, 23, 431-445. doi:10.1080/02699200902839800
- Pellowski, J. A., Kalichman, S. C., White, D., Amaral, C. M., Hoyt, G., & Kalichman, M. O. (2014). Real-time medication adherence monitoring intervention: Test of concept in people living with HIV infection. *The Journal of the Association of Nurses in AIDS Care: JANAC*, 25, 646. doi: 10.1016/j.jana.2014.06.002
- Robbins, R. N., Mellins, C. A., Leu, C. S., Rowe, J., Warne, P., Abrams, E. J., ... & Remien, R. H. (2015). Enhancing lay counsellor capacity to improve patient outcomes with multimedia technology. *AIDS and Behavior*, 19, 163-176. doi: 10.1007/s10461-014-0988-4
- Robbins, R. N., Brown, H., Ehlers, A., Joska, J. A., Thomas, K. G., Burgess, R., ... & Morgello, S. (2014). A smartphone app to screen for HIV-related neurocognitive impairment. *Journal of mobile technology in medicine*, 3, 23. doi:10.7309/jmtm.3.1.5
- Robertson, D. (2000). HIV-1 Nomenclature Proposal. *Science*, 288, 55d-55. doi: 10.1126/science.288.5463.55d
- Robertson, K., Liner, J., & Heaton, R. (2009). Neuropsychological assessment of HIV-infected populations in international settings. *Neuropsychology Review*, 19, 232-249. doi:10.1007/s11065-009-9096-z
- Rodriguez-Fornells, A., Krämer, U., Lorenzo-Seva, U., Festman, J., & Münte, T. (2012). Self-assessment of individual differences in language switching. *Frontiers in Psychology*, 2, 388. doi:10.3389/fpsyg.2011.00388
- Rosselli, M., Ardila, A., Araujo, K., Weekes, V. A., Caracciolo, V., Padilla, M., & Ostrosky-Solís, F. (2000) Verbal fluency and repetition skills in healthy older Spanish-English bilinguals. *Applied Neuropsychology*, 7, 17-24. doi: 10.1207/ S15324826AN0701_3
- Rosselli, M., Ardila, A., Salvatierra, J., Marquez, M., Matos, L., & Weekes, V. A. (2002). A cross-linguistic comparison of verbal fluency tests. *International Journal of Neuroscience*. 112, 759-776. doi: 10.1080/00207450290025752
- Sacktor, N., Lyles, R. H., Skolasky, R., Kleeberger, C., Selnes, O. A., Miller, E. N., ... & McArthur, J. C. (2001). HIV-associated neurologic disease incidence changes: Multicenter AIDS Cohort Study, 1990–1998. *Neurology*, 56, 257-260. doi: doi:10.1212/wnl.56.2.257
- Sacktor, N., Nakasujja, N., Okonkwo, O., Skolasky, R., Robertson, K., Musisi, S., & Katabira, E. (2013). Longitudinal neuropsychological test performance among HIV

- seropositive individuals in Uganda. *Journal of Neurovirology*, *19*, 48-56.
doi:10.1007/s13365-012-0139-5
- Sacktor, N., Nakasujja, N., Skolasky, R. L., Robertson, K., Musisi, S., Ronald, A., ... & Clifford, D. B. (2009). Benefits and risks of stavudine therapy for HIV-associated neurologic complications in Uganda. *Neurology*, *72*(2), 165-170. doi: 10.1212/01.wnl.0000339042.96109.86
- Shao, Z., Janse, E., Visser, K., & Meyer, A. S. (2014). What do verbal fluency tasks measure? Predictors of verbal fluency performance in older adults. *Frontiers in Psychology*, *5*, 1-10. doi: 10.3389/fpsyg.2014.00772
- Shuttleworth-Edwards, A. (2012). Guidelines for the use of the WAIS-IV with WAIS-III cross-cultural normative indications. *South African Journal of Psychology*, *42*, 399-410. doi:10.1177/008124631204200312
- Schneeweis, N., Skirbekk, V., & Winter-Ebmer, R. (2014). Does education improve cognitive performance four decades after school completion?. *Demography*, *51*(2), 619-643. doi: 10.1007/s13524-014-0281-1
- Smith, U. R., Kuiken, C. R., & Korber, B. T. (2003). Recent Evolutionary History of Human Immunodeficiency Virus Type 1 Subtype B—Response. *Journal of molecular evolution*, *56*, 643-644. doi: 10.1007/s00239-002-2438-6
- Snitz, B. E., Unverzagt, F. W., Chang, C. H., Bilt, J. V., Gao, S., Saxton, J., Hall, K. S., & Ganguli, M. (2009). Effects of age, gender, education and race on two tests of language ability in community-based older adults. *International Psychogeriatric*, *21*, 1051–1062. doi: 10.1017/S1041610209990214.
- Statistics South Africa. (2016). *Mid-year population estimates 2016*. Pretoria, South Africa: Author
- Strauss, E., Sherman, E. M. S., & Spreen, O. (2006). *A Compendium of Neuropsychological Tests: Administration, Norms and Commentary* (3rd ed). New York, NY: Oxford University Press.
- Tombaugh, T., Kozak, J., & Rees, L. (1999). Normative data stratified by age and education for two measures of verbal fluency: FAS and animal naming. *Archives of Clinical Neuropsychology*, *14*, 167-177. doi:10.1093/arclin/14.2.167
- Troyer, A. (2000). Normative data for clustering and switching on verbal fluency tasks. *Journal of Clinical and Experimental Neuropsychology*, *22*, 370-378. doi:10.1076/1380-3395(200006)22:3;1-v;ft370

