The effects of education on phonemic verbal fluency performance: An original empirical study and meta-analysis

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ABSTRACT

Two separate studies report on the relationship between level of education and performance on neuropsychological tests of phonemic verbal fluency. Study 1 investigated this relationship in 269 English-, Afrikaans- and isiXhosa-speaking individuals (8-25 years) in the Western Cape. More specifically, we created two letter sets and tested whether the three language groups, and males and females, produced an equivalent number of words to those stimuli. As predicted, neither language nor sex predicted performance on either letter set. I also predicted that individuals with more years of education would perform better, even taking into account differences in sex, socioeconomic status, and quality of education. That prediction was also confirmed. Study 2 used meta-analytic procedures to examine research findings on the effects of education on verbal fluency in developed and developing countries. Following the notion that the discrepancy between low and high levels of education would be greater in developing than developed countries, I hypothesized that the magnitude of the relationship between education and verbal fluency performance in developed countries would be smaller than that in developing countries. The results would suggest that a persons performance on the phonemic verbal fluency task depends on their level of education and specifically that the differences between those with high and low education in developed countries is substantially lower than those in developing countries. This research is valuable because the verbal fluency tests and the normative data collected appear to be appropriate for clinical use in the Western Cape, and it reveals the importance of the differential effects of education on verbal fluency for both developed and developing countries.

Keywords: COWAT; cross-cultural; education; normative data; South Africa; verbal fluency.

General Introduction

Tests of verbal fluency[1] are some of the simplest and most useful tests in a neuropsychological battery. In these tests, the patient or examinee is asked to produce as many words as possible, within given restrictions and rules, in a particular time. Tests of verbal fluency are particularly useful for neuropsychologists because they activate specific areas of the brain and because deficits in performance are associated with particular psychopathologies and neurological conditions. Phonemic verbal fluency tests are especially used to assess executive functioning in patients (Alvarez & Emory, 2006). Despite this clinical popularity and a long history of research into verbal fluency tests, there is still some debate as to the significance of moderator variables such as age, gender and education on phonemic verbal fluency performance. Additionally, there is little work on cross-cultural comparisons of phonemic verbal fluency performance.

History of Verbal Fluency Tests

Tests of verbal fluency date from the early 1960s, when Thurstone's Word Fluency test was published (Mitrushina, Boone, Razani, & D'Elia, 2005). Thurstone's test required patients to write down words beginning with a given letter, or words from a given category, in a set amount of time (usually 4 or 5 minutes). The fact that the test required written responses introduced numerous confounding variables (e.g., the literacy rate of the person, how fast the person could write, etc.). To control for them, the test was modified so that the patient's response was verbal; this was the Controlled Verbal Fluency Test (CVFT; Benton, 1967). The initial format of the CVFT involved asking the patient to name as many words as possible for each of the letters F, A, or S separately within a 1-minute time limit (Bechtold, Benton, & Fogel, 1962). The patient's total verbal fluency score was thus the sum of the number of words produced across the three letter cues. Remarkably, the letters F, A, and S were chosen with no empirical evidence supporting their status as particularly appropriate in terms of word frequency or word complexity in the English language.

The Controlled Oral Word Association test (COWAT) is a revision of the CVFT that uses letter sets supported by empirical analysis. Although the COWAT retains the format of

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[1]There are two basic measures of verbal fluency; phonemic and semantic. Phonemic verbal fluency is a test where words are generated for a letter in a set time limit while semantic verbal fluency is a test where words are generated from a particular category within a set time limit. This research focuses on the phonemic verbal fluency measure.

the CVFT in that participants are instructed to name as many words as they can that begin with a certain letter within 60 seconds, the newer test uses the letter sets CFL and PRW. Borkowski, Benton and Spreen (1967) demonstrated that these sets are equivalent, in the English language, in terms of word difficulty and complexity. More recent research has reviewed the equivalency of the COWAT letter sets, and has confirmed that they continue to be suitable alternatives to each other where the language of test administration is English (Ross, Furr, Carter, & Weinberg, 2006).

The Use of Verbal Fluency Tests in Research and Clinical Practice

Despite the empirical evidence in favour of CFL and PRW presented above, there is no consensus among contemporary clinical and experimental neuropsychologists as to which phonemic fluency letter set is best to use. Although most neuropsychologists use the COWAT administration format, the letter sets tend to vary by training, personal preference, language of administration, and country (Strauss, Sherman, & Spreen, 2006).

In research studies, many experimenters prefer the COWAT letter sets (CFL and PRW; see, e.g., Ross et al., 2006), while others prefer the original FAS set (see, e.g., Egeland, Landro, Tjemsland, & Walbaekken, 2006; Troyer, 2000). Some studies use only two letters such as PS (Ratcliff et al., 1998) or TN (Gauthier, Duyme, Zanca, & Capron, 2009), whereas other use a mixture of the COWAT sets and FAS (Ruff, Light, Parker, & Levin, 1996). The rationale for choosing letters other than the conventional CFL and PRW typically involves creating appropriate normative data for the particular population under investigation.

The studies referred to in the previous paragraph are all normative studies of phonemic verbal fluency performance, designed to produce standardized data relevant to clinical practice in the countries in which the research was conducted (Canada, Norway, India, and the United States). Phonemic verbal fluency tasks are also frequently used in neuroimaging and lesion studies because performance on such tasks is correlated with neural activity in specific brain regions. There seems to be consensus in the neuroimaging literature that participants engaging in verbal fluency tasks commonly activate regions in the left cerebral hemisphere more than in the right cerebral hemisphere (Billingsley et al., 2004). Confirming this proposal, Szatkowska, Grabowska, and Szymanska (2000) found that patients with lesions in the left dorsolateral prefrontal cortex performed significantly more poorly than healthy controls on a standard format phonemic fluency task.

Another reason for the popularity of phonemic verbal fluency tasks is their ability to measure aspects of executive functioning (e.g., generativity), which makes them most useful

in clinical settings (Fjell & Walhovd, 2003; Kockler & Stanford, 2008). This is especially the case for disorders such as dementia. A study by Piatt, Fields, Paolo, Koller, and Troster (1999) examined the performance of patients diagnosed with Parkinson's disease with dementia to those without dementia as well as to normal controls. The test used the original letter set (FAS) and followed the standardised procedure i.e. 60s time limit for each letter Results indicated that those diagnosed with Parkinson's disease with dementia did significantly worse than the control group and those with Parkinson's disease without dementia. Another study examined the effects of dementia on phonemic verbal fluency outcomes in a clinical population with patients who have frontal lobe dementia, dementia of the Alzheimer type and healthy controls. A 2 minute verbal task was used with the letter *P* where it was found that those with dementia of the frontal lobe and dementia of the Alzheimer type did significantly more poorly than controls (Pasquier, Lebert, Grymonprez, & Petit, 2009).

Phonemic verbal fluency tests are also frequently used in investigations of the neuropsychology of schizophrenia, a disorder that is commonly associated with frontal lobe dysfunction (Bonilha et al., 2008). One such study by Landro and Ueland (2008) compared phonemic verbal fluency in 21 adolescents diagnosed with schizophrenia to healthy controls. The letters used were *F* and *A* with the standard 60 seconds time limit for each letter. It was found that healthy controls did significantly better than the clinical population under investigation.

Significant Moderators of Phonemic Verbal Fluency Performance

Sex. Some research suggests that biological sex has a significant impact on phonemic verbal fluency performance and that it is therefore necessary to have separate normative data sets for men and women (Barr, 2003). Sex differences on phonemic verbal fluency tasks tend to be consistent with the conventional wisdom regarding differential male-female performance on cognitive tasks (i.e., the majority of studies indicate that women tend to do better than men on verbal fluency tasks; Aronoff, 2003). One such study by Burton, Henninger, and Hafetz (2005) investigated sex differences in numerous tasks including phonemic verbal fluency. This study required participants to write down as many words as possible that began with the letter *S* in 5 minutes and then, in 4 minutes, to use the letter *C* to write down as many four letter words as possible. The results showed the expected relationship; women performed significantly better than male participants. Another study by Aronoff (2003) looked at the phonemic verbal fluency performance of a group of high school

learners in a second-language class. They were all tested in the second language they were learning, with the rationale being that, regardless of sex, they would all have had the same amount of exposure to that language and its vocabulary. The results indicated that, despite this equivalency in exposure to the second language, women performed better than men on a written version of the phonemic fluency task.

