# The relationship between second-language proficiency and cognitive ability in bilingual South Africans

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**ABSTRACT**

The purpose of this study was to investigate the oft-debated relationship between bilingualism and cognitive ability from the perspective of two competing lines of research: the Cummins threshold hypothesis (where bilinguals are cognitively *advantaged* in relation to monolinguals only after they reach a certain level of second-language proficiency, and are otherwise comparatively disadvantaged), and cognitive neuropsychological theory (where, relative to monolinguals, bilinguals are *disadvantaged* on verbal tasks and advantaged on some non-verbal tasks). 66 individuals of varying degrees of bilingualism were assessed using the Wechsler Abbreviated Scale of Intelligence (WASI), the Controlled Oral Word Association Test (COWAT), and the Boston Naming Test (BNT). The participants' level of bilingualism was defined according to subjective (bilingual/monolingual self-rating, and similarity between home language, school language and testing language) and objective (level of dual-language activation in verbal fluency tasks) measures, and they were accordingly placed in one of three groups: the monolingual group, the unbalanced bilingual group, and the balanced bilingual group. Hierarchical regression analyses and planned contrasts provided evidence for Cummins' threshold hypothesis: the unbalanced bilinguals were disadvantaged relative to the monolinguals in the verbal domains, and only partially in the non-verbal domains. The balanced bilinguals, however, did not exhibit any effects of bilingualism on their cognitive abilities. The results were explained in terms of the unbalanced bilingual deficit, and the attenuation of bilingual effects, respectively.

Keywords: bilingualism; cognitive abilities; second-language proficiency; Cummins' threshold hypothesis; neuropsychology

Although more than half of the world's population is to some degree bilingual or multilingual, there is still much debate regarding the effect of bilingualism on cognitive processes (Ardila *et* al., 2000; Rosselli *et al*., 2000). In both the educational psychology and cognitive neuropsychological literatures, several different theories attempting to explain the effects of bilingualism on cognitive abilities have emerged and been empirically tested. Unfortunately, however, these empirical studies have delivered contradictory data, and so have done little to increase the understanding of the effect of this common phenomenon on cognitive abilities.

## BACKGROUND

The relation of bilingualism to cognitive function may be explored in terms of two apparently conflicting lines of research. I will outline how the relationship between bilingualism and cognitive abilities is understood in both educational psychological and cognitive neuropsychological research. The landmark study which led to the formation of a well-supported hypothesis in the educational psychology realm will be discussed, along with studies replicating its findings. Thereafter, I will discuss recent findings and possible mechanisms for the effect of bilingualism on cognitive abilities in the cognitive neuropsychological literature. Finally, I will consider the possibility that the consideration of second-language (L2) proficiency and the lack thereof in educational psychological and neuropsychological research, respectively, is implicated in the contradictory predictions made by the two lines of research.

### Defining Bilingualism

Hakuta, Ferdman, and Diaz (1987) explain that the concept of bilingualism in psychological research has been defined in several ways, and that discrepancies in operational definitions have led to inconsistent findings. According to those authors, research pre-1985 generally assigned a societal definition (e.g., bilinguals were individuals who were new immigrants to the United States), whereas research post-1985 tended towards a cognitive definition (e.g., bilingualism is a mental concept on the individual level and refers to individuals who possess or use two linguistic systems).

In contemporary cognitive neuropsychological and educational psychology studies, bilingualism is most often defined in terms of categorical (low, average, high) language proficiency. Language proficiency, in turn, is estimated from either objective (language tests) or subjective (self-report) measures, or, often, from a combination of the two (Karapetsas & Andreou, 2004; Sampath, 2005; Yamazaki & Yamazaki, 2006). The measurement of language proficiency has become standard practice in educational psychology studies as it is implicit in the threshold hypotheses that aim to explain the relationship between bilingualism and cognitive ability.

In the cognitive neuropsychological literature, however, bilingualism is not defined in terms of level of second-language proficiency. Although both subjective and objective measures of bilingualism are usually employed, the aim of the linguistic proficiency evaluation is not to determine an individual's level of bilingualism to facilitate placement in the appropriate bilingual subgroup, but rather to ascertain whether the individual is 'bilingual enough' to be placed in the bilingual group to be compared to a monolingual group (Mindt *et al.*, 2008). In this way, while bilingualism is defined on the basis of degrees in the educational psychology literature, the cognitive neuropsychological literature views bilingualism and monolingualism as a dichotomy.

**Bilingualism as a Cognitive Advantage**

Prior to 1962, it was widely held that bilingualism was associated with lowered cognitive function (Hakuta *et al*., 1987). For instance, some believed that bilingual children would become anomic and incur linguistic, intellectual and academic retardation in relation to their monolingual peers (Tucker & d'Anglejan, 1971). Peal and Lambert (1962), however, provided the first conclusive evidence that bilingualism could have a positive influence on cognitive processes. They demonstrated that bilinguals generally delivered significantly superior performance relative to monolinguals on both verbal and non-verbal tasks, and interpreted this superior performance as indicative of superior cognitive ability. They argued that bilinguals develop superior mental flexibility and concept formation abilities in order to switch between languages, and that these well-developed abilities then serve to increase general cognitive function. This finding has since been widely replicated, so much so that the educational psychology literature has widely accepted that bilingualism leads to an increase in various cognitive abilities (Bain, 1974; Cromdal, 1999; Ianco-Worrall, 1972; Kharkhurin, 2008).

In order to explain the discrepancy between conclusions drawn from Peal and Lambert (1962) and those drawn from earlier studies, threshold hypotheses were proposed. These threshold hypotheses, notably that of Cummins (1977), attempt to explain the diverse findings by positing that bilingualism leads to cognitive advantages, but only under certain circumstances (Hawson, 1997).

## Cummins' Threshold Hypothesis

### *The Landmark Study*

Cummins (1977) studied a sample of 85 bilingual (English-French) grade 6 students in Canada. On the basis of each child's home language and language of greatest proficiency, Cummins divided the sample into participants from exclusive French-speaking households, participants from exclusive English-speaking households, and participants from households in which both English and French were spoken. The results suggested that only the bilingual children who were highly proficient in their second language exhibited the cognitive advantages hypothesised for all bilinguals by Peal and Lambert (1962). Cummins also found that balanced bilinguals (i.e., bilinguals who had a similar degree of competence in both languages) scored higher than monolinguals on a measure of verbal divergence (i.e., verbal fluency, flexibility and originality; French, Ekstrom, & Price, 1963). These instances of the advantages of bilingualism were described by Cummins as 'additive': increased cognitive abilities resulted from the acquisition of a second language in addition to a relatively well-developed first language.

Further, Cummins found that those bilinguals who were in the low ranges of second-language proficiency exhibited cognitive *disadvantages* in comparison with monolingual controls. He described such instances of bilingualism as 'subtractive': decreased cognitive abilities arose from the replacement of elements of the first language by elements of the second language.

On the basis of these results, Cummins proposed a threshold hypothesis which stated that bilingualism can have positive or negative effects on cognitive ability, depending on one's level of second-language competence. This is therefore a hypothesis of two thresholds: the first threshold, or 'criterion of balance', is the level of second-language proficiency individuals must attain to avoid the subtractive, negative cognitive effects of bilingualism; the second threshold is the level of second-language proficiency individuals must attain to enjoy the additive, positive cognitive effects of bilingualism. Thus, Cummins introduced second-language proficiency as a potential mediator in the relationship between bilingualism and cognitive ability (Hawson, 1997).

*Evidence in Support of Cummins' Threshold Hypothesis*

In a recent study of 200 Greek first-language and English second-language high school students, Karapetsas and Andreou (2004) reported strong evidence for the additive effect predicted by Cummins' threshold hypothesis. On the basis of objective and subjective measures of bilingual fluency, students were divided into two equally-populated groups: a high proficiency group, and a low proficiency group. Students' verbal abilities were then assessed using the five Verbal scale subtests of the Wechsler Intelligence Scale for Children – Fourth Revision (WISC-IV; Wechsler, 2003), standardised for a Greek population. Results indicated that participants in the high proficiency group produced significantly better scores on four of the five subtests, with a marginally better score on the other subtest.

A similar study conducted in India provided evidence for both the additive and subtractive effects predicted by Cummins' threshold hypothesis. Sampath (2005) used a sample of 120 children and divided them into monolingual (Tamil) and bilingual (first language Telugu or Kannada, second language Tamil) groups, and then further classified participants in both bilingual groups as having low-average, average, or above-average proficiency in Tamil. Objective and subjective measures of language fluency were again used to make these divisions and subdivisions. WISC testing showed that bilingual children with a low level of Tamil proficiency scored lower than monolingual children with low Tamil proficiency on measures of perceptual organisation, mental calculation abilities, working memory, expressive language, and overall verbal intelligence. This finding is an example of the subtractive effects predicted for bilinguals of low second-language proficiency. Further, bilingual children with above-average Tamil proficiency scored higher in the aforementioned cognitive areas than did their monolingual counterparts with above-average Tamil proficiency. This finding is an example of the additive effects predicted for bilinguals of high second-language proficiency.