- Tyor, W., Fritz-French, C., & Nath, A. (2013). Effect of HIV clade differences on the onset and severity of HIV-associated neurocognitive disorders. *Journal of Neurovirology*, *19*, 515-522. doi:10.1007/s13365-013-0206-6
- UNAIDS. (2017). *UNAIDS Data 2017*. Geneva, Switzerland: Author.
- Van Staden, S., Bosker, R., & Bergbauer, A. (2016). Differences in achievement between home language and language of learning in South Africa: Evidence from prePIRLS 2011. *South African Journal of Childhood Education*, *6*, 1-10. doi:10.4102/sajce.v6i1.441
- Van Wijk, C. (2013). Screening for HIV-associated neurocognitive disorders (HANDs) in South Africa: A caution against uncritical use of comparative data from other developing countries. *Southern African Journal of HIV Medicine*, *14*. doi:10.7196/sajhivmed.855
- Van Wyk, C. (2014). *Verbal fluency and vocabulary in English in bi/multilingual adolescents living with HIV-1 in South Africa* (Doctoral dissertation).
- Watts, A., & Shuttleworth-Edwards, A. (2016). Neuropsychology in South Africa: confronting the challenges of specialist practice in a culturally diverse developing country. *The Clinical Neuropsychologist*, *30*, 1305-1324. doi:10.1080/13854046.2016.1212098
- Whiteside, D., Kealey, T., Semla, M., Luu, H., Rice, L., Basso, M., & Roper, B. (2015). Verbal fluency: Language or executive function measure? *Applied Neuropsychology: Adult*, *23*, 29-34. doi:10.1080/23279095.2015.1004574
- WHO. (2015). *Statistics 2015*. Retrieved from <http://www.who.int/countries/usa/en/>
- Yim, O., & Bialystok, E. (2012). Degree of conversational code-switching enhances verbal task switching in Cantonese-English bilinguals. *Bilingualism: Language and Cognition*, *15*, 873-883. doi:10.1017/s1366728912000478
- Zimmermann, N., Parente, M. A. M. P., Joannette, Y., & Fonseca, R. P. (2014). Unconstrained, phonemic and semantic verbal fluency: Age and education effects, norms and discrepancies. *Psicologia: Reflexão e Crítica*, *27*, 1-9. doi: 10.1590/S0102-79722014000100007

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Appendix A

Ethics Approval Letter



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Website: www.health.uct.ac.za/fhs/research/humanethics/forms

14 October 2014

HREC/REF: 596/2014

A/Prof J Joska
 Psychiatry & Mental Health
 J-block
 GSH

Dear A/Prof Joska

Project Title: A MOBILE APP FOR LMIC LAY HEALTH WORKERS TO SCREEN FOR NEUROCOGNITIVE IMPAIRMENT

Thank you for your response letter dated 07 October 2014, addressing the issues raised by the Human Research Ethics Committee (HREC).

It is a pleasure to inform you that the HREC has **formally approved** the above mentioned study.

Approval is granted for one year until the 30 October 2015.

Please submit a progress form, using the standardised Annual Report Form, if the study continues beyond the approval period. Please submit a Standard Closure form if the study is completed within the approval period.

Please note that the on-going ethical conduct of the study remains the responsibility of the principal investigator.

Please quote the HREC REF in all your correspondence.

Yours sincerely

PROFESSOR M BLOCKMAN
CHAIRPERSON, HSF HUMAN ETHICS

Federal Wide Assurance Number: FWA00001637.




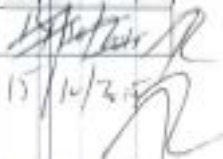
Institutional Review Board (IRB) number: IRB00001938

Hrec/ref:596/2014

This serves to confirm that the University of Cape Town Research Ethics Committee complies to the Ethics Standards for Clinical Research with a new drug in patients, based on the Medical Research Council (MRC-SA), Food and Drug Administration (FDA-USA), International Convention on Harmonisation Good Clinical Practice (ICH GCP) and Declaration of Helsinki guidelines.