Potential mechanisms for this sex difference include both sociocultural (e.g. girls start talking before boys and tend to be more proficient though out their lives; Kolb, & Whishaw, 2003) and neurological explanations (e.g. the hormone, oestrogen, has been related to improved verbal fluency outcomes; Zillmer, Spiers, Culbertson, 2008 and neuroimaging studies show that women have larger language areas; Kolb, & Whishaw, 2003). Evidence for the latter includes data from a recent study examining sex differences in brain activation during the performance of verbal fluency tasks. This study found that the left and right prefrontal cortex, cingulate gyrus, and right cerebellum were all significantly activated during testing for both men and women, but that women had significantly more activation in the right hippocampal gyrus and hippocampus (Weiss et al., 2003). This finding would suggest that women's activation of these areas contribute to better processing and performance on phonemic verbal fluency. A major weakness of this study, unfortunately, is that it was not possible for the researchers to compare actual behavioural performance across the sexes: The participants were instructed to silently think of words relevant to the task during functional magnetic resonance imaging (fMRI) scanning (in other words, the researchers could not measure how many words each participant actually produced).

Age and education. Strauss, Sherman, and Spreen (2006) advise that these moderating variables should be included in any study investigating phonemic verbal fluency performance. Most studies follow that advice (see, e.g., Mungas, Reed, Farias, & DeCarli, 2009; Tombaugh, Kozak, & Rees, 1999). However, because age and number of years of education are typically highly positively correlated, some studies investigating factors that moderate phonemic verbal fluency performance focus either on age (e.g., Kave, Samuel-Enoch, & Adiv, 2009; Landro & Ueland, 2008; Moreno-Martinez, Laws, & Schulz 2008; Rodriguez-Aranda & Martinussen 2006), whereas others focus exclusively on education (e.g., Da Silva, Petersson, Faisca, Ingvar, & Reis, 2004; Ratcliff et al., 1998).

With regard to age, a meta-analysis of 26 studies by Rodriguez-Aranda and Martinussen (2006) confirmed that an increase in age is associated with an increase in word production until approximately the age of 40, when slight decreases set in; these get more marked as old age advances. There remains some debate, however, as to the extent of the

effect of age on verbal fluency performance: some studies suggest age is only a slightly significant moderator variable (Troyer, 2000), whereas others suggest it is a highly significant moderator (Kave, Samuel-Enoch, & Adiv, 2009; Schneider, 2008).

With regard to education, it is the moderating variable most often found to have a significant effect on phonemic verbal fluency performance. For instance, at the very extreme, studies examining differences in verbal fluency performance between literate and illiterate participants find that the latter perform significantly more poorly than the former (Da Silva et al., 2004; Ratcliff et al., 1998). Further, these studies also suggest that participants with higher levels of education (i.e., usually more than 12 years of education) perform better than those with lower levels (i.e., usually less than 12 years of education) on these tasks. However, no South African study has established whether, and to what extent, level of education has a moderating effect on phonemic verbal fluency performance. Moreover, no study has compared the differential effects of education on verbal fluency performance in developed (i.e., relatively high quality educational systems) versus developing (i.e., relatively low quality educational systems). This study will attempt to fill these knowledge gaps.

Cross-Cultural Neuropsychology of Verbal Fluency: The South African context

As noted earlier, and as in most other countries where neuropsychology is practiced, phonemic verbal fluency tests are frequently used in South African clinical settings. Unfortunately, however, there are no published normative studies of verbal fluency in this country, and so South African clinical neuropsychologists often judge the performance of their patients against that of individuals in northern hemisphere countries (e.g., the United States, Canada, and the United Kingdom), where norms have been collected.

Although phonemic verbal fluency tasks are frequently used in clinical practise in South Africa, there are very few published research studies on verbal fluency performance in this country (H. Ferrett, personal communication, April 28, 2009). Of those that have been published, most focus on the comparison of a clinical population to a control population on the verbal fluency task. For instance, Kodituwakku et al. (2006) investigated the differences in phonemic verbal fluency between 62 children diagnosed with Fetal Alcohol Syndrome (FAS) and healthy matched controls. The language used by participants was Afrikaans. The letters *S* and *K* were administered under the standard format of the 60 seconds time limit per letter with the usual restrictions (proper nouns and same words with different endings were not allowed). As expected, healthy controls did significantly better than the children diagnosed with FAS. Similarly, Bittner and Crowe (2006) reported that adults who had

sustained a traumatic brain injury (TBI) performed significantly more poorly than healthy matched controls on a verbal phonemic verbal fluency test when using the F-A-S letter set.

To this point, there have apparently been no efforts to develop, in an empirical fashion, letter sets appropriate for the multilingual and multicultural South African society. Neuropsychologists in clinical practice most often follow international conventions in using the F-A-S set with their English-speaking patients; for Afrikaans-speaking patients, the most commonly used letter set is M-A-S (because the letter *F* rarely starts in words Afrikaans, and because it might be easily confused with *V* (H. Ferrett, personal communication, April 28, 2009). For Xhosa and Zulu speakers, tests are usually administered in English or Afrikaans, depending on what language the testee is educated in.[2]

Summary and Rationale for the Present Study

Since Thurstone and Thurstone (1962) first published their paper on tests measuring verbal fluency, the administrative procedure and stimuli featured within these tests have been reviewed and revised numerous times. Verbal fluency tests are now an important part of almost any neuropsychological test battery, and are widely used throughout the world. The fact that verbal fluency performance is clearly associated with discrete brain regions and those deficits in verbal fluency are associated with particular psychiatric diagnosis (e.g., schizophrenia) and neurological conditions (e.g., Alzheimer's disease), indicate that administration of these tests is useful in both clinical and research settings.

Studies focused on developing normative data, and investigating performance in healthy individuals, have established that age, sex, and education are important moderators of verbal fluency. Unfortunately, however, there are very few published research studies presenting verbal fluency data for South Africans. Given that (a) South Africa is a multilingual and multicultural society, (b) Western verbal fluency norms are potentially not suited for use in this country, and (c) clinical neuropsychologists in South Africa use verbal fluency tests at least as often as their North American and European counterparts, there is an urgent need for empirical studies aimed at developing appropriate letter sets for use with South African individuals of various first languages, at producing normative data for South African samples, and at investigating the influence of moderator variables (such as age, level

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[2]Bethlehem, De Piccotto, and Watt (2003) investigated semantic fluency in a bilingual English-Zulu cohort. They concluded that if a high proficiency of both languages is present the participant will choose to do the test in English, the language in which the participant is most likely to have received formal education.

of education, quality of education, home language, and bilingual/monolingual status) on verbal fluency performance.

The purpose of this study is to help in filling this knowledge gap by. There are three specific aims: (1) to establish the equivalency of the letters chosen to be equivalent across three South African languages; English, Afrikaans and isiXhosa; (2) to determine to what extent the variables of language, the years of education, gender and socio-economic status (SES) affects performance of young South Africans on phonemic verbal fluency tasks; (3) to place these findings from South Africa in a global context and to determine whether the level of formal education in developing countries has a larger or smaller moderating effect on phonemic verbal fluency performance than in developed countries.

Study 1

This study aims to determine the letter set equivalency for each of the languages under investigation; English, Afrikaans and isiXhosa. It also determines which variables have the most predictive value for outcomes on the phonemic verbal fluency task. The amount of education the participant has completed is hypothesized to be the most important variable in predicting phonemic verbal fluency outcomes.

Methods

Design and setting. The study is nested within a larger research project whose aim is to provide normative data for English-, Afrikaans-, and isiXhosa-speaking individuals in the Western Cape on the Wechsler Abbreviated Scale of Intelligence (WASI; Wechsler, 1999), the Boston Naming Test (BNT; Kaplan, Goodglass, & Weintraub, 1983), and phonemic and semantic verbal fluency tests. The entire test battery took approximately an hour, varying by 10 minutes.

Data were collected from learners at primary schools and high schools in the Cape Town region and from students at the University of Cape Town. Data collection took place on school premises and in the Department of Psychology at the University of Cape Town, respectively.

A quantitative, cross-sectional design was used in accordance with nonrandomized selection criteria. There was a single administration of the neuropsychological test battery.

Participants. The exclusion criteria used in the selection process were extensive, so that the results were not confounded by extraneous variables. Participants were required to (a) have English, Afrikaans or isiXhosa as their first language, (b) be between the ages of 7 and

25 years, (c) be currently attending a primary/high school or a tertiary institution, and (d) be residing in the Cape Town region. Furthermore, in order to ensure that participants had been educated in similar school systems and without specific hindrance, they all had to have been educated in South Africa for at least 5 years, and were required not to have learning disorders or educational difficulties. These criteria were put in place to ensure that a representative sample of South African children, adolescents, and young adults would be recruited, and to ensure ease of logistics.

Individuals were excluded from the study if they were on psychotropic medication, had a psychiatric diagnosis, had pre-natal or birth complication, had a head injury which resulted in a loss of consciousness for more than 5 minutes, or had seizure disorders, substance abuse disorders, a medical illness resulting in loss of cognitive functioning, language, speech or behavioural disorders; these exclusion criteria were put in place because performance on neuropsychological tests may reflect cognitive disadvantages related to the above conditions, thus confounding the results. Finally, participants who received psychometric testing within the past 12 months were excluded from the study due to the possibility of practice effects confounding the results.

Finally, a total sample of 269 participants was recruited (162 females, 107 males; 113 English-, 71 Afrikaans-, and 85 isiXhosa- speakers). The sample size used in the analysis presented below was 147 due to incomplete data (85 females, 62 males; 59 English-, 39 Afrikaans-, and 49 isiXhosa- speakers). The tertiary participants participated as part of their course requirements. Tertiary students who took part but did not receive course credit instead received a small gift voucher as compensation. All schoolchildren received similar vouchers as compensation for their participation.

Materials. The larger study within which the current study is nested uses a comprehensive battery of neuropsychological tests and questionnaires; only those relevant to the current study are discussed below.

All participants were required to complete a *demographic questionnaire*, designed as part of the larger study. The questionnaire gathered information regarding race, place of education, place of residence, medical history, and scholastic history. The school learners completed a slightly different demographic questionnaire (see Appendix A) to that completed by the university students (see Appendix B).

With regard to the *phonemic verbal fluency tests*, we used the standard COWAT administration format. This is a 1-min task that requires the participant to name as many words as possible that begin with a particular letter. The examiner gives a standard set of

instructions, and then gives the examinee the letter to which he/she should generate words. The examiner records the examinee's responses verbatim and in order, making sure to document which words appeared in each 15-seond interval. All repetitions, self-corrected errors, rule violations and set-loss errors[3] are recorded. The total score on a verbal fluency letter set is calculated as the sum of all words generated across the three letters, minus words that represent repetitions, rule violations, or set loss errors. The COWAT has excellent psychometric properties: inter-rater reliability is 0.9 (Ross, 2006), test-retest reliability is similarly high, and there are good correlations, ranging from 0.85 to 0.94, between letter sets (Lacy, Gore, Pliskin, & Henry, 1996; Troyer, 2000).

As noted earlier, the two letter sets used in the original COWAT are CFL and PRW. Neither these letter sets, nor the popular FAS set, have been normed for South African populations; furthermore, there are no letter sets with established equivalency across any subset of South Africa's official languages. In an initial attempt to remedy this situation, we consulted with linguists and established that the letter sets LBS and MAT were the most appropriate to use in the Western Cape, where the three dominant languages are English, Afrikaans, and isiXhosa. The construction of these letter sets was based on rankings of the relative frequency of words beginning with particular letters. The easiest (letters with the highest frequency) are 'L' and 'M', while 'S' and 'T' had the lowest equivalent frequency (and hence were the most difficult), with 'B' and 'A' falling in between.

Other than the variations in letter set, the standard COWAT administration and scoring procedures (described above), were followed.

Procedure

Preliminary procedure. After individuals had been screened according to the exclusion criteria, the parents of all participants under the age of 18 years completed informed consent documents (see Appendix C); all participants over the age of 18 years completed their own consent forms (see Appendix D). Parents of the younger learners were responsible for providing the relevant demographic information, while high school learners and tertiary students provided the information themselves.

In the case of the university students, a general meeting for interested applicants was held beforehand; at that meeting, (a) the researchers confirmed that students qualified for the

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[3] Set-loss error: A type of error where a participant gives a word which is not within the predetermined restriction (e.g. saying the word '*centre*' when the stimuli letter was *S*).

study, (b) potential participants completed the informed consent documents and the demographic questionnaire, and (c) individual appointments were made for administration of the test battery. A sample of the consent form is included in the Appendix.

Test battery administration. Before the battery was administered, participants were informed that they could withdraw from the study at any time, or take a break during the testing should they feel fatigued. Further, participants were informed that they would be completing various tasks, some of which will require their responses to be timed or audio recorded. Prior to the commencement of each test, participants were given clear instructions, as well as an opportunity to ask questions if they do not clearly understand.

Specifically with regard to the phonemic verbal fluency tasks, the researcher (a) gave standard instructions to each participant to control for any external bias that may have influenced the testing process, (b) gave examples of what was expected of them during the test, and (c) outlined restrictions on which kinds of words were allowed and which not (see Appendix E). The researcher then clearly told the participant when to start generating words and when to stop.

During phonemic fluency testing, if there was a pause, the researcher encouraged the participant to think of more words by saying, "What other words can you think of?" After the completion of each individual letter test, the researcher offered more words of encouragement, in the form of "that was good" or the like. To control for fatigue and order effects, half the participants were administered the MAT letter set first and the LBS letter set second; the other half received the letter sets in the opposite order. The phonemic verbal fluency task took approximately 8 minutes to administer.

Debriefing. Participants were debriefed at the end of the test battery administration and thanked for their participation. They were given the opportunity to express any opinions with regard to the testing experience, and they were informed of how to access the final results of the study if they wished to do so.

Statistical Analysis

All statistical procedures were completed on the Statistical Package for Social Sciences (SPSS), version 17.0 (SPSS Inc., Chicago IL).

Between-Group Comparisons: Ensuring letter set equivalency. Before completing any between-group comparisons, descriptive statistics were calculated for all relevant variables, and all assumptions underlying parametric stratified tests of significance were examined. To ensure the letters were equivalent in difficulty across the languages (i.e., to ensure that all

participants, regardless of language group, had equal opportunity to produce a reasonably equivalent number of words in response to each letter cue), a total of eight between-group comparisons of means were calculated (one for each of the letter sets, LBS and MAT, and one for each individual letter, L, B, S, M, A and T). In the event of missing data, cases were excluded from just that analysis. Following this, a similar eight one-way between-group comparisons of means were conducted to assess letter equivalency across male and female groups. Here, as in all subsequent analyses, the level of statistical significance (α) was set at .05.

Multiple Regression: Demographic predictors of phonemic verbal fluency performance. In this multiple regression analysis, the demographic variables *language of test administration*, *years of education*, *sex*, and *socio-economic status* (*SES*) were entered as predictors of the outcome variable *total phonemic verbal fluency score* (i.e., the sum of all correct words produced across both letter sets). The predictor variables were entered in one block because I had no theoretical or statistical basis to enter them in hierarchical fashion. Diagnostic tests were run and analyses of the residuals were examined; tolerance and any partial correlations were noted, and inspection for outliers was also done.

Results

Table 1 presents demographic information for the final sample of 269 participants. For all the variables presented in that table, the data were normally distributed and Levene's test for homogeneity of variance was not significant unless otherwise stated. As seen in the table, there were no statistically significant differences between the language groups in terms of age, years of education, or sex distribution. There was, however, a significant between-groups difference with respect to SES. Therefore, in all subsequent analyses of differences between language groups, SES was used as a covariate.

Table 1
Demographic Information for the Current Sample

	Group					
	English (n = 113)	Afrikaans (n = 71)	isiXhosa (n = 85)	F/χ^2	p	ESE (ω^2)
Age (years)[a]				0.080	.923	0.03
Range	7 - 25	7 - 25	7 - 25			
Mean (SD)	16.00 (4.44)	16.05 (4.49)	16.25 (4.56)			
Education (years)[b]				0.247	.782	0.04
Range	1 - 16	1 - 16	1 - 16			
Mean (SD)	8.87 (4.12)	8.84 (4.1)	8.47 (4.34)			
Gender[a]				1.143	.321	0.09[d]
Male:Female	49:64	23:48	35:50			
Income Range[c]				31.413	< .001***	0.40[d]
<10,000	5	14	30			
10,000 - 20,000	7	4	9			
20,000 - 40,000	5	5	4			
40,000 - 60,000	6	2	2			
60,000 - 100,000	9	5	2			
>100,000	27	9	2			

Note. Income was used to estimate socio-economic status (SES).
[a]df_{within} = 266
[b]df_{within} = 263 (three cases were excluded because of missing data)
[c]df_{within} = 144 (123 cases were excluded because of missing data—participants did not specify their income range)
[d]Effect size estimate here is Cramer's V
***p < .001

Between-Group Comparisons: Ensuring letter set equivalency. The results of the eight one-way analyses of covariance (ANCOVAs) comparing letter set and individual letter performance across language groups, with SES as a covariate, are shown in Table 2. ANCOVA revealed that SES was significantly related to language, $F(1, 143) = 4.159$, $p < .05$, $r = 0.17$. As the table shows, after controlling for SES, there were no statistically significant between-group differences on either of the letter sets or on any of the individual letters. To emphasize this point, there was no statistically significant between-groups effect on total phonemic verbal fluency (i.e., total across all letters) after controlling for SES, $F(2, 143) = 0.012$, $p > .05$, $r = 0.01$.

Table 2
Equivalency of Letter Sets and Letters across English, Afrikaans and isiXhosa after controlling for SES

Letter set / Letter	Group: English (n = 59)	Group: Afrikaans (n = 39)	Group: isiXhosa (n = 49)	F	p	ESE (r)[b]
LBS[a]	30.10 (8.84)	28.08 (11.15)	27.31 (8.88)	0.105	.901	0.15
MAT[a]	24.66 (8.33)	23.97 (9.62)	22.67 (8.34)	0.021	.500	0.16
L	8.80 (3.27)	8.15 (3.61)	8.12 (3.65)	0.125	.882	0.10
B	10.68 (3.01	9.38 (3.90)	8.96 (3.08)	0.678	.509	0.21
S	10.63 (3.89)	10.54 (4.72)	10.79 (3.79)	0.361	.698	0.09
M	8.71 (3.32)	9.03 (4.14)	8.21 (3.12)	0.416	.661	0.13
A	7.02 (2.68)	7.03 (3.23)	6.60 (3.22)	0.142	.868	0.14
T	8.93 (3.43)	7.92 (3.71)	8.33 (3.04)	0.672	.512	0.16

Note. In columns 2, 3, and 4, means are presented with standard deviations in parentheses.
[a]df_{within} = 143; all other df_{within} = 142
[b]r is used as the effect size estimate here following recommendation by Field (2005) for ANCOVA as opposed to ANOVA.

The results of the eight one-way analyses of variance (ANOVAs) comparing letter set and individual letter performance across males and females are shown in Table 3. As the table shows, there were no statistically significant between-group differences on either of the letter sets or on any of the individual letters.

Table 3
Equivalency of Letter sets and Letters across Males and Females

Letter set / Letter	Group: Males (n = 107)	Group: Females (n = 160)	F	p	ESE (ω^2)
LBS[a]	33.75 (12.23)	34.45 (11.96)	0.22	.640	-0.003
MAT[b]	28.22 (11.03)	29.87 (10.91)	1.46	.228	0.002
L[c]	10.34 (4.17)	10.24 (4.34)	0.03	.862	-0.004
B[c]	11.57 (4.38)	12.00 (4.28)	0.64	.426	-.001
S[c]	11.83 (4.98)	12.64 (4.28)	1.99	.159	.004
M[c]	10.03 (4.29)	10.74 (3.95)	1.97	.162	.004
A[c]	8.25 (3.81)	8.84 (3.72)	1.59	.209	.002
T[d]	10.00 (4.20)	10.70 (4.09)	1.83	.177	.003

Note. In columns 2 and 3, means are presented with standard deviations in parentheses.
[a]df_{within} = 267
[b]df_{within} = 266
[c]df_{within} = 265
[d]df_{within} = 264

An additional analysis of interest here concerns whether the two letter sets are (a) equally challenging, and (b) as challenging as the most current most commonly used letter set (FAS). A paired-samples *t*-test showed that the two letter sets were statistically significantly different from each other, $t(267) = 12.081$, $p < .001$, with the LBS letter set ($M = 34.10$, $SD = 12.01$) proving less challenging than the MAT letter set ($M = 29.22$, $SD = 10.97$).

Mitrushina et al. (2005) provide meta-analytic normative data for the FAS letter set, stratified by age group. For the 18-19-year-old group, the predicted test score, based on the equation [$Predicted\ test\ score = 34.29763 + 0.5537161*age - 0.0070315*age^2$] is 42.13. A one-sample *t*-test comparing the performance of the 18-19-year-olds in the current sample ($n = 59$) on the LBS letter set to that predicted score yielded a result of $t(58) = -0.60$, $p = .550$. A similar analysis of the current sample's 18-19-year-olds performance on the MAT letter set compared to that predicted score yielded a result of $t(58) = -4.61$, $p < .001$.

Based on the same equation given above, Mitrushina et al. (2005) predict an FAS normative score of 43.20 for 20-24-year-olds. A one-sample *t*-test comparing the performance of the 20-24-year-olds in the current sample ($n = 53$) on the LBS letter set to that predicted score yielded a result of $t(52) = -0.80$, $p = .429$. A similar analysis of the current sample's 20-24-year-olds performance on the MAT letter set ($n = 52$) compared to that predicted score yielded a result of $t(51) = -5.32$, $p < .001$.

These data, taken together with those reported above, indicate that, for 18-19-year-olds and for 20-24-year-olds (and regardless of sex or language of the individual), (a) the LBS letter set is as challenging as the FAS letter set, and (b) the MAT letter set is significantly more challenging than both LBS and FAS.

Multiple Regression: Demographic predictors of phonemic verbal fluency performance. Here I attempted to determine which of the set of demographic variables (language of test administration; years of education; sex; SES) served to best predict total phonemic verbal fluency performance. After running a block regression, the resulting model was significant, $F(4, 140) = 16.12$, $p < .001$, $R^2 = 0.32$.

Although diagnostics generally indicated that the model was sound, there was one minor problem: Pearson's product-moment correlations showed that SES was significantly related to language, $r = -0.561$, $p < .001$. Further diagnostics revealed, unsurprisingly, that SES and language load on the same eigenvalue. (This is, of course, consistent with the fact that SES was revealed as a potential covariate in the language group comparisons above.) Nonetheless, years of education was the strongest predictor of verbal fluency outcomes,

$t(140) = 7.42$, $p < .001$, followed by SES, $t(140) = 2.25$, $p < .05$. The final regression equation therefore took the following form:

Total Phonemic Verbal Fluency Performance =

15.049 + (-0.063)Language + (1.616)Education + (-1.025)Sex + (0.782)SES

Discussion

Phonemic verbal fluency tests are a staple of neuropsychological test batteries across the world because of their utility in detecting executive functioning deficits in a variety of psychopathological and neurological conditions, and because of the clear correlation between performance on such tests and activity in discrete brain regions. Unfortunately, however, there is wide variation in the stimuli that comprise the test: many use the conventional FAS (e.g., Loonstra, Tarlow, & Sellers, 2001) or the COWAT letter sets CFL and PRW (e.g. Ruff, Light, & Parker, 1996), while some use subsets of CFL (e.g. Sumerall, Timmons, James, Ewing, & Delert, 1997) and others use completely different letters/letter sets (Tallberg, Ivachova, Tinghag, & Ostberg, 2008; Mathuranth et al., 2003; Ratcliff et al, 1998). The reasons for this variation largely involve personal preference, differences in training, and language/cultural/geographic considerations. In the current study, I attempted to determine (a) whether two letter sets specially designed for use in South Africa (and more specifically, the Western Cape) would be equally difficult for English-, Afrikaans-, and isiXhosa speakers, and (b) whether performance of South African individuals on those letter sets would be influenced by the same demographic factors as performance by, for instance, American individuals on the FAS letter set.

The data reported above indicate that, if SES is controlled, the letters and letter sets chosen are equivalent across all three languages (i.e., participants from the three language groups produced reasonably equivalent numbers of words across both letter sets). This result is encouraging for South African clinicians and researchers (and particularly for those in the Western Cape): It suggests that these letter sets can be used, without adjustment, in practice and experimental settings where English-, Afrikaans-, and isiXhosa-speaking individuals are present.

Further, the analyses reported above comparing current data to normative data provided in Mitrushina et al. (2005) suggest that the letter set LBS, but not the set MAT, is comparable to the original and widely-used FAS set. This results stand in contrast to those of Barry, Bates, and Labouvie (2008), who compared the relative difficulty of the FAS and CFL

letter sets. They found CFL to be more challenging than FAS, and noted that FAS administration tended to be associated with greater variation in performance.

The regression results reported above suggest that education accounts for most of the variance in this sample's phonemic verbal fluency performance, but that the sex of the participant has no significant effect on that performance. This finding is similar to that of Tombaugh, Kozak and Rees (1999), who found identical patterns in terms of educational and sex differences. Numerous other studies have also found a non-significant relationship between sex and verbal performance (see, e.g., Brickman et al., 2005; Egeland et al., 2006; Tallberg, Ivachova, Tinghag, & Ostberg, 2008). Obviously, this result suggests that, in the clinical setting and in the absence of demographically-stratified normative data, both the amount of education the person has had and their SES should be carefully considered when interpreting their score on phonemic verbal fluency tasks.

With regard to limitations of the present study, the first is that the participants were drawn from only three of the 11 official language groups in South Africa. Clearly, a direction for future research is to extend the methodological principles developed in this study (i.e., the way in which the letter sets were determined, and the way in which their equivalence across language was tested) to other South African language groups.

Perhaps a more serious limitation, however, involves the population from which the data were derived: students. Although it is commonplace to use such samples in psychology studies, this does present presents problems of generalizability to the entire population. This is especially the case in South Africa, where the majority of the population does not have access to high levels of education (especially tertiary education). The fact that variations in SES had a significant effect on phonemic verbal fluency performance further suggests the importance of taking into account differences between those who have resources and those that do not when interpreting scores on this test and when creating normative data for it. I examine this relationship further in the next study.

Study 2

This study is a meta-analysis of published articles relating to the relationship between years of education and phonemic verbal fluency performance. More specifically, I examine that relationship in developed countries separate from that in developing countries. The rationale behind this separation is that developed countries are resource rich and thus (one might assume) can afford to place greater emphasis on education as a worthwhile investment,

whereas developing countries are resource poor and thus (one might assume) are unable to invest as much in their population's education.

Design and Methods

Data were drawn from studies conducted and published in different countries around the world and included tests of phonemic verbal fluency that were then compared to each other using the same education categories. The countries included were categorized as either developed or developing following criteria described in Appendix F and Table 1. Studies were thus divided into those conducted in developed (or resource-wealthy) countries and those conducted in developing (or resource-poor) countries. Within each country, comparisons were made between the phonemic verbal fluency performance of groups with high levels of education and those with low levels of education.

Selection of Studies and Criteria for Inclusion. Two procedures were used to select studies. First, the databases *PsychInfo*, *PubMed* and *Web of Science* were searched using a specific time limit and the following keywords: *verbal fluency*, *controlled oral word association*, *COWAT*, *FAS*, *lexical fluency*, *letter fluency*, *phonemic fluency*, *word fluency* and *word list generation*. In this way, all peer-reviewed studies that were published between 1990 and 2009 and that focused on phonemic verbal fluency were retrieved. A total of 43 studies were thus identified as being suitable for further analysis.

The second procedure involved applying the following criteria to determine which articles would be included in the final meta-analytic sample:

1. Explicit mention of the language in which the test was administered.
2. Explicit mention of the first language of the participant.
3. Explicit mention of which letters were used in the phonemic verbal fluency test.
4. Explicit mention of discrete categories describing the years of education the participants had.
5. Use of only cognitively healthy humans as participants.
6. Provision of separate and independent raw scores for the phonemic verbal fluency tests, regardless of how many and which other tests were also administered.
7. Provision of means, sample sizes and standard deviations for each phonemic verbal fluency measure within each education category.

After applying those inclusion/exclusion criteria, 9 studies were judged suitable for inclusion in the final set of analyses. The studies from developed countries that were included in the final analysis are shown in Table 3 and the studies included from developing countries are

shown in Table 4. The studies excluded, and reasons for their exclusion, are presented in Appendix G.

Variables of Interest. Besides the mean, sample size and standard deviation, other variables of interest were: the language in which the test was administered, the country in which the study was conducted, letters used, age range of sample, year study was published, the number of letters, whether the country could be classified as a developed or developing nation, sex of participants, age of participants, the number of education categories used, and which education categories were used.

Statistical Analysis

Standard meta-analytic procedures were followed to explore the relationship between years of education and performance on measures of phonemic verbal fluency.

For studies conducted in developed countries, one comparison was between participants with education of less than or equal to high school (≤ 12 years of education) versus those with education of more than high school (>12 years of education). Another comparison was between participants with relatively low levels of education (≤ 15 years) versus those with relatively high levels of education (>15 years). These two separate comparisons had to be conducted because different studies used different categories in defining participant levels of education, and I wanted to maximise the number of studies included in this meta-analysis.

For studies conducted in developing countries, the comparison was between participants with some high school education (<= 12 years) and those with more than high school education (> 12 years).

Some of the studies used unique education categories (e.g., 13-15 years; Egeland et al. 2006), and so these categories had to be combined with others so they would fit into the structure outlined above. When education categories were combined, the sample statistics were combined in ways described elsewhere (Loonstra, Tarlow, & Sellers, 2001; Winer, Brown, & Michels, 1991).

Ultimately, a total of nine analyses were performed. In each case, effect sizes were calculated using Hedges' formula and analyses were conducted using procedures outlined by Lipsey and Wilson (2001).

Table 3

Studies from Developed Countries included in the Meta-Analysis

								Education Categories					
								≤ 12 years			>12 years		
Study No.	Authors	Year	Country	Language	Letters used	Age range	*N*	*Mean*	*SD*	*n*	*Mean*	*SD*	*n*
1	Ruff, Light, & Parker	1996	USA	English	C F L P R W	16 - 70	360	36.50	9.90	120	41.90	1.90	240
2	Loonstra, Tarlow, & Sellers	2001	USA	English	F A S	15 - 95	1945	30.70	13.09	1357	41.14	12.37	588
3	Kave	2005	Israel	Hebrew	B G S	18 - 85	369	36.00	9.00	89	38.60	10.10	180
4	Egeland, Landro, Tjemsland, & Walbaekken	2006	Norway	Norwegian	F A S	16 - 77	201	38.00	9.50	52	48.00	11.48	104
6	Tallberg, Ivachova, Tinghag, & Ostberg	2008	Sweden	Swedish	F A S	16 - 89	165	38.80	12.50	82	45.50	15.50	83
								<=15 years			>15 years		
1	Ruff, Light, & Parker	1996	USA	English	C F L P R W	16 - 70	360	40.00	9.70	240	43.80	10.60	360
8	Brickman et al.	2005	UK, USA, Australia, Netherlands	English/Dutch	F A S	21 - 82	471	18.02	0.29	245	19.17	0.43	471
9	Sumerall, Timmons, James, Ewing, & Dehlert	1997	USA	English	C F L	70 - 95	47	29.60	9.40	28	38.50	11.90	47
4	Egeland, Landro, Tjemsland, & Walbaekken	2006	Norway	Norwegian	F A S	16 - 77	201	41.00	10.35	104	52.00	11.20	156

Table 4

Studies from Developing Countries included in Meta-Analysis

								Education Categories					
								≤ 12 years			>12 years		
Study No.	Authors	Year	Country	Language	Letters used	Age range	*N*	*Mean*	*SD*	*n*	*Mean*	*SD*	*n*
7	Ratcliff	1998	India	Hindi	P S	34 - 55	90	8.59	6.11	60	23.13	5.96	30
10	Mathuranth, George, Alexander, Sarma, & Sarma	2003	India	Malayaham	P	55 - 84	153	4.78	3.57	113	7.55	2.80	40
11	Unpublished	2009	South Africa	English	L B S M A T	7 - 25	269	7.60	3.68	219	14.04	1.00	47

Results

Seven studies from developed countries and three from developing countries (including the unpublished data presented in Study 1 of the this paper) were included in the final meta-analysis.

In the seven studies from developed countries, sample sizes ranged from 47 to 1945, while age ranges were from 15 to 95 years. Across these studies, phonemic verbal fluency tasks were administered in five different languages: English (4 studies), Hebrew (1), Swedish (1), Norwegian (1), and Dutch (1). As shown in Table 5, mean effect sizes were large and negative for both educational categories. Unfortunately, the *Q* test of homogeneity was statistically significant in both meta-analyses, indicating that the two groups used for each educational category were significantly different (i.e., groups were heterogeneous). This heterogeneity could have resulted from the small number of studies included in the analysis.

Table 5
Meta- analysis of phonemic verbal fluency by education category for developed countries

Compared Education Categories	*k*	*n*	Mean Effect Size	*SE*	95% CI Lower	95% CI Upper	*Q*
<= 12 years vs. >12 years	5	2895	-0.71	.05	-0.80	-0.61	0.0000023
<= 15 years vs. >15 years	4	1034	-0.56	.09	-0.74	-0.38	0.033

Note. *k* = number of articles for each education category; *n* = total number of participants in each study; 95% CI = 95% confidence interval for mean effect size; Q = test of homogeneity.

In the three studies from developing countries, sample sizes ranged from 90 to 260, while age ranges were from 7 to 84 years. Across these studies, phonemic verbal fluency tasks were administered in five different languages: Hindi, Malayaham, English, Afrikaans and isiXhosa. As shown in Table 6, mean effect sizes were very large and negative, indicating that phonemic verbal fluency scores for those with high school education or less were significantly worse than those with tertiary education. Again, the *Q* test for homogeneity was significant, indicating that the groups were heterogeneous and suggesting that more studies need to be included to give more statistical power to the model.

Table 6
Meta-analysis of phonemic verbal fluency by education category for developing countries

Compared Education Categories	*k*	*n*	Mean Effect Size	*SE*	95% CI Lower	95% CI Upper	*Q*
<= 12 years vs. >12 years	3	509	-1.29	.16	-1.60	-0.29	0.000318

Note. *k* = number of articles for each education category; *n* = total number of participants in each study; 95% CI = 95% confidence interval for mean effect size; Q = test of homogeneity.

Discussion

This study is set against a background, originally established in northern hemisphere literature and expanded upon in Study 1 of this paper, of extensive evidence illustrating that education has a substantial effect on phonemic verbal fluency performance. Here, I aimed to show that, because we might assume that the difference between high and low levels of education in developed countries is smaller than that in developing countries, there is a greater magnitude of relationship between level of education and phonemic verbal fluency performance in developed than in developing countries.

The series of meta-analyses presented above tended to confirm the predictions: Mean effect sizes in developing countries were almost twice as large as in developed countries. Moreover, the large effect sizes for individuals with less than high school versus more than high school education in developed countries leads one to the conclusion that tertiary education offers the potential for substantial gains on phonemic verbal fluency tasks (and possibly on other neuropsychological tests).

The implications of these data are that researchers and clinicians must take into account not only number of years of education but also the socioeconomic context in which education takes place when interpreting performance on phonemic verbal fluency tasks. In developing, or resource-poor, countries, there are likely to be much larger disparities between those with high levels of education and those with low levels of education than in developed, or resource-wealthy, countries. This disparity probably relates to the availability of resources for educational purposes at all levels, and the differences in value attached for high and low levels of education. In other words, the normative performance of healthy individuals with low levels of education in developing countries is likely to be considerably worse not only than that of healthy individuals with high levels of education in their own countries, but also than that of healthy individuals with low levels of education in developed countries.

Despite the substantial effect sizes observed in the meta-analyses presented here, there are several notable limitations of this study. First, there were a small number of studies

included in each analysis. Although this fact is offset by the substantial sample sizes in the included studies (for studies conducted in developed countries, the smallest *N* is 509), a clear direction for future research is to broaden the base of included studies. This is relatively easily done: The current search extended only as far back as 1990, whereas the original verbal fluency tasks were developed in the 1960s, and some of the most important research in the field was conducted in that decade. Second, time constraints in producing this manuscript dictated that more complicated analyses, some of which require a larger sample of studies, could not be conducted. For instance, further research is needed into *why* there are these effect size differences between developing and developed countries; one might use a meta-regression to calculate potentially significant predictors of the relationship, and thereby answer that mechanism question. Third, because the *Q* test for homogeneity was consistently statistically significant (indicating the groups in the meta-analyses were heterogeneous), the addition of studies to the meta-analysis would increase the statistical power of the model. Also, the significant Q statistic might indicate that the education categories, as they are currently constituted, may be too broad in their classification, hence causing groups to be heterogeneous. Thus, another way to counteract the heterogeneity of the groups would be to create smaller education groups (e.g., 0-3 years, 4-6 years, etc.) which would become more exclusive and hence more accurately defined and homogenous.

General Discussion

Phonemic verbal fluency tasks have great practical value in neuropsychology, and are used in research and clinical settings across the world. Although numerous studies have attempted to provide normative data that is culturally fair to the population in which the task is being used, there are no published South African-specific phonemic verbal fluency norms. For numerous reasons, clearly outlined in previously published South African literature and clearly understood by South African clinicians, the use of normative data from other (and specifically, developed) countries cannot be justified.

Study 1 detailed the development of two linguistically equivalent phonemic verbal fluency letter sets (LBS and MAT) for specific use in research and clinical settings in the Western Cape. The data presented showed that, across three language groups (English, Afrikaans, and isiXhosa) there were no statistically significant differences in terms of performance on the letter sets and on the individual letters. Furthermore, males and females performed equally well on the newly developed letter sets, corroborating data from previous studies which suggest that there are no sex differences in performance on phonemic verbal

fluency tasks (Bolla, Lindgren, Bonaccorsy, & Bleeker, 1990; Egeland et al., 2006; Ruff, Light, & Parker, 1996). Additionally, the data from Study 1 showed that performance by our South African sample on the LBS letter set is very similar to performance by northern hemisphere normative samples on the widely-used FAS version of the test. Importantly, this implies that, in the absence of extensive normative data for LBS, performance on this letter set can be evaluated using the extensive and freely available normative data for FAS.

Although the sample used in Study 1 is relatively restricted in its generalizability to the entire South African population, it is a step forward in developing culturally appropriate normative data for the linguistically diverse South African population. This is the first study of its kind in South Africa, and it is of immense value: Not only do these results provide letter sets that are of practical use in the clinical setting, the process of letter set development and data collection across different language groups provides a template for researchers in other provinces who might want to develop letter sets appropriate for use in their regions.

The regression model presented in Study 1 sought to determine which demographic variables were predictive of outcomes on the phonemic verbal fluency task. The variables found to be most predictive were socio-economic status of the participant and the amount of education he/she had attained. With regard to the former, literature on the effects of SES on measures of verbal fluency is scant. Most studies in this field do not examine participants' SES, suggesting either that the significant predictive value this variable has within the multiple regression model may be unique to South Africa (which would not be surprising, given that South Africa's racial past continues to be manifest in correlated disparities in SES, language, and academic performance), or that the researchers responsible for those studies do not believe that SES plays a major role in the performance on phonemic verbal fluency tasks by their largely middle-class participants.

This study sought to determine which variables are most influential in determining important variables in verbal fluency. Although it has accomplished what it has set out to do, it has also raised some important questions. The first question involves the relationship between the language of the participant and their SES. All post hoc tests showed a significant difference between the English group to the Afrikaans and isiXhosa groups. A study examining the source for this difference would reveal important information about the populations that are reliant on government funding and could help direct funds to those who need it most.

With regard to education, although the regression model suggests that years of completed education is a significant predictor of phonemic verbal fluency outcomes (and,

indeed, of performance on many other neuropsychological tests; Shuttleworth-Edwards, Kemp, Rust, Muirhead, Hartman, & Radloff, 2004), there are many issues surrounding the availability and quality of education in this country. The South African government has acknowledged that teachers tend to be poorly trained and that schools lack the relevant infrastructure such as science and sports equipment, adequate library materials, etc. Recent estimates suggest that 24% of adults over the age of 15 are illiterate, which translates into roughly 7 million adults in South Africa who are unable to read (SouthAfrica.info, 2006).

Study 2 attempted to place phonemic verbal fluency performance in South Africa in a more global context. It is well known that South Africa suffers from some of the worst inequality in the world; the difference between those with the necessary resources to attain high levels of education differs drastically from those who do not possess such resources. This sort of disparity is typical in developing countries; in contrast, individuals in developed countries have much higher standards of living and higher average incomes, and thus a higher percentage of those populations are able to access the benefits of higher education. More specifically, though, the difference between high and low levels of education is substantially smaller than that in developing countries, as more resources are directed to the improvement of education at all levels. Therefore, those who are able to afford tertiary education in developing countries differ substantially from those who can only afford high school education, whereas this is not the case in developed countries, where, in any case, substantially more people are able to undertake tertiary education.

The results of the meta-analyses presented in Study 2, although preliminary and suffering from numerous limitations, support the notion that there are greater disparities between high and low levels of education in developing than in developed countries, and that these greater disparities have a sizable impact on phonemic verbal fluency performance.

In closing, it is important to reiterate that the sample in this study was drawn from a relatively wealthy area of South Africa, and that therefore these results should be used with caution when being applied to populations outside of urban and suburban neighbourhoods in the Western Cape. Our hope is that this research is built upon and extended to include normative data for other official languages, for rural populations, and for an increased overall sample size that includes a more heterogeneous sampling within each carefully defined educational category.

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APPENDIX A

DEM – Child English Demographic Questionnaire Participant self-report (younger participants assisted by clinician and/or parent)

GENERAL INFORMATION

Full name:				
How would you describe your race?	1. Black 2. Coloured 3. White 4. Asian 5. Other(specify): 6. Refuse to answer			
Contact numbers:	Person	Home	Work	Cell
	Self			
	Mother			
	Father			
	(Guardian)			
Residential Address:				

EDUCATION

Name and area of Current School:	School: Suburb / area:
If you are attending Secondary school, what is the name and area of the Primary School you attended in Grade 7?	School: Suburb / area:

RESIDENTIAL INFORMATION

How long have you lived at your current address?	
How would you describe your dwelling?	1. Shack 2. Wendy house or backyard dwelling 3. Tent or traditional dwelling 4. Flat / apartment 5. Town house / semi-detached house 6. Freestanding brick house 7. Other (specify):
Which of these items do you have in your home? (mark as many as necessary)	A. Tap water B. Flush toilet inside home C. Electricity D. Telephone (landline) E. Television F. Computer G. Car
How many people sleep in the same room with you at night when you are at home?	1. one 2. two 3. three 4. four 5. five 6. more than five 7. none

FAMILIAL INFORMATION

Who is your primary care-giver? (Describe the relationship, e.g. mother, father, uncle etc.)	
What is your relationship with your BIOLOGICAL MOTHER?	1. Unknown 2.Known, but irregular contact 3. Known and regular contact 4. Living with child 5. Deceased
How old is she? (If deceased, specify age and reason of death)	
What is your relationship with your BIOLOGICAL FATHER?	1. Unknown 2.Known, but irregular contact 3. Known and regular contact 4. Living with child 5. Deceased
How old is he? (If deceased, specify age and reason of death)	

What is your parents' marital status?	1. married 2. co-habiting 3. Widowed 4. divorced & living apart 5. divorced & living together 6. separated 7. remarried 8. other (specify):

MEDICAL HISTORY

Do you have any problems with your sight, hearing or with co-ordination?	1. No 2. Yes
If YES, please provide some details:	

Have you ever been admitted to hospital?	1. No 2. Yes If YES, please answer the following:
Why were you hospitalized?	
How old were you?	
How long did you stay in hospital?	

Have you ever had a head injury?	1. No 2. Yes If YES, please answer the following:
How did the injury occur?	
Did you lose consciousness?	
How long were you unconscious?	
How old were you?	

Have you ever had a fit / seizure?	1. No 2. Yes If YES, please answer the following:

How old were you?	
What caused it?	
Has it happened more than once?	
Do you take medication for it?	

Have you ever had a serious illness?	1. No 2. Yes If YES, please answer the following:	
Name of illness/es		age

Have you ever had to take medication for over two weeks? (do not include medication for common conditions such as colds, flu, gastro enteritis)	1. No 2. Yes If YES, please answer the following:
What was the reason for the medication?	
What was the name and dosage of the medication?	
Are you currently taking any medication?	
What is the reason for the medication?	
What is the name and dosage of the medication?	

PSYCHIATRIC HISTORY

Have you ever sought counselling (at school, church or elsewhere) for	1. No 2. Yes If YES, please answer the following:

emotional or other difficulties?	
How old were you?	
Who did you receive help from?	
For how long did you consult the person / agency?	
Did the treatment help your condition?	

PSYCHOMETRIC HISTORY

Have you had a psychometric evaluation (for example, aptitude of "IQ" test) in the last 12 months?	1. No 2. Yes If YES, please answer the following:
What was the purpose of the test?	
Who tested you?	

SCHOLASTIC HISTORY

In comparison with your peer group, have you ever experienced severe difficulties in coping with your school work?	1. No 2. Yes If YES, please answer the following:
If YES, please provide some details?	

APPENDIX B

DEM – Student English Demographic Questionnaire Participant self-report

GENERAL INFORMATION

Full name:				
How would you describe your race?	1. Black 2. Coloured 3. White 4. Asian 5. Other(specify): 6. Refuse to answer			
Contact numbers:	Person	Home	Work	Cel
	Self			
	Cohabitant			
Residential Address:				

EDUCATION

Name and area of Primary School attended for Grade 7:	School: Suburb / area:
Name and area of Secondary School attended for Grade 12:	School: Suburb / area:
Name of Tertiary Institution:	
How many years of tertiary education have you completed (and passed completely?)	

RESIDENTIAL INFORMATION

How long have you lived at your current address?	
How would you describe your dwelling?	1. Shack 2. Wendy house or backyard dwelling 3. Tent or traditional dwelling 4. Flat / apartment 5. Town house / semi-detached house 6. Freestanding brick house 7. Other (specify):
Which of these items do you have in your home? (mark as many as necessary)	A. Tap water B. Flush toilet inside home C. Electricity D. Telephone (landline) E. Television F. Computer G. Car
How many people sleep in the same room with you at night when you are at home?	1. one 2. two 3. three 4. four 5. five 6. more than five 7. none

MEDICAL HISTORY

Do you have any problems with your sight, hearing or with co-ordination?	1. No 2. Yes
If YES, please provide some details:	

Have you ever been admitted to hospital?	1. No 2. Yes If YES, please answer the following:
Why were you hospitalized?	
How old were you?	
How long did you stay in hospital?	

Have you ever had a head injury?	1. No 2. Yes If YES, please answer the following:
How did the injury occur?	

Did you lose consciousness?	
How long were you unconscious?	
How old were you?	

Have you ever had a fit / seizure?	1. No 2. Yes If YES, please answer the following:
How old were you?	
What caused it?	
Has it happened more than once?	
Do you take medication for it?	

Have you ever had a serious illness?	1. No 2. Yes If YES, please answer the following:	
Name of illness/es		age

Have you ever had to take medication for over two weeks? (do not include medication for common conditions such as colds, flu, gastro enteritis)	1. No 2. Yes If YES, please answer the following:
What was the reason for the medication?	
What was the name and dosage of the medication?	
Are you currently taking any medication?	

What is the reason for the medication?	
What is the name and dosage of the medication?	

PSYCHIATRIC HISTORY

Have you ever sought counselling (at school, church or elsewhere) for emotional or other difficulties?	1. No 2. Yes If YES, please answer the following:
How old were you?	
Who did you receive help from?	
For how long did you consult the person / agency?	
Did the treatment help your condition?	

PSYCHOMETRIC HISTORY

Have you had a psychometric evaluation (for example, aptitude of "IQ" test) in the last 12 months?	1. No 2. Yes If YES, please answer the following:
What was the purpose of the test?	
Who tested you?	

SCHOLASTIC HISTORY

In comparison with your peer group, have you ever experienced severe difficulties in coping with your school work?	1. No 2. Yes If YES, please answer the following:
If YES, please provide some details?	

APPENDIX C

ENGLISH CHILD ASSENT, PARENT CONSENT AND INFORMATION LEAFLET

RESEARCH PROJECT NUMBER: NO8/08/227

RESEARCH PROJECT TITLE: *Comparing the utility of South African adaptations of the Wechsler Abbreviated Scale of Intelligence, the Controlled Oral Word Association Test and the Boston Naming Test for English, Afrikaans and Xhosa-speaking 8-25 year olds in the Western Cape Province.*

INVESTIGATORS: Mrs H. Ferrett (PI), Dr P. Carey, Dr K. Thomas

Dear Volunteer

Why is this study being done?
A research study is a way to learn more about something. A team of researchers from the Universities of Stellenbosch and Cape Town are trying to learn more about the ways in which children's brains develop. Many of the tests (called neuropsychological tests) that we use come from other countries. We want to be able to use these tests in South Africa, for children who speak English, Afrikaans or Xhosa.

Who can take part in the study?
Learners who are at school, older than 8 years and have passed Grade 1 may take part in this study. If you speak English, Afrikaans or Xhosa as your home language, you may take part. We will ask your parent/guardian to fill in a form for us which will tell us if you have ever had any serious medical problems. If you have had serious problems with your health or schooling, you will not be able to take part in this study, but you may be able to take part in some of our other studies.

What will happen to you if you agree to take part in this study?
If you agree to take part in the study, a researcher will visit you twice at your school during school hours. At the first visit, the researcher will explain everything to you and answer any questions or concerns you may have. You will be asked to fill in a form to give us some information about yourself. The researcher will help you to complete the form if you need help. You will be given a form to take home for your parent/guardian to read and to sign if they agree to let you take part. If they agree, they will also be asked to fill in a short questionnaire giving us some information about your medical history and where you live. Once you have returned the forms to the school, the researcher will arrange a time and date for you to be tested. At the second visit, you will be tested by yourself in a quiet room in your school. You will be asked to answer some questions and do some activities like naming things or describing things to us. You do not have to study for the "test" and you are not expected to get everything correct. All you will be asked to do is to try your best. The test will take about one hour. The tests will not hurt you in any way. You may feel a bit tired during the tests, so the researcher will allow you to take short breaks. If you feel too tired to

complete the tests on the second visit, the researcher will arrange to finish the test with you on another day.

What will happen to the information you give us?

If you agree to take part, the researcher will use a code for the information about you. This means that the information that you give us will be kept private and your name will not be used.

Do you have to pay to take part?

You don't have to pay anything to take part in this study. If you fill in all the forms and complete the tests, we will give you a gift voucher for R50. This is our way of thanking you for taking part in the study.

Do you have to take part in the study?

You do not have to take part in the study. It is up to you and your parent/guardian to decide whether you want to take part or not. If you want to take part, we would like you and your parent/ guardian to write your names and signatures on this form. If you sign the papers now and then decide to change your mind later, all you have to do is to tell us that you don't want to take part anymore. No-one will get cross with you if you decide not to take part, or if you agree to take part and then change your mind later.

What if you have any questions?

If you have any questions about this study, you may ask the researcher about them during one of the visits, or later on. You can phone Mrs Alexander on 021 938 9771 or 073 548 3928 between 08h30 and 16h30 on weekdays if you have any more questions.

If you (the learner) agree to take part in this study and you understand what the researcher has explained to you, please write and sign your name below:

Child's name: _____

Child's signature: _____

Date: _____ Place: _____

If your parent or guardian has read this form and allows you to take part in the study, please ask him/her to sign his/her name below:

Parent (or guardian's) name: _____

Parent (or guardian's) signature _____

Date: _____ Place: _____

The researcher must sign his/her name below to confirm that he/she has explained the study to you in your home language and answered the questions you have about it:

Researcher's name: _____

Researcher's signature: _____

Date: _____ Place: _____

APPENDIX D

ENGLISH STUDENT CONSENT AND INFORMATION LEAFLET

RESEARCH PROJECT NUMBER: NO8/08/227

RESEARCH PROJECT TITLE*:* *Comparing the utility of South African adaptations of the Wechsler Abbreviated Scale of Intelligence, the Controlled Oral Word Association Test and the Boston Naming Test for English, Afrikaans and Xhosa-speaking 8-25 year olds in the Western Cape Province.*

INVESTIGATORS: Mrs H. Ferrett (PI), Dr P. Carey, Dr K. Thomas

Dear Volunteer

Why is this study being done?
A research study is a way to learn more about something. A team of researchers from the Universities of Stellenbosch and Cape Town are trying to learn more about the ways in which people's brains develop. Many of the tests (called neuropsychological tests) that we use come from other countries. We want to be able to use these tests in South Africa, for people who speak English, Afrikaans or Xhosa.

Who can take part in the study?
Learners who are at school, older than 8 years and have passed Grade 1 and students attending tertiary education institutions may take part in this study. If you speak English, Afrikaans or Xhosa as your home language, you may take part. If you have had serious problems with your health or schooling, you will not be able to take part in this study, but you may be able to take part in some of our other studies.

What will happen to you if you agree to take part in this study?
If you agree to take part in the study, you will have two appointments with a researcher. At the first visit, the researcher will explain everything to you and answer any questions or concerns you may have. You will be asked to fill in a form to give us some information about yourself and to sign the consent form. You will also be asked to bring a copy of your matriculation certificate in a sealed envelope. The researcher will give the envelope to the Principal Investigator, who will make sure that the information is appropriately coded so that it is anonymous. At the second visit, you will be tested by yourself in a quiet room at one of the universities involved in the study. You will be asked to answer some questions and do some activities like naming things or describing things to us. You do not have to study for the "test" and you are not expected to get everything correct. All you will be asked to do is to try your best. The test will take about one hour. The tests will not hurt you in any way. You may feel a bit tired during the tests, so the researcher will allow you to take short breaks. If you feel too tired to complete the tests on the second visit, the researcher will arrange to finish the test with you on another day.

What will happen to the information you give us?

If you agree to take part, the researcher will use a code for the information about you. This means that the information that you give us will be kept private and your name will not be used.

Do you have to pay to take part?

You don't have to pay anything to take part in this study. If you fill in all the forms and complete the tests, you will be given credits for research participation.

Do you have to take part in the study?

You do not have to take part in the study. It is up to you to decide whether you want to take part or not. If you want to take part, we would like you to write your name and signature on this form. If you sign the papers now and then decide to change your mind later, all you have to do is to tell us that you don't want to take part anymore. No-one will get cross with you if you decide not to take part, or if you agree to take part and then change your mind later.

What if you have any questions?

If you have any questions about this study, you may ask the researcher about them during one of the visits, or later on. You can also phone one of the researchers, who will provide his/her contact details during working hours.

If you agree to take part in this study and you understand what the researcher has explained to you, please write and sign your name below:

Student's name: _____

Student's signature: _____

Date: _____ Place: _____

Researcher's name: _____

Researcher's signature: _____

Date: _____ Place: _____

APPENDIX E

COWAT SA Phonemic Fluency: First Letter Set: 1. L, 2. B, 3. S

	I will say a letter of the alphabet. Then you must name as many words that begin with that letter as quickly as you can. For example, if I say D, you might give me DOG, DATE, DIRTY. Do not use words which begin with capital letters, like DURBAN or DAVID. Also, don't use the same word with different endings, like DIG, DIGGER, DIGGING. Do you have any questions? Start when I say the letter... (L,B,S)		Ek gaan ‘n letter van die alphaber sê. Dan moet jy so veel moontlik woorde sê wat met daardie letter begin, so gou as wat jy kan. Byvoorbeeld, as ek D sê, mag jy DOM, DONKER, DOF sê. Moenie woorde gebruik wat met hoofletters begin nie, soos DURBAN en DAWID. Moenie dieselfde woord gebruik met verskillende eindes nie, soos DEEL, DEELTEKEN. Het jy enige vrae? Begin as ek die letter noem... (L,B,S)
	Some repetitions may be acceptable if an alternate meaning was intended by the examinee (e.g. SUN and SON). Clarify any ambiguous, inaudible or unknown words at the end of the relevant letter.		
	Begin as soon as the examiner says the letter.		
	Stop after one minute. If the examinee discontinues before the end of the period, encourage him/her to produce more words.		
	Time one minute, but allow extra time if instructions are repeated during administration. Mark 15 second interval divisions.		
☑☒	Score later.		Record answers verbatim. Record Errors later (Repetitions, Rule Violations, Set Loss Errors).

APPENDIX F

The economic variable used in this study to determine the status of a country comes from the World Banks classification system that uses the countries gross national income (GNI) to determine its status as a developed or developed country, or more specifically as a low income, middle income or high income country.

Table 1

Table showing the classification of countries included in meta-analysis according to GNI per capita in US$ (Based on World Bank, 2008 categories)

Developed Countries		Developing Countries			
High Income Country	GINI per capita	Upper Income Country	GNI per capita	Low Middle Income Country	GNI per capita
Australia	40,350	South Africa	5,820	India	1,070
Israel	24,700				
Netherlands	50,150				
Norway*	>87,071				
Sweden	50,940				
UK	45,390				
USA	47,580				

Note; High income country: GNI per capita >= $11,906; Upper Middle Income country: GNI per capita $3,856<= $11, 905; Lower Middle Income Country: GNI per capita $976<=$3,855
**Data not available, rank is approximate*

Gross National Income (GNI), this value is derived from the total production of a country (i.e. gross domestic product, GDP) and from the total income originating from countries abroad that are sent back to the country of origin in the form of labour income, profits etc. The World Bank uses the 'Atlas Method', which takes a country's average exchange rate with the US dollar for the past 3 years to calculate the GNI per capita in US dollars. The reason why the exchange rate is averaged over 3 years is to account for any fluctuations that may be present.

APPENDIX G

This table shows the studies that were excluded because they did not include the mean, standard deviation and sample size for each of their education categories.

Study No.	*Authors*	*Year*
1	Bolla, Lindgren, & Bonaccorsy	1990
2	Mcgrath, Schneldt, Welham, & Clair	1997
3	Troyer, Moscovitch, & Winocur	1997
4	Bolla et al.	1998
5	Fernaeus, & Almkvist	1998
6	Johnson-Selfridge, Zalewski, & Aboudarhan	1998
7	Harvey, & Siegert	1999
8	Iverson, Franzen, & Lovell	1999
9	Phillips	1999
10	Harrison, Buxton, Husain, & Wise	2000
11	Troyer	2000
12	Auriacombe et al.	2001
13	Rey et al.	2001
14	Ross	2001
15	Ravdin, Katzen, Agrawal, & Relkin	2003
16	Tingley, Kyte, Johnson, & Beitchman	2003
17	Goldstein, Obrzut, John, Hunter, Armstrong	2004
18	Henry, & Crawford	2005
19	Henry, Crawford, & Phillips	2005
20	Ross et al.	2005
21	Plumet, Gil, & Gaonac'h	2005
22	Henry	2006
23	Henry, & Crawford	2006
24	Hurks et al.	2006
25	Kave	2006
26	Ross, Furr, Carter, & Weinberg	2006
27	Senhorini, Amaro, de Mello Ayres, de Simone, & Busatto	2006
28	Gasquoin, Croyle, Cavazos-Gonzalez, & Sandoval	2007
29	Rogalski, Rademaker, & Weintraub	2007
30	Ross et al.	2007
31	Barry, Bates, & Labouvie	2008
32	Dufouil, Alperovitch, & Tzourio	2009
33	Hessen, Lossius, & Gjerstad	2009
34	Kave	2009

Plagiarism Declaration

1. I know that plagiarism is wrong. Plagiarism is to use another's work and pretend that it is one's own.

2. I have used the APA convention for citation and referencing. Each contribution to, and quotation in, this thesis from the work(s) of other people has been attributed, and has been cited and referenced.

3. This essay thesis is my own work.

4. I have not allowed, and will not allow, anyone to copy my work with the intention of passing it off as his or her own work.

5. I acknowledge that copying someone else's assignment or essay, or part of it, is wrong, and declare that this is my own work.

Date: 29 October 2009

Signature: .....

Full Name of Student: Angela Lesley Baufeldt