Although Sampath's study failed to show an association between second-language proficiency and scores on measures of global intelligence (WISC Full Scale IQ) or of non-verbal intelligence (WISC Performance IQ), it nonetheless provides convincing evidence, in terms of verbal abilities, for the additive and subtractive effects predicted by Cummins' threshold hypothesis. Further, the study used equivalent monolingual controls for the low-average, average and above-average Tamil proficiency groups, which is a strength of this study over the Karapetsas and Andreou (2004) study. In other words, the use of monolingual controls shows that attainment of a certain second-language proficiency, and not bilingualism alone (as hypothesized by Peal and Lambert (1962)), is a necessary criterion for increased cognitive ability due to bilingualism.

Both the Karapetsas and Andreou (2004) and the Sampath (2005) studies, although convincing, only provide evidence for the increased *verbal* abilities of bilinguals who attain the threshold of second-language proficiency. The Sampath (2005) study found no significant effect of language proficiency on non-verbal abilities, while the Karapetsas and Andreou (2004) study did not measure non-verbal abilities. Although Cummins' threshold hypothesis originally predicted effects for overall cognitive abilities, the effect is most often demonstrated only for verbal abilities, and so the hypothesis is usually applied only in terms of verbal abilities (Costa & Santesteban, 2004).

**Bilingualism as a Cognitive Disadvantage**

Whereas the educational psychology literature accepts that bilingualism generally leads to verbal advantages depending on level of second-language proficiency, recent cognitive neuropsychological literature proposes that bilinguals are verbally disadvantaged relative to monolinguals (Gollan & Brown, 2006). Cognitive neuropsychological research has suggested that, relative to monolinguals, bilinguals have smaller vocabularies in each language (Mindt *et al*., 2008), are slower to respond and name fewer pictures correctly on picture naming tasks (Gollan, Montoya, Cera, & Sandoval, 2008), perform more poorly on verbal fluency tasks (Rosselli *et al*., 2000), are less adept at word identification through noise (Rogers, Lister, Febo, Besing, & Abrams, 2006, as cited in Bialystok, 2009), experience more tip-of-the-tongue instances (Gollan & Brown, 2006), and are subject to more interference in lexical decision tasks (Ransdell & Fischler, 1987, as cited in Bialystok, 2009). In light of these findings, the cognitive neuropsychological literature hypothesises a relative deficit account of bilingualism, named 'the bilingual effect', for bilinguals' verbal abilities in relation to those of monolinguals (Gollan & Brown, 2006; Gollan *et al*., 2008).

## Cognitive Neuropsychological Theory

### *Frequency of Use and the Bilingual Effect*

Mindt and colleagues (2008) explain that bilinguals' verbal deficit is the result of two mechanisms: frequency of use and interference. Bilinguals' acquisition of a second language necessarily results in a reduction in the frequency of use of both languages (Gollan & Brown, 2006). Because it is impossible to concurrently produce language in two language mediums, bilinguals use the words of each language less frequently than monolinguals use the words of their single language. According to the 'weaker links' hypothesis, the reduction in the frequency of use of each language results in weaker connections between semantic representations and their respective phonology in each lexical system, leading to a smaller vocabulary in each language compared with that of monolinguals, and a resultant disadvantage on speaking tasks (Gollan *et al.*, 2008).

The size of a child's vocabulary has been shown to predict acquisition of literacy, which in turn influences further linguistic development (Adams, 1990, as cited in Bialystok, Luk, & Kwan, 2005). Since vocabulary size serves as a proxy for children's linguistic development, bilingual children's relatively smaller vocabulary size is regarded as indicative of an overall verbal deficit (Bialystok, 2009).

### *Interference and the Bilingual Effect*

The second proposed mechanism for the verbal deficit seen in bilinguals is that both languages are constantly active (Mindt *et al.*, 2008). In order for bilinguals to produce language in a particular target language, there is a need to control activation of the non-target language. The level of interference and consequent need to control language activation is greatest when bilinguals are required to produce low-frequency words (words that do not occur frequently in a language); or when bilinguals are required to speak in their second-language (as the dominant, first-language must be suppressed) (Gollan *et al.*, 2008). Unlike monolinguals, bilinguals are required to use executive processes for control, attention and switching in order to inhibit interference from the non-target language (Bialystok, 2009). Interference from the non-target language is credited with the reduction in speed and efficacy of lexical access, and hence with deficits seen in tasks which depend on lexical access, such as naming and verbal fluency tasks. Cognitive neuropsychological research thus indicates that bilinguals' verbal disadvantage stems both from a reduced vocabulary size and a deficit in lexical retrieval from the mental lexicon (Bialystok, 2009).

The bilingual effect, as it is referred to by cognitive neuropsychologists, has been recorded for both children (e.g., young bilinguals have smaller vocabularies in each language relative to their monolingual counterparts) and adults (e.g., older bilinguals perform more poorly than monolinguals on rapid lexical retrieval tasks), and so the cognitive neuropsychological literature has shown that bilinguals endure lifelong verbal disadvantages (Bialystok, 2009).

### *Non-Verbal Advantages Due to the Bilingual Effect*

Despite the additional demands and general verbal deficits incurred due to the interference effect, bilinguals' continued need to control activation of the non-target language has been implicated in more developed executive functioning abilities (e.g., being more adept at response inhibition and switching), such that bilinguals tend to show non-verbal advantages relative to monolinguals, in tasks that require these abilities (Mindt *et al*., 2008).

The cognitive neuropsychological literature cites neuroanatomical evidence for balanced bilinguals' increased executive functioning abilities. Neuroimaging studies have indicated that bilinguals, when compared to monolinguals, have a larger volume of grey matter in the left inferior parietal cortex, attributed to increased stimulation of the executive function (Gollan *et al*., 2008). This is especially the case in early bilinguals (those who acquired their second-language at an early age) and fluent bilinguals (Hernandez & Li, 2007). Authors thus attribute the bilingual advantage to the greater volume of physical matter, as well as to the increased efficiency of processes for resolving non-verbal conflict (Bialystok, 2009).

Similar to the verbal deficits hypothesised according to the bilingual effect, the bilingual advantage for executive processes has been shown to endure over the entire lifespan (Bialystok, 2009). The accumulation of increased executive stimulation over a lifetime has also been shown to lead to increased cognitive reserve, acting as a protective buffer against executive decline in healthy aging and in Alzheimer's disease, such that bilinguals' executive control abilities decline less severely than those of monolinguals (Bialystok, Craik, & Freedman, 2007).

*Metalinguistic Advantage*

Although bilingual children's acquisition of a second language may hinder the development of the first language, thereby being disadvantageous to linguistic development (Mindt *et al*., 2008), emerging research indicates that if the two languages share the same writing system, literary skills acquired in one language may transfer to the other, thus adding to linguistic development (Bialystok *et al*., 2005). It has also been shown that bilingual children have a metalinguistic advantage over monolingual children, exhibiting greater phonological awareness and a greater understanding of the reading process and of the symbolic writing system. The transfer of literary skills and bilinguals' metalinguistic advantage equate respectively with faster acquisition of literary abilities (such as reading) in the subsequently-learnt language, as well as a greater understanding of the language system itself.

In summary, although the cognitive neuropsychological theory shows that bilingualism has different effects on verbal and non-verbal abilities, as well as heterogeneous effects on different verbal abilities, the consensus in the literature remains that bilingualism leads to overall verbal disadvantages and some non-verbal advantages.

*Criticism of the Cognitive Neuropsychological Literature*

A notable weakness of the cognitive neuropsychological literature is that little attention is paid to bilinguals' level of second language proficiency, which, according to Cummins' threshold hypothesis, is a crucial factor in the relationship between bilingualism and cognitive abilities (Cummins, 1977). In the cognitive neuropsychological literature, degree of proficiency is considered to the extent that bilinguals are defined as such on the basis that they are 'adequately bilingual'; unlike in the educational psychology literature, the bilingual group is not subdivided into an unbalanced and balanced group such that the effect of level of second-language proficiency on cognitive abilities may be investigated (Bialystok *et al*., 2005; Gollan *et al*., 2008). Therefore, the findings in the cognitive neuropsychological literature refer to the differences between balanced bilinguals and monolinguals, and do not consider how unbalanced bilinguals differ from balanced bilinguals and monolinguals alike.

**Rationale for Research and Specific Aims and Hypotheses**

The educational psychology and cognitive neuropsychological literatures make conflicting predictions regarding the effects of bilingualism on verbal abilities: Cummins' threshold hypothesis, from the educational psychology literature predicts *verbal advantages* for balanced bilinguals relative to monolinguals, whereas cognitive neuropsychological theory predicts *verbal disadvantages* in the same case. Whereas Cummins' threshold hypothesis predicts verbal disadvantages for unbalanced bilinguals relative to monolinguals, the cognitive neuropsychological literature does not consider the effect of bilingualism for unbalanced bilinguals. Similarly, whereas the cognitive neuropsychological literature predicts that balanced bilinguals have some non-verbal advantages relative to monolinguals, Cummins' threshold hypothesis predicts that balanced bilinguals will have non-verbal advantages relative to monolinguals and that unbalanced bilinguals will have non-verbal disadvantages relative to monolinguals (although these predictions have not been well supported).

Despite predicting opposite effects for balanced bilinguals' verbal abilities, there is recent, empirical evidence in favour of both Cummins' threshold hypothesis and cognitive neuropsychological theory. Evidence for conflicting hypotheses in recent research raises the point as to whether the disparate findings are due to consideration of second-language proficiency (as in the educational psychology studies) or due to the lack of such consideration (as in cognitive neuropsychological studies).

In addition to the above empirical questions, there is little evidence regarding the applicability of research findings in this area to the South African population. South Africa, with its linguistic diversity and widespread bilingualism and multilingualism, presents a unique population for bilingualism research. For local purposes, there is a need to understand whether the large South African bilingual population is cognitively advantaged or disadvantaged in relation to their monolingual peers. If unbalanced bilinguals indeed experience subtractive cognitive effects, educational policies need to be implemented in order to encourage additive bilingualism. South Africa is a developing nation, striving to increase its GDP and participate competitively in the international market. The possibility that a portion of South Africa's largely bilingual workforce may experience subtractive cognitive effects could be to the detriment of the nation's economy. Hence, the primary objective of this study was to pit predictions from Cummins' threshold hypothesis against those from cognitive neuropsychological theory with regard to both unbalanced and balanced bilinguals' verbal and non-verbal abilities. Furthermore, the bulk of bilingual research has focused on the performance of unbalanced and balanced bilinguals relative to monolinguals. This study thus aimed to clarify the effect of bilingualism by investigating the ordinal arrangement of the groups with regards to performance on the outcome variables, such that the relation of each group to the other two groups could be better understood. The intended outcome of the study was to establish the applicability of the respective predictions for the South African population.

These specific hypotheses were tested:

1. For verbal abilities, unbalanced bilinguals will be cognitively disadvantaged relative to both monolinguals and balanced bilinguals. The disadvantage relative to monolinguals is predicted by the subtractive effect of Cummins' threshold hypothesis. Due to the conflicting predictions in the literature for balanced bilinguals' verbal abilities relative to that of monolinguals, I predict that there will be no significant verbal cognitive differences between balanced bilinguals and monolinguals, and as such that the unbalanced bilingual disadvantage will also be apparent relative to the balanced bilinguals.
2. For non-verbal abilities, unbalanced bilinguals will be cognitively disadvantaged relative to monolinguals, and balanced bilinguals will be cognitively advantaged relative to monolinguals, in line with the subtractive and additive components of Cummins' threshold hypothesis[1], respectively. As such, the non-verbal performances of the groups will be arranged in a linear fashion, where balanced bilinguals will also have superior performance relative to unbalanced bilinguals.

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[1] Because the test battery did not comprise non-verbal measures for abilities where the cognitive neuropsychological literature predicts balanced bilingual advantages, the educational psychology predictions are used in this case, despite the fact that they are less well corroborated than their verbal equivalents.

# METHODS

## Research Design and Setting

This study is nested within a larger research project whose aim is to norm the Wechsler Abbreviated Scale of Intelligence (WASI; Wechsler, 1999), Controlled Oral Word Association Test (COWAT; Benton & Hamsher, 1989; Strauss, Sherman & Spreen, 2006), and the Boston Naming Test (BNT; Kaplan, Goodglass, & Weintraub, 1983) for English, Afrikaans, and Xhosa-speaking individuals in the Western Cape.

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

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

## Participants

The total set of collected data included 221 participants (42 monolinguals, 22 unbalanced bilinguals and 157 balanced bilinguals). Due to the loss of statistical power associated with large discrepancies in sample sizes, the monolingual and balanced bilingual groups were reduced so that each group had an equal number of participants ($n$ = 22) (Field, 2005). Participants were matched first according to gender, and then according to age. The sample for the present study thus comprised 66 participants. The exclusion criteria used in the selection process were extensive, such that the results were not confounded by extraneous variables.

### *Exclusion Criteria*

Participants all had English, Afrikaans or Xhosa as their first language, were between the ages of 8 and 25 years, were currently attending school or a tertiary institution, and were residing in the Cape Town region. These criteria were set to ensure (a) ease of logistics, and (b) that the participants matched the population of interest for the larger study. In order to ensure that participants had been educated in similar school systems and without specific hindrance, participants had all received education in South Africa for at least the past 5 years (where total duration of education was more than 5 years), and individuals with learning disorders and educational difficulties were excluded from the study. Individuals were also excluded on the basis of current psychotropic medication prescription, psychiatric diagnosis, prenatal or birth complications, head injury resulting in loss of consciousness for more than 5 minutes, seizure disorders, substance abuse disorders, medical illnesses resulting in loss of cognitive functioning, as well as language, speech and behavioural disorders.

The extensive list of exclusion criteria was employed to safeguard the integrity of the data, as performance on neuropsychological tests may reflect cognitive disadvantages related to the above conditions (Ferrett *et al*., 2009). Furthermore, individuals who described themselves as multilingual were excluded from the study, citing the little-known, but potentially influential, effect of increase in number of known languages on cognitive abilities (Kavé, Eyal, Shorek, & Cohen-Mansfield, 2008).

Finally, the demographics questionnaire, administered in participants' language of choice (see English version for school-going participants in Appendix A, and English version for university students in Appendix B) was used to establish whether student participants had received psychometric testing within the previous 12 months. In the case that the psychometric testing was similar to that administered in the neuropsychological battery, participants were excluded from the study on the grounds of potential practice effects (Ferrett *et al*., 2009).

## Materials

### *Degree of Bilingualism*

Both objective and subjective measures should be used to estimate level of bilingualism (Mindt *et al*., 2008). Common subjective measures include clinical interviews, bilingualism questionnaires and parental rating of reading and speaking skills; common objective measures include school ratings of native and second-language abilities and a variety of language proficiency tests, such as verbal fluency tests and the Boston Naming Test (Karapetsas & Andreou, 1999, 2004; Rosselli *et al.*, 2000; Sampath, 2005).

In this study, participants' self-rating of bilingual/monolingual status, and the relation of participants' home, school and testing languages were used as subjective indicators of level of bilingualism. Following Mindt *et al.* (2008), participants' level of dual-language activation in verbal fluency tasks was used as an objective indicator of level of bilingualism. Participants were divided into one of three groups (monolingual, unbalanced bilingual, balanced bilingual) based on the above indicators.

*Grouping Variables*

Participants in the monolingual group had no or very limited competency in a second language. They were subjectively defined by a monolingual self-rating and a choice to complete the battery in their home language, which in turn was the same as their school language. They were objectively defined by only target language activation in the verbal fluency tasks.

Participants in the unbalanced bilingual group had a discrepant degree of competency in spoken languages. They were subjectively defined by a monolingual[2] self-rating and a choice to complete the battery in their home language. They were objectively defined by some dual-language activation in the verbal fluency tasks.

Participants in the balanced bilingual group had a similar or equal degree of competency in spoken languages. They were subjectively defined by a bilingual self-rating or[3] the choice to complete the battery in a language which was the same as their school language, but different to their home language[4]. Unlike the other groups, they were not objectively defined as it was understood that balanced bilinguals may successfully inhibit the non-target language and generate words in only the target language for the verbal fluency tasks. The grouping criteria are depicted in Table 1.

[2] Because individuals more frequently underestimate than overestimate their level of bilingualism, the monolingual self-rating is applicable to this group (Mindt *et al*., 2008).
[3] The use of the 'or' condition in this instance is due to the possibility that the relevant bilinguals may not be forthcoming with a bilingual self-rating (Mindt *et al*., 2008).
[4] Because it can be assumed that home language is the most proficient language, those who chose to be tested in a language that was not their proficient home language were considered balanced bilinguals

**Table 1**.
*Subjective and Objective Grouping Criteria*

| | Monolinguals | Unbalanced bilinguals | Balanced bilinguals |
|---|---|---|---|
| Subjective criteria | Monolingual self-rating and Home, school and test language are the same | Monolingual self-rating And Home and test language are the same | Bilingual self-rating or School and test language are the same, but unlike home language |
| Objective criterion | Verbal fluency tasks: No dual-language activation | Verbal fluency tasks: Some dual-language activation | N/A |

*Neuropsychological Test Battery*

The test battery consisted of both verbal and non-verbal measures. The original English version of each test was translated and culturally adapted into Afrikaans and Xhosa. Participants were administered the tests in their language of preference.

An adapted version of the WASI was used to assess both verbal and non-verbal abilities. The Vocabulary subtest provided a measure of word knowledge, while the Similarities subtest measured verbal abstract reasoning. The Block Design subtest assessed spatial analysis, and the Matrix Reasoning subtest measured conceptual reasoning.

An adapted short form of the BNT was used to assess visual naming ability. This version of the BNT included 16 picture items judged by its compilers to be more culturally appropriate for the South African population than the original version (Ferrett *et al*., 2009).

An adapted version of the COWAT, featuring both a phonemic fluency component and a semantic fluency component, was used to measure verbal fluency. In the original COWAT, the phonemic fluency subtest uses the letters ‘F’, ‘A’ and ‘S’. However, for English and Afrikaans participants, the adapted phonemic fluency subtest included the letter sets ‘L’, ‘B’, ‘S’ and ‘M’, ‘A’, ‘T’, as these letters are more appropriate for the South African English and Afrikaans populations. For the Xhosa participants, the phonemic subtest used letters identical to those used for the English and Afrikaans samples, except that the letter ‘S’ was replaced with the letter ‘I’. This alteration was made as words in Xhosa do not as frequently begin with the letter ‘S’ as they do in English and Afrikaans. The letter ‘I’, however, has a frequency in Xhosa equivalent to the frequency of ‘S’ in English and Afrikaans, and was thus chosen as a substitute.

Two letter sets were administered instead of the usual single set in order to ensure that degrees of difficulty and frequency of use of letters could be compared cross-lingually. Further, the use of composite measures (i.e., more than one letter set) has been shown to yield more consistent and reliable results (Chiu *et al*., 1997; Mitrushina *et al*., 2005). The letter sets were counterbalanced across participants to control for practice effects in the current battery. In the semantic fluency subtest, animals, food and clothing were the target categories. These categories are commonly used in the literature (Mitrushina *et al*., 2005) and have been judged to be adequately appropriate for the linguistically diverse South African population (Ferrett *et al*., 2009).

**Procedure**

*Preliminary Procedure*

A social worker screened the school learners according to the exclusion criteria and assisted with obtaining assent from both the learners and their parents (see English version in Appendix C), as well as with completion of the demographics questionnaire.

The university students were screened at a preliminary meeting, where the students also completed the assent forms (see English version in Appendix D) and the demographics questionnaire, and made individual appointments for administration of the test battery.

*Battery Administration*

Before the battery was administered, participants were informed that they may 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 would require their responses to be timed or audio recorded.

Prior to the commencement of each subtest, participants were given clear instructions, as well as an opportunity to ask questions if they did not clearly understand. In some cases, they were given an example of what was expected of them in each test.

The tests were administered in the following order: BNT, WASI Vocabulary, COWAT phonemic fluency (letter set 1), WASI Block Design, WASI Similarities, COWAT phonemic fluency (letter set 2), WASI Matrix Reasoning, COWAT semantic fluency.

*Debriefing*

At the end of the test battery, participants were given the opportunity to express any opinions regarding the testing experience, and were informed how they may access the final results of the study. The participants were then thanked for their participation and either reimbursed for their participation or given course credit. The testing session, including orientation and debriefing, lasted an estimated 90 minutes.

**Statistical analysis**

SPSS Version 17.0 (SPSS Inc., 2008) was used for all data inspections and analyses. Composite neuropsychological scores were computed to reduce the number of variables initially examined. Outcome measures were grouped into domains based on theoretical assumptions (Lezak, Howieson, & Loring, 2004), and then average domain *z*-scores were computed. Goodness-of-fit was assessed by calculating Cronbach's alpha co-efficient for the Verbal Expression domain ($\alpha = .848$). I derived four composite neuropsychological domains: Verbal Expression (WASI Vocabulary, phonemic fluency, semantic fluency, Boston Naming Test), Verbal Reasoning (WASI Similarities), Non-Verbal Concept Formation and Reasoning (WASI Matrix Reasoning), and the Visuospatial and Construction Ability (WASI Block Design). Note that only the first domain comprised several measures.

*Group status* was the categorical, independent variable. *Cognitive ability*, as an outcome measure of each subtest, as well as each composite neuropsychological domain, served as the dependent variable.

Because this study formed part of a larger normative data-gathering project, no norms were available for the target population. Therefore, with regard to the WASI, raw scores could not be converted to age-adjusted standard scores. Instead, for WASI Block Design and Matrix Reasoning, raw scores were used as the basis for analysis; for WASI Vocabulary and Similarities, the subtests made use of different cut-off points on the basis of participant age, and so these data were converted into percentages of possible scores for each age group. These percentage scores then formed the basis for further analysis of those subtests.

In order to allow comparability of outcome scores over age groups, all outcome variables (percentage scores for WASI Vocabulary and Similarities; raw scores for WASI Block Design and Matrix Reasoning; raw scores for total phonemic fluency and total semantic fluency; raw scores for total number of items correct on the BNT) were further converted into *z*-scores by using the age group[5] mean and standard deviation as stand-ins for population means and standard deviations.

The data analysis procedure was twofold. Initially, the distributions of the outcome variables (both overall and by group) were inspected to ensure that the assumptions for parametric statistical tests were upheld. The central tendency and variance of the outcome measures were calculated, and frequency tables and box-and-whisker plots were created in order to better understand the data. All data were checked and cleaned before analysis. All the assumptions for the parametric analyses were upheld, unless otherwise noted.

The main data analysis consisted of a series of hierarchical regression analyses, which were used to examine the predictive strength of group status for cognitive ability. Measures comprising the domains significantly predicted by group status were examined in post-hoc regression analyses. Planned contrasts were then conducted in order to clarify the ordinal arrangement of the group performances as well as to substantiate the findings of the regression analyses using greater statistical power (Rosenthal, Rosnow, & Rubin, 2000).

## RESULTS

### Participant Demographics

Past research has suggested that socioeconomic status and age may function as covariates when there are such between-group differences (Arefi & Alizadeh, 2008; Bialystok *et al.*, 2005; Duncan & Seymour, 2004; Gollan & Brown, 2006; Mindt *et al.*, 2008; Mitrushina *et al*., 2005). As shown in Table 2, when between-group SES differences were investigated, Pearson's Chi-Square test returned a non-significant value, indicating that the participant groups were homogenous with regards to SES.

With regards to the distribution of the participants' ages, the analysis indicated that they were not normally distributed (standardised $S = 2.78$). Because the standardised *S*-statistic was above the recommended level for small samples (2.58), the data were log transformed in order to ensure the normality of the distribution (Field, 2005; Appendix E shows the distribution of the

[5]Each individual year from 7-17 years old constituted a separate age group (i.e. 7-year-olds formed one age group, 8-year-olds a separate age group, and so on), and 18-24-year-olds were all placed into one age group.

age data before and after the log transformation). A one-way ANOVA was then conducted to determine whether age differences existed between the groups. As shown in Table 2, the analysis detected statistically significant between-group differences. Tukey's post-hoc test showed that, on average, participants in the monolingual group were significantly older than participants in the unbalanced bilingual group, $p = .033$. Similar analyses detected no other statistically significant between-group age differences.

**Table 2.**
*Demographic Characteristics of Participants*

| | Monolinguals ($n$ = 22) | Unbalanced bilinguals ($n$ = 22) | Balanced bilinguals ($n$ = 22) | $F$ or $\chi^2$ | $p$ | ESE |
|---|---|---|---|---|---|---|
| Age | | | | | | |
| *M* (*SD*) | 15.01 (4.33) | 11.96 (3.75) | 12.28 (3.72) | 3.914 | .025 | .080[a] |
| Gender | | | | | | |
| M:F | 13:9 | 13:9 | 13:9 | 0.000 | 1.000 | .000[b] |
| SES[c] | | | | | | |
| Lo:Med:Hi | 10:5:6 | 8:9:5 | 5:7:9 | 4.083 | .395 | .179[b] |

*Note.* Age was represented in mathematical years, where participants' age at time of testing was recorded in months and then divided by 12 such that age was represented on a decimal scale (e.g., if age at time of testing is 13years 6months, age in months would be 162months ((12)(13)+6), which would then equate with 13.50 (162/12) mathematical years).
ESE = effect size estimate.
[a]Effect size estimated using $\omega^2$.
[b]Effect size estimated using Cramer's V.
[c]SES was estimated using the 2001 census data for the median annual income level for participants' suburb of residence, where the low, medium and high brackets were defined using the 1st and 3rd quartiles of the distribution.

Table 3 displays descriptive statistics for the outcome measure raw scores, as well as *z*-scores for each domain.

**Table 3.**
*Neuropsychological Performance Within Composite Domains*

| | Monolinguals (*n* = 22) | | Unbalanced bilinguals (*n* = 22) | | Balanced bilinguals (*n* = 22) | |
|---|---|---|---|---|---|---|
| | Range | *M (SD)* | Range | *M (SD)* | Range | *M (SD)* |
| **Verbal Expression (α=.848)** | -0.47 – 1.92 | 0.68 (.57) | -1.65 – 2.48 | -0.18 (.99) | -0.56 – 1.39 | 0.48 (.59) |
| WASI Vocabulary | 22 – 72 | 50.73 (15.80) | 10 - 50 | 32.62 (12.15) | 22 - 61 | 38.64 (10.62) |
| Phonemic fluency | 28 – 112 | 66.72 (22.18) | 21 - 65 | 44.68 (11.47) | 24 - 78 | 53.36 (14.92) |
| Semantic fluency | 25 - 83 | 50.73 (17.46) | 18 - 47 | 35.18 (8.32) | 23 - 72 | 43.00 (12.72) |
| BNT | 6 - 16 | 12.77 (3.15) | 6 - 12 | 9.36 (1.81) | 8 - 15 | 10.95 (1.96) |
| **Verbal Reasoning** | -1.54 – 1.96 | 0.67 (1.00) | -2.69 – 1.17 | -0.68 (0.93) | -0.94 – 1.20 | -0.02 (0.56) |
| WASI Similarities | 11- 42 | 30.86 (8.83) | 4 - 34 | 19.52 (7.46) | 16 - 36 | 24.73 (5.45) |
| **Non-Verbal Concept Formation and Reasoning** | -1.31 – 1.42 | 0.15 (0.78) | -2.54 – 1.75 | -0.32 (1.05) | -1.21 – 1.91 | 0.17 (0.85) |
| WASI Matrix Reasoning | 3 - 34 | 21.00 (9.24) | 3 - 27 | 13.27 (6.58) | 6 - 29 | 16.55 (7.14) |
| **Visuospatial and Construction Ability** | -1.44 – 1.42 | 0.18 (0.83) | -1.95 – 1.26 | -0.42 (0.90) | -1.35 – 1.56 | 0.24 (0.92) |
| WASI Block Design | 7 - 67 | 34.14 (19.97) | 6 – 44 | 16.68 (11.22) | 8 - 64 | 23.36 (14.31) |

*Note.* Data presented are *z*-scores for composite domains and raw scores for individual tests.

**Regression Analyses and Planned Contrasts**

A series of multiple regression analyses was conducted to ascertain whether group status (monolingual, unbalanced bilingual, balanced bilingual), demographic factors and/or test language medium predicted performance on each domain score. For all analyses, the neuropsychological domain score was the outcome variable, group status was entered as the primary predictor, the log transformation of age at time of testing was entered at the second step[6], while language of test administration, SES and gender were entered as predictors in the third step. According to the research hypotheses, performance on the outcome measures is contingent on group status. Age was shown to be distributed in a heterogeneous fashion across the groups, and to be a predictive factor on the outcome measures, and so was included in the second step (Mindt *et al*., 2008). Similarly, previous research has shown that language of test administration, SES and gender may also influence the outcome measures (Mindt *et al*., 2008). The results for the regression analysis are depicted in Table 4.

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[6] Initially, age at time of testing and number of years of completed education were entered as a block at Step 2, as both have been shown to influence the outcome variables (Mindt *et al*., 2008). As expected, however, there was a high level of multicollinearity between the predictors ($r$ = .97). In order to avoid violating the regression assumption of no multicollinearity, number of years of completed education was removed from the model. Because the participants were all sourced from either a school or from a tertiary education institution, number of years of completed education was reflected in their age, and so the omission was justified.

**Table 4.**

*Regression Analyses of Neuropsychological Domains*

| | Verbal Expression | | | Verbal Reasoning | | | Non-Verbal Concept Formation and Reasoning | | | Visuospatial and Construction Ability | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *β* | *t* | *p* | *β* | *t* | *p* | *β* | *t* | *p* | *β* | *t* | *p* |
| **Step 1** | | | | | | | | | | | | |
| Constant | | 4.319 | <.001*** | | 3.686 | <.001*** | | .775 | .441 | | .941 | .350 |
| Group: | | | | | | | | | | | | |
| a. Unbal vs. Mono | -.504 | -3.794 | <.001*** | -.639 | -5.142 | <.001*** | -.246 | -1.718 | .091 | -.308 | -2.20 | .032* |
| b. Bal vs. Monol | -.122 | -.921 | .361 | -.332 | -2.676 | .010* | .011 | .074 | .941 | .028 | .203 | .839 |
| **Step 2** | | | | | | | | | | | | |
| Constant | | 1.411 | .163 | | -4.899 | <.001*** | | .744 | .460 | | .908 | .368 |
| Group: | | | | | | | | | | | | |
| a. Unbal vs. Mono | -.532 | -3.790 | <.001*** | -.450 | -4.290 | <.001*** | -.275 | -1.816 | .074 | -.342 | -2.317 | .024* |
| b. Bal vs. Mono | -.147 | -1.058 | .295 | -.169 | -1.626 | .109 | -.014 | -.096 | .924 | -.001 | -.008 | .993 |
| Age | -.079 | -.646 | .521 | .534 | 5.823 | <.001*** | -.081 | -.615 | .541 | -.097 | -.751 | .456 |
| **Step 3** | | | | | | | | | | | | |
| Constant | | 1.455 | .151 | | -3.666 | .001** | | 1.001 | .321 | | 1.140 | .259 |
| Group: | | | | | | | | | | | | |
| a. Unbal vs. Mono | -.384 | -2.113 | .039* | -.288 | -2.263 | .028* | -.023 | -.125 | .901 | -.235 | -1.278 | .207 |
| b. Bal vs. Mono | -.185 | -1.265 | .211 | -.222 | -2.167 | .035* | -.090 | -.601 | .550 | -.084 | -.566 | .573 |
| Age | -.098 | -.706 | .483 | .454 | 4.644 | <.001*** | -.123 | -.854 | .397 | -.178 | -1.261 | .212 |
| Language of test administration: | | | | | | | | | | | | |
| a. Afrik vs. Eng | -.206 | -1.234 | .203 | -.216 | -1.845 | .070 | -.344 | -2.004 | .050 | -.205 | -1.214 | .230 |
| b. Xho vs. Eng | -.201 | -1.289 | .203 | -.297 | -2.715 | .009** | -.281 | -1.752 | .085 | -.160 | -1.013 | .315 |
| SES: | | | | | | | | | | | | |
| a. Med vs. Lo | -.008 | -.049 | .961 | -.089 | -.811 | .421 | -.067 | -.412 | .682 | .102 | .643 | .523 |
| b. Hi vs. Lo | -.045 | -.296 | .768 | -.111 | -1.053 | .297 | .079 | .506 | .615 | .100 | .651 | .518 |
| Gender | .008 | .061 | .951 | .107 | 1.194 | .238 | .052 | .396 | .694 | .232 | 1.802 | .077 |
| | $R^2$= .207 for Step 1 | | | $R^2$= .306 for Step 1 | | | $R^2$= .063 for Step 1 | | | $R^2$= .104 for Step 1 | | |
| | $\Delta R^2$ = .006 for Step 2 | | | $\Delta R^2$ = .253 for Step 2 | | | $\Delta R^2$ = .006 for Step 2 | | | $\Delta R^2$ = .008 for Step 2 | | |
| | $R^2$= .213 for Step 2 | | | $R^2$= .559 for Step 2 | | | $R^2$= .069 for Step 2 | | | $R^2$= .113 for Step 2 | | |
| | $\Delta R^2$ = .035 for Step 3 | | | $\Delta R^2$ = .070 for Step 3 | | | $\Delta R^2$ = .118 for Step 3 | | | $\Delta R^2$ = .101 for Step 3 | | |
| | $R^2$= .247 for Step 3 | | | $R^2$= .630 for Step 3 | | | $R^2$= .187 for Step 3 | | | $R^2$= .213 for Step 3 | | |

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

Because the regression results were produced via unfocused, omnibus *F*-tests which did not specifically test the predicted trends regarding the performance of the groups in relation to one another (Rosenthal *et al*., 2000), the results of the regression analyses were clarified through planned contrasts.

**Hypothesis 1: Verbal Abilities**

In the regression analysis, group status significantly improved prediction of performance on tasks within the Verbal Expression and Verbal Reasoning domains, ($F(2,60) = 7.831$, $p = .001$, and $F(2,60) = 13.228$, $p < .001$, respectively), where the total amount of explained variance was approximately 21% ($R^2 = .207$) and 31% ($R^2 = .306$), respectively. Examination of the coefficients confirmed what is suggested in Table 3: the effect of group status is most prominent between unbalanced bilinguals and monolinguals in the Verbal Expression domain, where unbalanced bilinguals performed significantly worse. While there was no significant difference between balanced bilinguals and monolinguals in the Verbal Expression domain; in the Verbal Reasoning domain, the regression coefficient indicated that monolinguals performed significantly better than both unbalanced and balanced bilinguals.

When age was added as a predictor in Step 2 of the Verbal Expression model, the change in amount of explained variance was not significant, $\Delta R^2 = .006$, $p = .521$. However, age added a significant amount of explained variance to the Verbal Reasoning model, $\Delta R^2 = .253$, $p < .001$. The $\beta$, $t$, and $p$ values shown in Table 4 suggest that, although this model still predicts poorer performance for unbalanced bilinguals relative to monolinguals, it no longer predicts a significant difference between balanced bilinguals and monolinguals.

Because the predictors in Step 3 did not significantly improve either the Verbal Expression or Verbal Reasoning models, $\Delta R^2 = .035$, $p = .778$; $\Delta R^2 = .070$, $p = .085$, respectively, it was concluded that group status alone was the most successful predictor of performance on tasks in the Verbal Expression domain, while group status and age were most strongly associated with scores in the Verbal Reasoning Domain. The accuracy of these models was confirmed using diagnostic tests, which indicated that the standardised residual were normally distributed (see Appendix F).

*Regression Analyses: Individual neuropsychological tests within the Verbal Expression domain*

Post-hoc regression analyses indicated that unbalanced bilinguals and balanced bilinguals performed more poorly than monolinguals on the WASI Vocabulary subtest ($\beta$ = -.559, $p$ < .001, and $\beta$ = -.348, $p$ = .008, respectively). Group differences were only evident between the unbalanced bilinguals and monolinguals on the phonemic fluency task and on the Boston Naming Test, where unbalanced bilinguals performed more poorly than monolinguals ($\beta$ = -.318, $p$ = .024, and $\beta$ = -.380, $p$ =.007, respectively). Group status, however, did not successfully predict performance on the semantic fluency task, $F(2,62) = 1.606$, $p$ = .209.

*Planned Contrasts*[7]

In the Verbal Expression domain, the planned contrast replicated the finding in the regression analysis and confirmed the first research hypothesis: unbalanced bilinguals performed significantly more poorly than both monolinguals and balanced bilinguals, who performed similarly in relation to each other, $F_{contrast}(1, 63) = 15.518$, $p_{contrast} < .001$, $r_{contrast} = .445$[8], $r_{effect\ size} = .424$. Due to the high significance of this result and the magnitude of the effect after controlling for other between-group variation, the planned contrast confirms not only what was suggested by the regression analysis, but also shows that unbalanced bilinguals performed more poorly than balanced bilinguals, thereby providing strong empirical evidence in favour of the first research hypothesis.

In the Verbal Reasoning domain, the planned contrast also confirmed the first research hypothesis, $F_{contrast}(1, 63) = 20.836$, $p_{contrast} < .001$, $r_{contrast} = .498$, $r_{effect\ size} = .478$, where once again, unbalanced bilinguals performed more poorly than monolinguals and balanced bilinguals, where there was no significant difference. While the corresponding regression analysis showed that both age and group status were predictive of performance in this domain, the magnitude of $r_{contrast}$ indicates that when the effect of the age covariate is partialled out, group status alone largely accounts for the between-group differences. The results of the planned contrast thus

[7] In the verbal domains, the single case of missing data was replaced by the group mean, such that planned contrasts using equal sample sizes could be conducted.

[8] $r_{contrast}$ is a partial correlation of the outcome measure and the lambda weights associated with the groups, after controlling for the effect of all other between group differences. In this way, $r_{contrast}$ controls for the effect of the age confound between the unbalanced bilinguals and the monolinguals. $r_{effect\ size}$, however, is a measure of the effect without partialling out other between-group variation (Rosenthal, Rosnow, & Rubin, 2000)

confirm the effect of group status on performance, independent of the age predictor that was suggested in the regression analysis.

**Hypothesis 2: Non-Verbal Abilities**

As shown in Table 4, none of the predictors were significantly associated with performance within the Non-Verbal Concept Formation and Reasoning domain. Of note, group status only explained 6.3% ($R^2 = .063$, $p = .137$, $SE = .90$) of the variance in the scores. A regression model is thus not proposed for this domain, as the between-group differences were not significant. As expected, then, the planned contrast indicated that the linear prediction was not upheld, $F_{contrast}(1, 63) = 1.969$, $p_{contrast} = .165$, $r_{contrast} = .174$, $r_{effect\ size} = .163$. This result confirms the finding in the regression analysis: there was no significant linear relation between the groups.

In contrast, and as also shown in Table 4, in the Visuospatial and Construction Ability domain, the regression analysis indicated that group status significantly improved prediction of performance, $F(2,61) = 3.553$, $p = .035$, where the total amount of explained variance was 10% ($R^2 = .104$, $p = .035$), and unbalanced bilinguals performed significantly worse than monolinguals, while the difference between balanced bilinguals and monolinguals was not significant. The amount of explained variance did not increase significantly through the addition of predictors in Step 2 and 3, and so the model with group status as the sole predictor was selected as the most economically viable. Although the amount of variance explained by group status was less in this case than in the verbal domains, this model nonetheless departs from that of the Non-Verbal Concept Formation and Reasoning domain, where group status was not predictive of performance. The distribution of the residual according to the proposed model is shown in Appendix F. The planned contrast, however, did not confirm the linear prediction, $F_{contrast}(1, 63) = 2.02$, $p_{contrast} = .160$, $r_{contrast} = .176$, $r_{effect\ size} = .162$ for this domain, as there was no significant difference between balanced bilinguals and monolinguals.

**DISCUSSION**

The results for the verbal domains convincingly confirmed the first research hypothesis. As predicted, the regression analysis showed that unbalanced bilinguals performed more poorly than monolinguals, while monolinguals and balanced bilinguals performed at similar levels. The regression results were clarified by the planned contrasts, which confirmed differences in performance between the two bilingual groups, and confirmed the predicted effect of group status on performance after controlling for age as a covariate and co-predictor of performance (in the case of the Verbal Reasoning domain). In the non-verbal domain of Visuospatial and Construction Ability, the performance trend resembled that of the verbal domains: the regression analysis showed that unbalanced bilinguals performed worse than monolinguals, and that monolinguals and balanced bilinguals performed at similar levels. However, since the hypothesis for the non-verbal domains predicted cognitive advantages for balanced bilinguals relative to monolinguals, the research hypothesis for the Visuospatial and Construction Ability domain was not confirmed, as indicated by the non-significant result of the planned contrast. The observed results for the Verbal Expression, Verbal Reasoning, and Visuospatial and Construction Ability domains may be explained in terms of the unbalanced bilingual deficit and the attenuation of the bilingual effect.

**The Unbalanced Bilingual Deficit**

The deficit observed for unbalanced bilinguals in relation to monolinguals is in accordance with the subtractive effect of Cummins' threshold hypothesis, which predicts this exact effect. In addition, the unbalanced bilingual deficit was also evident relative to balanced bilinguals. Because the groups were homogenous with regards to SES and the planned comparisons accounted for the between-group age discrepancy, deficits due to economic deprivation or age confound cannot be proposed as a rationale for the unbalanced bilingual deficit.

A possible rationale for the unbalanced bilingual deficit is that these individuals may have received their early education in a medium of instruction in which they were not proficient, and consequently endured academic and developmental deficits which are in turn reflected in their comparatively poorer performance on the outcome measures (Allman, 2005; Thomas & Collier, 1997). Citing logistical reasons, and perceptions of the superiority of a particular language, parents often choose to school their young children in their non-proficient second language (Thomas & Collier, 1997). A frequent consequence is that such children may experience verbal deficits in their first language if crucial first-language development is halted when a second language is introduced before the first language is adequately developed (Allman, 2005). Further, previous research conducted in South Africa has shown that tuition in a language is which one is not proficient may lead to an overall lag in educational development and several verbal and non-verbal cognitive disadvantages (Krishnan, 2009). If these individuals subsequently remained unbalanced bilinguals, one may speculate that this is a possible explanation for the observed deficit. Unfortunately, however, this explanation cannot be confirmed as such information was not collected from participants

**Balanced Bilingual Performance**

Neither Cummins' threshold hypothesis nor the cognitive neuropsychological literature provides an explicit rationale as to why the performance of the balanced bilinguals would be consistent with that of the monolinguals. Indeed, Cummins' threshold hypothesis and the cognitive neuropsychological literature provide, respectively, advantageous (where balanced bilinguals are advantaged relative to monolinguals) and deficit (where balanced bilinguals are disadvantaged relative to monolinguals) accounts of balanced bilingualism, and do not account for occasions where there is little or no discrepancy in cognitive abilities between balanced bilinguals and monolinguals.

There is, however, recent documentation of balanced bilinguals and monolinguals performing equally well on cognitive measures. Rosselli and colleagues (2000) found that balanced bilinguals and monolinguals performed similarly on phonemic fluency, oral description and sentence repetition tasks, while Hakuta (1987) produced the same pattern of results in both verbal and non-verbal domains. Furthernore, Gollan and colleagues (2005) made an anecdotal suggestion that "[balanced] bilinguals are different from monolinguals in subtle ways that may attenuate quickly" such that "[balanced] bilinguals and monolinguals would be more similar than they are different" (p. 1232). The notion of the attenuation of the bilingual deficit is central to Diaz's (1985) threshold hypothesis, outlined below.

*Diaz's Threshold Hypothesis and the Attenuation of Deficit*

Diaz's (1985) threshold hypothesis claims that the cognitive effects (verbal and non-verbal) of bilingualism attenuate once bilinguals reach a certain level of second-language proficiency. Although this threshold hypothesis predicts that unbalanced bilinguals will be cognitively *advantaged* relative to monolinguals until they reach a certain threshold of second language proficiency (whereas in the current study, unbalanced bilinguals showed disadvantages relative to monolinguals), it suggests the possibility for the attenuation of the effect of bilingualism (whether additive or subtractive) once a high level of second-language proficiency is attained. Hence, although Diaz's threshold hypothesis predicts that the *additive* effect of bilingualism may attenuate once a threshold of second-language proficiency is attained (whereupon the individual becomes a balanced bilingual), it may be postulated that, in the present case, it was the *subtractive* effect of unbalanced bilingualism that attenuated as participants tended towards the threshold of proficiency.

In contrast, Gollan *et al.*'s (2005) suggestion for the attenuation of the bilingual effect referred to the attenuation of *balanced bilinguals'* cognitive *disadvantages* relative to monolinguals. Taken together, these two sources suggest that the attenuation of effect may occur as unbalanced bilinguals tend towards *balanced bilingualism*, and that cognitive *disadvantages* resulting from bilingualism may be subject to attenuation. The attenuation of effect, as suggested by Gollan *et al.* (2005) and Diaz (1985) is thus in accordance with the results of the current study: the cognitive disadvantages associated with unbalanced bilingualism became less pronounced, or were virtually eliminated, as individuals approached balanced bilingualism.

**The Non-Verbal Concept Formation and Reasoning Domain: The complexity of bilingual effects**

In contrast to the findings in the aforementioned domains, performance in the Non-Verbal Concept Formation and Reasoning Domain was the same for all groups. It is of particular interest that while there was a difference between monolinguals and unbalanced bilinguals in the Visuospatial and Construction Ability domain, there was no such difference in the other non-verbal domain. Similarly, although results for the verbal domains suggested an overall unbalanced bilingual deficit, the post-hoc procedures showed that the effects of bilingualism were not completely uniform, as balanced bilinguals were also disadvantaged relative to the monolinguals in the WASI Vocabulary subtest, and all groups performed similarly in the semantic fluency tasks.

In addition, although ‘verbal’ and ‘non-verbal’ measures are traditionally lumped together in both the bilingualism literature and elsewhere, there is widespread neuroanatomical and cognitive evidence that ‘verbal’ and ‘non-verbal’ abilities are in many ways heterogenous, and are better defined by separate composite neuropsychological domains, rather than under the larger umbrella categories (Lezak *et al*., 2004).

The results suggested that the effects of bilingualism vary within domains (as in the case of the WASI Vocabulary and semantic fluency tasks relative to the overall Verbal Expression domain), and between domains within the same traditional umbrella category (as in the case of the Non-Verbal Concept Formation and Reasoning domain relative to the Visuospatial and Construction Ability domain). Despite the apparent inconsistencies in the overall results, in all but one instance, the only observed effect of bilingualism was the unbalanced bilingual deficit in relation to monolinguals, which was evident in both the traditional ‘verbal’ and ‘non-verbal’ categories. As previously stated, however, the unbalanced bilingual deficit was absent on two measures (semantic fluency and WASI Matrix Reasoning).

The overall results thus indicate that the predicted ‘verbal’/’non-verbal’ distinction was not applicable, as the single effect of bilingualism (the unbalanced bilingual deficit) was illustrated for both ‘verbal’ and ‘non-verbal’ domains. Instead, the unbalanced bilingual deficit differentiated on the basis of individual cognitive abilities, as it was evident on most measures, but absent on two. Krishnan (2009) and Sampath (2005) reported similar results: in these studies, the unbalanced bilingual deficit was present across a substantial portion of both the ‘verbal’ and ‘non-verbal’ individual subtests, while the remainder of the subtests showed no cognitive effect of bilingualism.

Clearly, because the effects of bilingualism in the Krishnan (2009), Sampath (2005) and present studies were not differentiated on ‘verbal’/’non-verbal’ lines, and instead on the basis of individual cognitive ability, the implication is that some cognitive abilities (such as word generation in the semantic fluency task, and conceptual reasoning in the WASI Matrix Reasoning task, in the present study) are more resistant to the unbalanced bilingual deficit than are other abilities. If the previously mentioned early educational deprivation mechanism is indeed implicated in the unbalanced bilingual deficit, it may be posited that some cognitive abilities of bilinguals are more resistant to the unbalanced bilingual effect as they are less reliant on formal tuition, and thus less affected by early educational deprivation (Krishnan, 2009).

**Limitations and Directions for Future Research**

Due to the constraints imposed by the overarching norming study within which this study was nested, I was limited in my use of measures to define bilingualism, an integral element of the study. Although both subjective and objective measures of bilingualism were employed in accordance with wide-spread recommendation (Mindt *et al*., 2008), the validity of the subjective measure of second-language proficiency could be increased through the use of a comprehensive bilingualism questionnaire that investigated the age and manner of language acquisition, degree of contact with each language, preference for the use of each language (e.g., at home, with friends, to watch television), as well as self-rated proficiency in speaking, reading, writing and understanding each language (Rosselli *et al*., 2000). The validity of the objective measure could also be increased by administering the verbal fluency tasks in both languages to facilitate comparison of the number of words generated in each language, in order to assess the degree of discrepancy between language proficiencies (Karapetsas & Andreou, 2004). In addition, the constraints on the present study were such that it did not include non-verbal measures for which the neuropsychological literature predicts balanced bilingual advantages (e.g., the Stroop task). Future efforts should aim to incorporate measures that involve control, inhibition and switching in order to test the non-verbal neuropsychological predictions.

Although the sample size in this study was too small to make further distinctions, future research should aim to collect larger sample sizes such that each group may be divided along language-dominance lines, as it has been suggested that there may be within-group differences if bilinguals diverge on dominant language (Gollan *et al*., 2008). Age of second language acquisition, which may interact with the effect of level of bilingualism on cognitive abilities, has also been shown to be associated with language dominance, and so future research should address these issues in combination (Gollan *et al*., 2008, Hernandez & Pi, 2007).

Lastly, multilinguals were excluded from the study due to the hypothesised complexity of cognitive effects associated with multilingualism (Kavé *et al*., 2008). It would be interesting for future research to investigate the effect of an increase in known languages on cognitive abilities, as it especially applies to the South African population.

**Summary and Conclusions**

The present study showed evidence in favour of only the subtractive effect hypothesised by Cummins' threshold hypothesis of the educational psychology literature, where unbalanced bilinguals were generally disadvantaged relative to monolinguals. The interpretation made here is that the unbalanced bilingual deficit may have been the result of educational development deprivation, caused by early instruction in a non-proficient second-language (Allman, 2005; Thomas & Collier, 1997). None of the data supported the predictions made by the cognitive neuropsychological literature.

Although the literature was not predictive on this account, the unbalanced bilingual deficit was also apparent relative to the balanced bilinguals, who performed similarly to the monolinguals. While balanced bilinguals were spared the cognitive disadvantages that befell the unbalanced bilinguals, they did not (aside from a small advantage on the WASI Vocabulary outcome measure) enjoy the cognitive advantages hypothesised by the additive effect under Cummins' threshold hypothesis. Instead of providing a relative deficit or advantageous account of balanced bilingualism, these results suggest that cognitive abilities are implicated in balanced bilingualism only so far as the attenuation of the deficit associated with unbalanced bilingualism. In this way, there is no effect of balanced bilingualism *per se*, as balanced bilinguals did not diverge from the monolingual yardstick, and so the only effect of bilingualism was the unbalanced bilingual deficit.

In terms of predictions, the first hypothesis was confirmed as unbalanced bilinguals generally performed more poorly than monolinguals in the 'verbal' domains, where balanced bilinguals and monolinguals performed similarly. The second hypothesis, however, was not confirmed as there was no difference between the groups on the Non-Verbal Concept Formation and Reasoning domain, and no difference between monolinguals and balanced bilinguals (as hypothesised by the additive effect of Cummins' threshold hypothesis) on the Visuospatial and Construction Ability domain.

Notably, although the hypotheses predicted different bilingual effects for 'verbal' and 'non-verbal' domains, the results indicated that this distinction was illusionary as the unbalanced bilingual deficit affected both 'verbal' and 'non-verbal' domains. Instead, the results showed that the unbalanced bilingual deficit distinguished between cognitive abilities, where the majority of abilities showed signs of deficit, whereas some exhibited resistance and did not show deficits.

The implication here is that the research hypotheses in the present study may have been more appropriate if orientated to specific cognitive abilities (e.g., unbalanced bilinguals will be disadvantaged on conceptual reasoning abilities, but not on spatial analysis abilities) as opposed to the ‘verbal’/’non-verbal’ distinction (e.g., balanced bilinguals will be disadvantaged on non-verbal abilities and perform similarly to monolinguals on verbal abilities).

As such, the unbalanced bilingual deficit was not absolute, as it was not evident in parts of the Verbal Expression domain, or in the Non-Verbal Concept Formation and Reasoning domain. This finding shows that although there was a pattern of disadvantage, the effects of bilingualism do indeed affect cognitive abilities in heterogeneous ways, as abilities may be differentially susceptible to the effects of bilingualism (Bialystok *et al*., 2005). Accordingly, researchers should examine cognitive abilities on an individual basis, instead of emphasising the ‘verbal’/‘non-verbal’ distinction, such that the more subtle effects of bilingualism on individual cognitive abilities may be explored.

It is, however, unfortunate that the most predominant effect of bilingualism for the South African population is that of a deficit account of unbalanced bilingualism, which could possibly be to the detriment of both the large bilingual population, as well as the nation’s economy. Future studies should thus make use of the above-mentioned research design improvements in order to ascertain whether the observed unbalanced bilingual deficit is indeed prevalent in the South African population and thus worthy of intervention.

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## APPENDIX A

### English Child Demographics Questionnaire

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

GENERAL INFORMATION

<table>
<tr><td>Full name:</td><td colspan="4"></td></tr>
<tr><td rowspan="2">How would you describe your race?</td><td colspan="4">1. Black 2. Coloured 3. White</td></tr>
<tr><td colspan="4">4. Asian 5. Other(specify): 6. Refuse to answer</td></tr>
<tr><td rowspan="5">Contact numbers:</td><td>Person</td><td>Home</td><td>Work</td><td>Cel</td></tr>
<tr><td>Self</td><td></td><td></td><td></td></tr>
<tr><td>Mother</td><td></td><td></td><td></td></tr>
<tr><td>Father</td><td></td><td></td><td></td></tr>
<tr><td>(Guardian)</td><td></td><td></td><td></td></tr>
<tr><td>Residential Address:</td><td colspan="4"></td></tr>
</table>

EDUCATION

| | |
|---|---|
| **Name and area of Current School:** | **School:**<br>**Suburb / area:** |
| **If you are attending Secondary school, what is the name and area of the Primary School you attended in Grade 7?** | **School:**<br>**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**<br>**3. Tent or traditional dwelling 4. Flat / apartment**<br>**5. Town house / semi-detached house**<br>**6. Freestanding brick house 7. Other (specify):** |
| **Which of these items do** | **A. Tap water B. Flush toilet inside home C.** |

| | |
|---|---|
| **you have in your home? (mark as many as necessary)** | **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 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 B

## English Student Demographics Questionnaire

| DEM – Student English Demographic Questionnaire<br>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:**<br>**Suburb / area:** |
| **Name and area of Secondary School attended for Grade 12:** | **School:**<br>**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**<br>**3. Tent or traditional dwelling 4. Flat / apartment**<br>**5. Town house / semi-detached house**<br>**6. Freestanding brick house 7. Other (specify):** |
| **Which of these items do** | **A. Tap water B. Flush toilet inside home C.** |

| | |
|---|---|
| **you have in your home? (mark as many as necessary)** | **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** | **1. No 2. Yes If YES, please answer the** |

| | |
|---|---|
| **medication for over two weeks? (do not include medication for common conditions such as colds, flu, gastro enteritis)** | **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 Form

**ENGLISH CHILD CONSENT, 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 Assent Form

**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**: __________________________________

**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 E**

**Age Distributions**

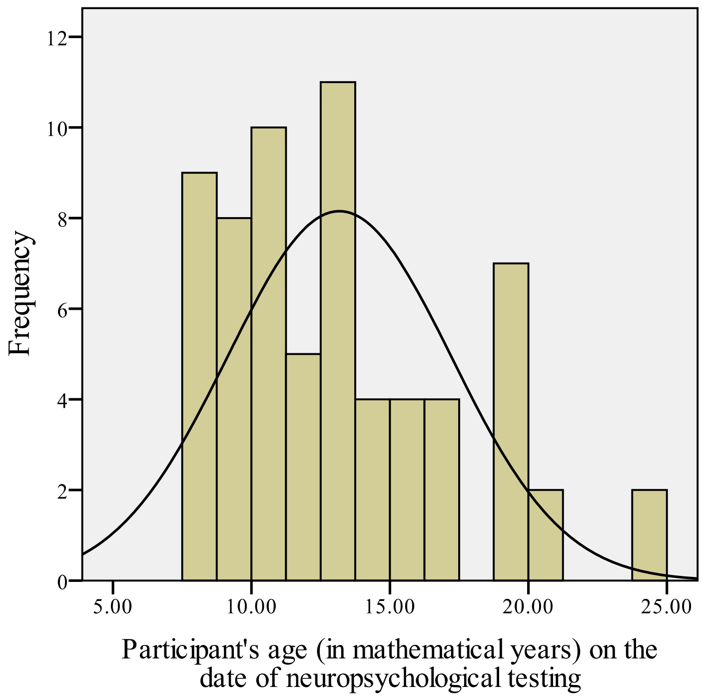


*Figure 1.* Distribution of age before logarithm correction

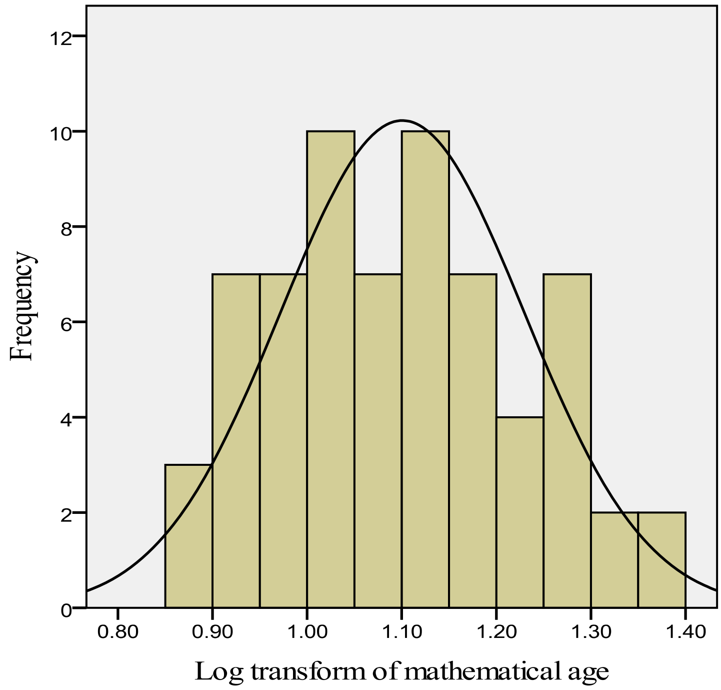


*Figure 2.* Distribution of age after logarithm correction

**APPENDIX F**

**Diagnostic Statistics for Regression Models**

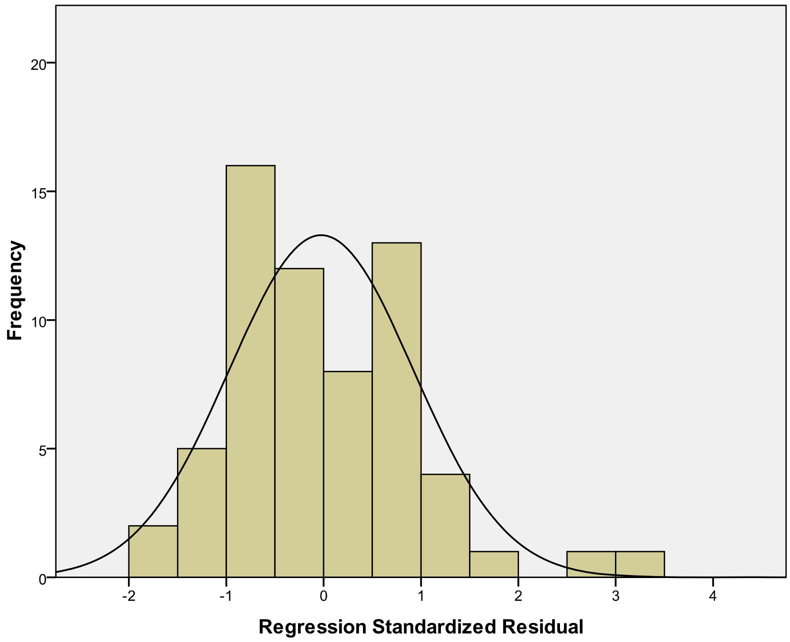


*Figure 3.* Standardised residual distribution for Verbal Expression domain

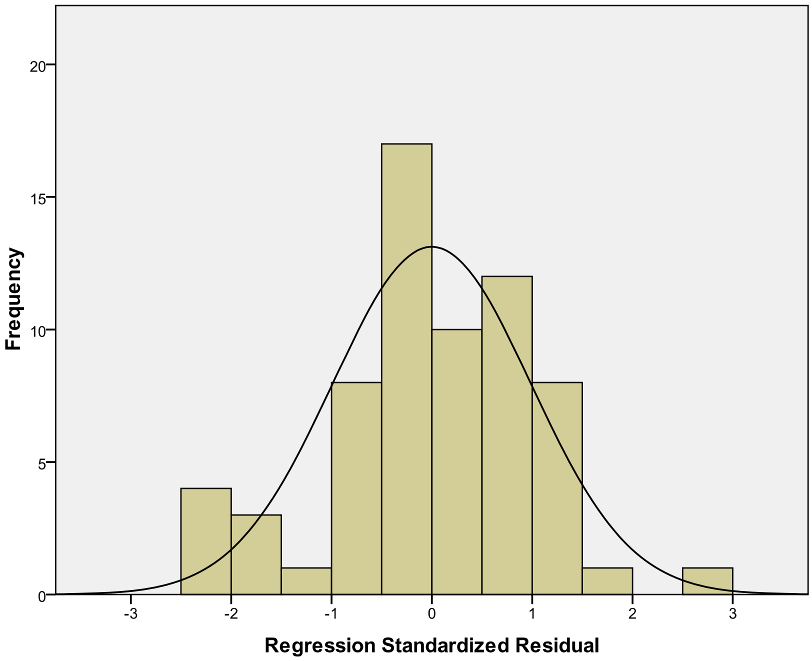


*Figure 4*. Standardised residual distribution for Verbal Reasoning domain

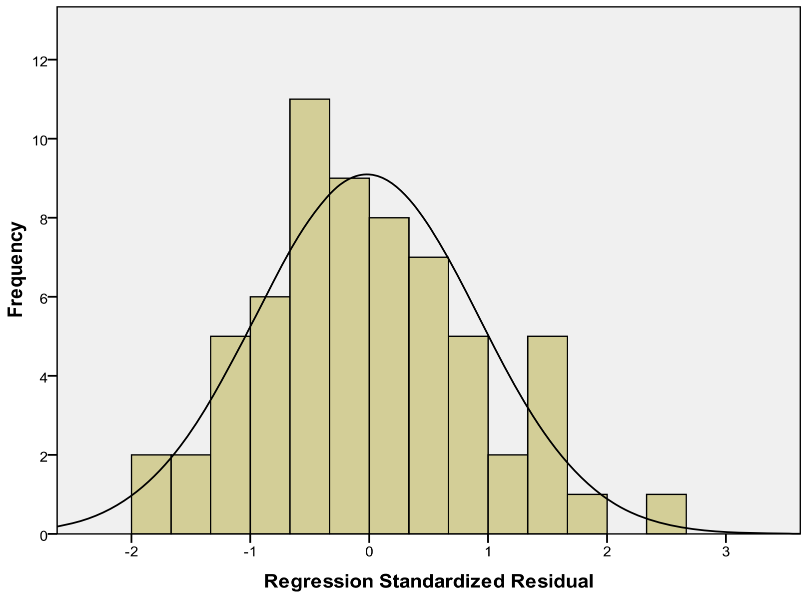


*Figure 5*. Standardised residual distribution for Visuospatial and Construction Ability domain