The Research Ethics Committee granting this approval is in compliance with the ICH Harmonised Tripartite Guidelines E6: Note for Guidance on Good Clinical Practice (CPMP/ICH/135/95) and FDA Code Federal Regulation Part 50, 56 and 312.

Appendix B
Amended Ethical Approval letter

 UNIVERSITY OF CAPE TOWN <small>UNIVERSITEIT VAN KAAPSTAD</small>	FACULTY OF HEALTH SCIENCES Human Research Ethics Committee	
Form FHS006: Protocol Amendment		
HREC office use only (FWA00001637; IRB00001938)		
<input checked="" type="checkbox"/> Approved	<input checked="" type="checkbox"/> Type of review: Expedited	<input type="checkbox"/> Full committee
This serves as notification that all changes and documentation described below are approved.		
Signature Chairperson of the HREC		Date
		 15/10/2015
<p>NOTE: Ethics number for this grant is 596/2014 and not 295 as indicated in the text. 20 April 2016.</p>		
<div style="border: 1px solid black; padding: 10px; width: fit-content; margin: 0 auto;"> <p style="text-align: center;">HUMAN RESEARCH ETHICS COMMITTEE</p> <p style="text-align: center;">15 OCT 2015</p> <p style="text-align: center;">HEALTH SCIENCES FACULTY UNIVERSITY OF CAPE TOWN</p> </div>		
26 March 2015	Page 1 of 6	FHS006



Note: All major amendments should include a **PI Synopsis** justifying the changes for the amendment (please see notice dated 23 April 2012)

Comments to PI from the HREC

We are requesting to make an amendment to our protocol 296/2014, "A Mobile App for LMIC Lay Health Workers to Screen for Neurocognitive Impairment." We would like to add a matched sample of 100 healthy, HIV-uninfected adults. This will not change or alter or study aims. Adding the control group will enhance the precision of the sensitivity and specificity estimates that will be generated for the app's ability to detect neurocognitive impairment for Aim 2 of the study. Further, we believe that adding the control group will make our findings more generalisable.

We would also like to add five more, standard, brief, neuropsychological tests to the full neuropsychological test battery being administered in the study. We would like to add the Montreal Cognitive Assessment (MoCA), the CLOX test, Judgment of Line Orientation, the Paced Auditory Serial Addition Test, and Action Fluency – all well-established and commonly used neuropsychological tests. All of these tests are brief, and we estimate that the addition of them will increase the study visit no more than 20-30 minutes. We also believe that the compensation remains fair given the increased burden. In our experience, the current test battery takes, on average, just under 2.5 hours to complete. Adding 20-30 minutes would still keep the study visit within the 3-hour maximum as stated in the consent form. Only the control group would receive these extra tests, as we will achieve our target sample size of 100 HIV-infected adults within the next 2-3 weeks.

Adding the control group and additional tests will change or recruitment strategy, inclusion criteria, consent form, and assessment instruments. We have updated the following sections (all changes have been bolded):

Lay Summary
 Description of Subject Population
 Recruitment Procedures
 Inclusion/Exclusion Criteria #2
 Consent Procedures
 Assessment Instruments

We have also included a new Consent Form specifically for the control participants. We have included a version with tracked changes and a version with accepted changes.

Please do not hesitate to contact me if you have any additional questions or need additional information.

Sincerely,

John Joska.

Principal Investigator to complete the following:

1. Protocol information

Appendix C

Semantic Fluency Administration Sheet

MSV Participant ID#	mHealth Study #	Participant's Initials	Date of Visit	Interviewer's Initials
BR120	MH201	OX	03 / FEB / 2016 <small>Day Month Year Date format = DAY/MONTH/YEAR Example: 03 APR 2015</small>	INM

Category/Semantic Fluency

Animals:

I want to see how many animals as you can say in one minute. They can be wild or tame animals. Name them as quickly as possible.

Fruits and Vegetables:

Now tell me the names of as many fruits and vegetables as you can. Name them as quickly as possible.

Each category timed for 1 minute. Record each response given.

Seconds	Animals	Fruits and Vegetables
0 - 15"	Baboon Cat Hedgehog cow Dog Lion Tiger Scorpion 8	Apple Banana Strawberry Cabbage Carrot Spinach Avocado Tomato 8
16 - 30"	Rabbit Snake 2	Orange Sweet corn Basil 3
31 - 45"	Chicken Giraffe Zebra 3	 0
46 - 60"	Springbok 1	Pumpkin Potato 2

Correct Words:

Repeats/Perseverations:

Intrusions:

Correct Words:

Repeats/Perseverations:

Intrusions: