Title: Exploring the Relation between Language Experience, Verbal Working Memory and Visual and Verbal Long-Term Memory

Name: Otsile Motlhabane

The University of the Witwatersrand

Student Number: 310827

Supervisor: Ms Aline Ferreira Correia

Degree: MA in Psychology by Coursework and Research Report

Declaration

This research report is submitted in order to fulfil the requirements for the MA in Psychology by Coursework and Research Report degree in the field of Research Psychology in the Faculty of Humanities at the University of the Witwatersrand, Johannesburg.

I declare that this research report is purely my own work. It has not been submitted before for any other degree or study that may be related to it at this university or any other institution.

The word count is 20 764..

14/03/2016

Otsile Motlhabane Date

Acknowledgements

I would like to take this opportunity to thank the following people:

- Ms Aline Ferreira Correia, my supervisor for all the support, valuable feedback, patience and advice throughout the process of conducting this research study and completion of this report.
- Maritza Lubbe (who was part of the MA in Psychology by Coursework and Research Report and a fellow researcher on the research team) for the support and time spent collecting part of the data.
- Dr Sherianne Kramer for assisting with the data analysis.
- The participants who volunteered their time to take part in this study and made an effort to participate to their fullest capacities.
- My family for their extraordinary support, encouragement and never-ending assistance during the extremely busy year.

Table of Contents

List of Figures

List of Tables

1. Introduction

The ability to communicate in many languages makes it advantageous to proceed with everyday life, especially in the South African context where there are a number of languages spoken and eleven of them have been recognised by the Constitution (Act 108 of 1996) as official languages.

It is becoming evident that there are far reaching benefits of being able to speak a variety of languages as multilingualism has become a global phenomenon and has been explored from multiple perspectives such as a social and political context (see Alexander, 1989, 2011) as well as a cognitive standpoint (see Bialystok et al, 2005). The correlation between speaking different languages and outperforming monolingual speakers in activities of executive functions namely; inhibitory control, task switching and working memory seems to lay in the fact that bilingual and multilingual speakers need to continuously use executive functions to control two languages or more as well as manage to suppress the interference from other languages while using another (Abutalebi & Green, 2007; Blumenfeld & Marian, 2011; Prior & Gollan, 2010). Schroeder and Marian (2012) have also reported that there have been a number of studies that have demonstrated that bilingual adults display a higher performance in executive functioning, especially in areas that are linked to memory performance.

Marian and Kaushanskaya (2007) suggest that language and memory are a tightly connected entity. Using a bilingual framework, Marian and Neisser (2000) proposed that language framework leading to encrypting specificity and linguistical elements at the time of recollection might impact memory accessibility. Language-dependent effects extend across various types of memory including autobiographical memory, episodic memory and academic learning (Marian & Neisser, 2000; Ross, Xun & Wilson, 2002; Marian & Fausey, 2006).

In order to establish a better understanding of the effects of being a bi/multilingual speaker, especially the effects it has on verbal working memory as well as visual and verbal memory, this study will seek to measure the language experiences of adult multilingual speakers in South Africa in order to establish whether there is indeed a relation between their multilingualism and their verbal working memory as well as their visual and verbal memory by utilising a battery of neuropsychological assessments.

2. Background

2.1 Rationale

Learning new languages has been reported to stimulate memory and other executive functions (Jessner, 2010). Procedural and declarative memory play a significant role in language acquisition with the former being involved in the application of grammar rules during speech and is needed in the learning and use of one's first language (L1) while the latter is involved in grammar use (metalinguistic knowledge) as well as memorisation of vocabulary use in one's second and other languages (L2) (Gomez-Ruiz, 2010). There is a need to conduct this form of research in order to fully comprehend if there are any cognitive implications that present with multilingualism in the South African context, especially in terms of the potential implications on scores of cognitive measures and the present educational policies on multilingualism (Broeder, Extra & Maartens, 1998) in other words, it is essential to establish if multilinguals perform differently on tests because their cognitive functioning is different and/or because they have been educated in a second language. Therefore, this research study will seek to investigate the nature in which language experience or multilingualism may have an effect on healthy adults' cognitive functions of verbal working memory as well as visual and verbal memory ability.

2.2 Research Questions

- Is there a relation between language experience and verbal working memory?
- Is there a relation between language experience and visual and verbal long-term memory?

3. Literature Review

3.1 Language Experience

Language can be classified as the practice of a systematised process of combining words in order to transfer information (Sternberg, 2009). Since language is the core tool of communication at the disposal of people (Alexander, 2011), it is of the utmost importance to highlight that the particular aspect of language and communication that has captured the attention of the greater research community, especially in the particular area of cognitive psychology and neuropsychology has been that of bi/multilingualism.

Multilingualism is the global norm today; the increase of the link of languages is one of the sources to intercultural interaction and social unity (Alexander, 2011). Individuals around the world have become accustomed to learning more than just their primary language (native language/mother tongue) due to the need to be able to communicate with others who are from different cultural backgrounds, those who have immigrated and migrated due to industrialisation and those seeking better opportunities which are prevalent in certain areas as opposed to others. The introduction of English as the most recognised and preferred medium of educational instruction and business consultation around the world, has made it a necessity to learn and to incorporate its use in practically most countries (Schiffman, 2005).

It is imperative to note the work of Alexander (2011) in terms of analysing educational policy, as it reports that it is in the best interest of those living in a multilingual society to learn the language of dominance or power in order to have uniform opportunities in the work market and in other situations. South Africa is not unique to having incorporated English as its basic medium of educational instruction. While this is the case, the South African school system encourages bilingualism and multilingualism and perhaps even aims to maintain equilibrium of the use of a number of the official languages by having some schools teach the languages which are dominant in the different provinces in order to preserve the learners' mother tongues as second and third languages in the curriculum (Broeder et al, 1998).

A mini-dissertation by October (2002) assumed that African first language speaking learners from the Western Cape are inclined to underperform in their matric examinations as opposed to their English speaking counterparts due to the mode of education and assessments not being in their primary language but in a second or third language. The focus of the study was based on the learners' degree of proficiency in the language of teaching of their institutions of education (which are mainly either Afrikaans or English in the Western Cape) versus the level of academic performance. The study compared similarities and /or differences of schools in three categories namely; Afrikaans, English and Xhosa medium schools in the year 2000 and assessed the average matric pass rates in the subjects of Biology, English First Language, Physical Science, Geography and Mathematics. The pass rate averages were accessed from the Western Cape Education Department's statistics. The results found slight differences in the Afrikaans and English First Language results in the non-linguistic subjects while the Xhosa First Language group performed significantly lower in those subjects as the examinations were in a second and sometimes third language. This is a particularly significant finding as Collier (1995) stipulated that it can take between 4 and 12 years for a second language English speaker to function (linguistically and cognitively) on the same level as a native English speaker. This speaks to challenges that many pupils/people may be facing in academic and cognitive testing spheres in South Africa and the extensive work that still needs to be put in to remedy the situation that African first language speaking students face daily.

Given South Africa's historical background with the Apartheid regime having declared Afrikaans as the preferred medium of communication, the other languages spoken by the majority of the country suffered and the shift towards English can be attributed towards the 'empowerment' of the African people who bore the brunt of the effects of marginalisation

(Alexander, 2011). The Constitution of the Republic of South Africa (Act 108 of 1996) enacts eleven official languages and stipulates that the government must take steps to uplift the prominence of all the languages; the national government and each provincial government must use at least two official languages; municipalities must consider the language use and inclinations of its inhabitants and all official languages must be treated with the same equity (Alexander, 2011). The elevation of multilingualism in South Africa constitutes a phenomenon of interest in the field of neuropsychology due to the issues surrounding language, language use and the factors that play a potential role in the assessment process. However, it is a complicated concept to study as there seems to be a breach between the way multilingualism is practiced and the way it is conceived by the individual language keepers. It is essential to ponder what the term ‘multilingual’ means in relation to the measure of capability of the individual speaker while also taking into account what the individual’s main language is and what the mother tongue symbolises or signifies to the individual (Hacksley, Jeffery, Mesthrie, Reddy & Wildsmith-Cromarty, 2007).

Baker’s taxonomy (1993) intends to understand bilingualism from the perspective of its effects on the mother tongue. The taxonomy interprets additive bilingualism as a circumstance in which ‘the addition of a second language and culture may not substitute or shift the first language and culture’ and subtractive bilingualism as a condition in which ‘the studying of a common second language may weaken a person’s minority first language and culture’. The Threshold Theory proposed by Cummins (1977) (in Baker, 2007) states that there may be negative and positive consequences to being a bilingual or multilingual depending on the threshold level of proficiency in both or all acquired languages (a higher level of proficiency in all the languages spoken would indicate positive cognitive effects and a low level of proficiency in all languages would indicate negative cognitive effects). In relation to the South African population, research was conducted in 1990 in the form of a project titled the "Threshold Project" which has revealed that many African pupils suffered from the consequences of subtractive bilingualism due to the abrupt change over from a first to a second language medium of teaching in Grade 5. The "project discovered that pupils could not clarify in English what they previously understood in their first languages; nor could they reassign into their first languages the new knowledge that they had absorbed through English" (October, 2002, p.16). The taxonomy by Barker and the "Threshold Project" provide thought provoking perspectives on the effects of the practice of multilingualism for English second language speakers in South African schools and the challenges they face due to not having the same advantages as their English first language speaking counterparts as they are not necessarily developed on an equal level where the transfer of mastery and academic-related skills can take place from their primary language (October, 2002). Where academic learning is concerned, Marian and Fausey (2006) found that bilinguals were superior at recalling information when it was examined in the same language in which the information was initially learned (although language proficiency controlled the outcomes).

Being a multilingual involves far more than just speaking little bits of languages, it also includes the abilities to perform in other components of the language such as reading, writing and understanding although there is currently no homogenous formula for concluding bilingual proficiency and dominance (Marian, Blumenfeld & Kaushanskaya, 2007). Using each language that one speaks in the correct context is extremely important to the development of the speaker's proficiency (Bethlehem, De Picciotto & Watt, 2003).

Although there is a variety of contradictory literature regarding the advantages and disadvantages of bilingualism, bilinguals tend to demonstrate an improved ability to disregard disturbing and extraneous stimuli, not only in language undertakings but also in overall cognitive processing (Viswanathan, Martin & Bialystok, 2002). Thus it is imperative to explore how the learning and the use of more than one language may have an impact in everyday settings in order to fully grasp the reaching effects of multilingualism.

3.2 Verbal Working Memory and Its Relation to Language Experience

Working Memory (WM) is the portion of memory that encompasses all the knowledge of details and techniques that have been recently activated in memory; this includes the short-lived, transitory short-term memory and the subject matter it holds (Dosher, 2003). According to Brito, Grenell & Bar (2014, p.3) “working memory has the ability to store information in mind and revise this information while performing a task”. Working memory plays a very critical role in various cognitive domains including academic accomplishment, mathematical abilities and working memory abilities have been correlated with language (Brito et al, 2014) which attests to the level of importance that working memory plays in people’s lives.

Baddeley (2003) suggests that there is a model of working memory that comprises of four core elements which essentially make up working memory. “The four elements include the following: a Visuospatial Sketchpad, which is involved in the process of briefly holding visual images in memory. The Phonological Loop retains inner speech for the purposes of verbal understanding and acoustic rehearsal. There are two main components of the Phonological Loop. The first one is Phonological storage, which is responsible for holding material in memory. The other is Sub-Vocal rehearsal, and it is involved in incorporating information into memory in the first place. The third component of working memory is the Central Executive, which organizes attentional activities and controls responses. The fourth component of working memory is a variety of other “Subsidiary Slave Systems” that execute other cognitive or perceptual tasks. The Episodic Buffer falls under the “Subsidiary Slave Systems” and is a limited capacity system that connects information from the subsidiary systems and from long-term into a unitary episodic representation. The phonological loop is of the utmost importance and interest where this research is concerned as it is important for verbal working memory to function” (Sternberg, 2009, pp.192-193).

A large amount of evidence reviewed by Baddeley, Gathercole and Papagno (1998) from adults, children and patients supports the idea that verbal working memory primarily acts as a language learning device although it is not necessarily restricted to word learning. Working memory has been widely reported to play a fundamental part in learning a second language. In bilinguals, brain activation patterns during working memory tasks have been observed to be more complex when using a second language. Administering information in a second language is more challenging and may be less competent. It can be assumed that language perceptive defects in a second language are at least moderately due to this reduced competence of working memory in its phonological as well as in its semantic subsystem (Ardila, 2003).

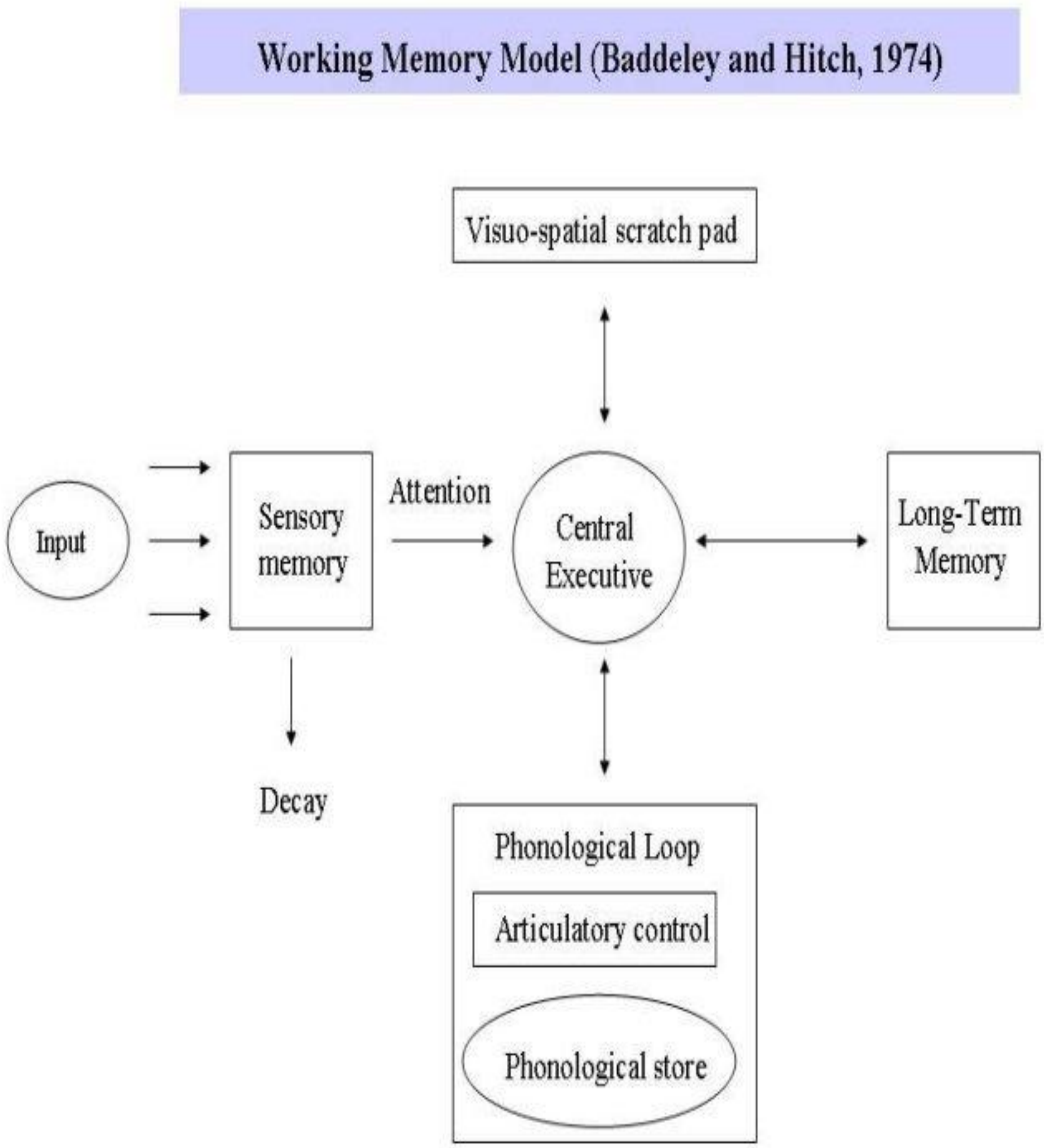

Figure 1: Working Memory Model (Baddeley & Hitch, 1974).

The above model of working memory was conceptualised by Baddeley and Hitch (1974) as a means of 'upgrading' the short-term unitary store model by Atkinson and Shiffrin (1971) which was found to be somewhat limiting in its approach of fully describing the processes of memory beyond short-term storage. The above model on the other hand, presents an overview of a multi-store model which involves active processing and transient storage of information and how the information is transmitted from one form of memory to another.

Baddeley and Hitch's model is however not without its own limitations as the role and limitations of the central executive can be regarded as somewhat unclear. A number of problems have been found with the model, such as the storage capacity being removed from the central executive (Baddeley & Logie, 1999) which became a processing-only component; this then led to some issues with the short-term storage capacity of the "phonological loop and visuospatial sketchpad (collectively known as "slave systems") being found to be insufficient in explaining human subjects performance in a series of experimental tasks and complex cognitive activities" (Baddeley, 2007, p.141). For more limitations on the model see (Baddeley & Wilson, 2002; Baddeley, 2000; Baddeley, Hitch & Allen, 2009).

Sternberg (2009) provides a metaphor for the working memory model which compares it to a "multimedia production house". It incessantly produces and influences sounds and images. It also coordinates the combination of sights into significant arrangements. Once images, sounds and other information have been deposited, they are still available for reformatting and reintegration in unique ways, as new loads and new information become obtainable. There are many demands that are placed on working memory and it can be easily overloaded due to its limited capacity. Working memory is involved in a number of operations, which include attempts to control interference from recently presented but currently unnecessary information, selecting among contesting response alternatives, interchanging among compound task objectives, the erasure of working memory contents that are no longer applicable in task performance and strategic encoding and retrieval (Hedden & Gabrieli, 2004). "Working memory can be assessed through a variety of dissimilar tasks including digit-span tasks and simple arithmetic problems" (Sternberg, 2009, p.194). Findings of a study which compared bilinguals and monolinguals working memory capabilities reflect that there may be a bilingual advantage in the working memory of bilinguals as opposed to that of their monolingual counterparts. This is due to bilinguals possessing a superior ability to uphold a task relevant set in working memory and perhaps also in their grander alertness and flexibility in both set formation and translation of stimuli into appropriate responses (Bialystok et al, 2005). The inability to form and maintain a relevant working memory set results in a failure to screen out irrelevant and misleading information and an increased tendency for behaviour to be dominated by prepotent, habitual stimulus response links at lower levels of control, even to be dominated in extreme cases by the external environment (Braver et al, 2001; Lhermitte, 1983; Mesulam, 2002). Marian and Neisser (2000) have also proposed that language context leads to encoding specificity.

One study analysed the lexical knowledge and working memory of second-generation Spanish-English bilinguals in Florida between the ages of 19 and 54 who were born from native-Spanish parents, who had either moved to the United States before the age of 10 or were born there and mostly/totally attended school in English using subtests such as the Letter-Number Sequencing (from the WAIS-IV), Verbal Fluency, Digits, Sentence repetition (from the Multilingual Aphasia Examination), the Vocabulary Subtest (from the WAIS-III) and more. The results of the study concluded that the second-generation bilinguals have more lexical knowledge and a better verbal working memory capacity in their L2 (English) than their L1 (Spanish) (Ardila et al, 2015). This study by Ardila et al (2015) reflects some similarities to the study conducted in the present report as multilingual, young adults were also studied using the Letter-Number Sequencing (from the WAIS-IV) and therefore, it is pivotal to consider the outcome of the former study as it speaks to the nature of the role that L2 plays in the lives of multilingual speakers who have to manage more than three languages.

Daneman and Merikle (1996) purport a review which suggests that there are high correlations between working memory capacity and language comprehension and between working memory capacity and fluid intelligence. There seems to be a link between language experience and verbal working memory that requires further investigation. Furthermore, working memory has not been the only type of memory that has been studied in the area of bi/multilingualism; there has also been interest in the relation between visual and verbal memory and bi/multilingualism.

3.3 Visual and Verbal Long-Term Memory and Its Relation to Language Experience

Memory is the means by which we are able to preserve and elicit on our past experiences to use that information in the present (Tulving, 2000b; Tulving & Craik, 2000). Long-term memory stores a very large amount of information for very long periods, perhaps even indefinitely in contrast with working memory which is only capable of storing relatively limited amounts of information for very brief periods (Richardson-Klavehn & Bjork, 2003).

According to Herz and Engen (1996), memory compromises of three common procedures, namely: encoding, storage and retrieval. Encoding refers to the transformation of a physical, sensory input into a kind of representation that can be placed in memory. Storage refers to the retention of encoded information in memory. Retrieval refers to how access is gained to information which has been stored in memory (Herz & Engen, 1996). Encoding, storage and retrieval are observed as sequential stages. “First the information is taken in, and then the information is held in for a while and later the information can be pulled out” (Sternberg, 2009, p.217). The level of processing of information influences the encoding of information into long-term storage. “When studying lists of words, participants transport additional information into long-term memory when using a semantic encoding strategy than when using a non-semantic strategy, but encoding of information in long-term memory is not exclusively semantic, there is evidence for visual and acoustic encoding as well” (Sternberg, 2009, p.219). The multi-store model taxonomy (see Atkinson & Shiffrin, 1968) describes memory as information flowing through a system which results in it falling under short-term memory or long-term memory based on whether rehearsal was present or not. Raaijmakers and Shiffrin (2003) later suggested that rehearsal could be elaborative. For this reason, this study has decided to describe the visual and verbal aspects of memory in this regard as long-term memory (which is also referred to as semantic memory) due to the extensive rehearsal and learning that took place during the two tests that were used to measure these two variables.

Chomsky (1965, 1972) supports the notion that humans may very well possess some sort of predisposition to language acquisition. "Human speech discernment is quite astonishing given the sort of auditory processing capacities for other noises. Although adults do not have the same rapid rate of language acquisition as children, many adults still have a good ability of learning new languages though they are likely to retain an accent that reflects the phonemes of their first language when they speak the new language" (Sternberg, 2009, pp. 368-369). Metacognition, which is our ability to understand and control our cognition, also plays a significant role in the learning of new languages. However, metacognition assists to the extent at which the new language/s is similar to the languages that are already known (Scheck & Nelson, 2003).

Long-term memory for visual information has confirmed that humans have an impressive ability to recognise (Shepard, 1967; Standing, Conezio & Haber, 1970) and recall (Bousfield, Esterson, & Whitmarsh, 1957) pictorial information. Adding to that, Mandler and Johnson (1977) as well Mandler and Parker (1976) showed that memory for the elements in a picture and memory for spatial arrangement of the components can be influenced independently in experiments. However, additional research by (Mandler, Seegmiller & Day, 1977) has suggested that a great deal of spatial information is automatically processed when the components of a visual scene are encoded in long-term memory.

The studies on memory for language of input reveal that although retention for the language of words presented in syntactic isolation is quite precise under a variety of experimental circumstances, it is not seamless. It is not well-defined, however, to what extent these results generalise to situations in which language in natural settings is used. In natural settings of language dispensation (everyday situations), words occur in the context of sentences, the goal of the language is comprehension and communication of gist and language can often be derived from the context (speaker, environment, and subject). In the experiment setting, words are typically presented in separation, the aim varies, and the context provides no clues to the language. Also, the experiments on memory for language of input only test over a relatively short retention interval. Francis (1999) has stated that extraneous variables such as lengthy delays and more intervening linguistic experiences may lead to the deterioration of language in memory and this is in relation to memory for content. There is interest in comprehending the manner in which visual and verbal long-term memory may be impacted by bi/multilingualism in the South African setting and in the area of neuropsychology and these factors will be explored in this research.

4. Methodology

4.1 Research Aim

4.1.1 General Aim. The general aim of this research was to explore the relationship between language experience and verbal working memory and visual and verbal long-term memory in a group of healthy multilinguals.

4.2 Research Design

4.2.1 Research Description. This research study is of a quantitative nature. It falls under the positivist paradigm and it could be classified as an applied research study.

4.2.2 Research Variables.

4.2.2.1 Language Experience

4.2.2.1.1 Conceptual Definition. Language experience relates to the ability of individuals to speak a variety of languages; in other words, speaking two languages (bilingualism) or more (multilingualism) and the ability to maintain and switch languages in situations that warrant for it (Marian et al, 2007).

4.2.2.1.2 Operational Definition. The Language and Experience Proficiency Questionnaire (LEAP-Q) was used to measure the self-reported linguistic ability of participants by expanding on their bi/multilingualism in terms of establishing the manner in which they utilised their attained languages in social, academic and other related settings. Factors such as reading, speaking and watching television in the languages that the bi/multilinguals use are also accounted for.

4.2.2.1 Verbal Working Memory

4.2.2.1.1 Conceptual Definition. Working memory has been suggested to be divided into four elements namely: a Visuospatial Sketchpad which stores visual images briefly, a Phonological Loop which stores inner speech for verbal comprehension and acoustic rehearsal, a Central Executive which is responsible for managing attentional activities as well as governing responses and the Episodic Buffer which is responsible for connecting information that comes from subsidiary systems as well as long-term memory (Baddeley, 2000a, 2001).

4.2.2.1.2 Operational Definition. The verbal-auditory element of working memory was assessed by means of utilising The Letter- Number Sequencing subtest of the (WAIS-IV).

4.2.2.2 Visual and Verbal Long-Term Memory

4.2.2.2.1 Conceptual Definition. Visual and verbal long-term memory are cognitive processes involving three main operations namely: "encoding which involves the transformation of a physical, sensory input into a form of representation that can be placed into memory, storage refers to the retention of encoded information in memory and retrieval deals with the manner in which one gains retrieval to information that has been kept in memory. These steps are viewed as sequential although the processes interact with one another and are interdependent" (Sternberg, 2009, p.217). For the purposes of this research, visual and verbal memory are being categorised as part of long-term memory due to the nature of the duration of exposure to the information, the encoding and storage of the information being different from that of the working memory and to create a distinction between the two types of memory (see Atkinson & Shiffrin, 1968 taxonomy on memory stores and rehearsal).

4.2.2.2.2 Operational Definition. Verbal long-term memory was measured by utilising the Rey Auditory Verbal Learning Test (RAVLT) Trials II – VI, Delayed and Recognition Trials and the Visual Reproduction subset from the Wechsler Memory Scale- IV (WMS-IV) II and the Recognition Trial.

4.3 Sample and Sampling

A non-probability, purposive sampling technique was implemented (Terre Blanche, Durrheim & Painter, 2010). The sample consisted of 30 people who were considered to be healthy adults (adults who have not suffered from any neurological diseases, have no history of traumatic brain injuries with loss of consciousness and/or post-traumatic amnesia, and were not suffering from metabolic conditions due to an illness). These individuals had to be between the ages of 19 and 25 years old. The participants were South African citizens and considered themselves to be multilingual (had the ability to communicate in three of the eleven official South African languages with English being their second language and had learnt all the languages they reported to speaking before the age of 6 as that would indicate a suitable level of proficiency in the languages).

Those who had been on chronic medication (medications such as Anti-Retro Viral medication, anti-depressive medication, bipolar disorder medication, etc.) were excluded from the study as chronic medication is said “to cause side effects which can affect cognitive performance such as attention and memory inconsistency” (Medalia & Revheim, 2002, p.11).

No participants under the age of 19 were included in the sample due to the study requiring all participants to be in possession of a valid South African matric certificate and most people are still completing their matric at the age of 18. Another reason for choosing this sample was due to the change implemented in the South African educational curriculum in 2008 (which was introduced to learners in 2006 who were in Grade 10 at the time. The National Senior Certificate based on the National Curriculum Statement requires all students to take seven subjects including Mathematics and Life Orientation in order to pass the curriculum. The students have to comply with the assessment requirements by achieving 40% in three subjects, one of which being an official language at home language level and achieve 30% in three other subjects) (Department of Basic Education, 2009) thus we required all participants to have the same kind of educational/ curriculum exposure in order to maintain some sort of equilibrium and fairness.

This sample of participants was also chosen due to the fact that they were easily accessible to the researcher in that they had volunteered their time to participate in the study. The participants were sourced by means of recruiting acquaintances and friends of friends (in order to maintain a professional rapport as they would not be familiar with the researcher), as well as students from the University of the Witwatersrand.

This sample only consisted of first language African speaking individuals. This is due to first language African speakers being taught their mother tongue first and subsequently being taught English as their second and even third language and they are most likely to have the ability to speak some of the other official languages as most of the languages are interconnected.

All participants who took part in this research study were required to have a minimum schooling level of matric with English having being the language of instruction for at least the five years of the participants high school education as this would increase the participants ability to understand the instructions of the assessments and would have enabled them to have a fair chance at participating to their full capacity. Furthermore, two extensive studies have testified that, on average, at least five years is essential for English Second Language (ESL) students to achieve grade norms on academic (context-reduced, cognitively demanding) properties of English proficiency (Collier, 1987, 1989; Cummins, 1981b).

4.4 Instruments

4.4.1 Biographical Questionnaire. The biographical questionnaire was used to explore the suitability of the potential participants to be included in the sample of the study.

This questionnaire recorded details about the participant's age, gender, level of education and schooling history (see Appendix B).

4.4.2 Wechsler Adult Intelligence Scale IV (WAIS-IV) Letter-Number Sequencing Subtest (LNS). The Letter-Number Sequencing Subtest involves seven sets of random combinations of numbers and letters. Each set is divided into three trials, each with a different combination. The examinees were required to recall the numbers in ascending order and the letters in alphabetical order. Scoring highly on this test indicated a good working memory. The reliability score of this test is considered to be outstanding. "The range of internal consistency reliability for the LNS is between 0.85 and 0.91 and the range of test-retest reliability is between 0.70 and 0.81" (Sattler & Ryan, 2009, p.38). A good performance on this measure suggests that the person has good sequencing, attention and concentration. In contrast, a low score indicates that an individual has difficulty with auditory sequencing, has poor short-term auditory memory, is inattentive, and may also be anxious, impulsive or poorly motivated (Groth-Marnat, 2009). The UK version of the measure was used and the validity scores of this measure for the South African population are extremely high with the validity percentages of the age group between 20 and 24 is 0.89, the gender scores for males and females are 0.90 and 0.89 and the score for the ethnic group of black Africans is 0.81 (Wechsler, 2014). The results of a study by Crowe (2000) indicates that LNS task assesses auditory working memory, attention (as 68% of the variance of the performance on the letter-number sequencing is attributable to performance on the Digit-Span task) and visuospatial functions, thus it was more appropriate to use the LNS task as opposed to the Digit-Span task as it assesses similar functions and beyond those functions.

4.4.3 Rey Auditory Verbal Learning Test (RAVLT). The Rey Auditory Verbal Learning Test (RAVLT) was used to assess verbal learning and memory, including immediate memory span, new learning, susceptibility to interference and recognition memory. The test consists of two word lists (List A and List B), five trials, a delayed trial and a recognition trial. Participants were given a list (List A) of 15 unrelated words repeated over five trials which they needed to repeat. The participants were then given another list (List B) consisting of 15 words, the participants were then required to repeat the original list of words and again after a delay period. “The reported reliability for the RAVLT varied from 0.70 for List A and 0.38 for List B. The test-retest reliability for one year interval between test administrations is reportedly moderate at 0.55” (Dickov et al, 2012, p.1054).

The RAVLT is commonly used to measure a person’s ability to encode, consolidate, store, and retrieve verbal information (Schmidt, 1996). Research by (Salgado et al, 2011) projected the relationship between age, gender, educational level and test performance, significant correlations were found between these variables and the procedures of memory and learning evaluated. Furthermore, “populational studies of other countries indicate that the RAVLT displays a tendency toward strong psychometric properties, including an internal consistency of at least above 0.9” (de Paula et al, 2012, pp. 19-20). This measure is factorial in structure however; it is also heterogeneous and dependent on the sample (Strauss, Sherman & Spreen, 2006).

4.4.4 Wechsler Memory Scale- IV (WMS-IV) Visual Reproduction Subtest. The Visual Reproduction -IV subtest of the WMS-IV is designed to test “memory for non-verbal visual stimuli through trials of immediate and delayed recall” (Spedo et al, 2012, p.113). In the delayed condition (VR II), the examinee is first asked to draw the designs shown during the immediate condition from memory in any order, 20–30 minutes after VR I. Next, the examinee is asked to choose which of the six designs on a page matches the original design shown during the immediate test (VR II Recognition). The VR – IV is said to have a high internal consistency (Spedo et al, 2012). “The coefficient of internal consistency for Cronbach’s alpha coefficient is 0.92 and 0.88 for all variables of the VR-IV. The coefficient of internal consistency (Cronbach's alpha) exceeds 0.70 for the tasks of immediate and delayed recall of the VR." (Spedo et al, 2013, pp. 112, 113, 115).

4.4.5 Language Experience and Proficiency Questionnaire (LEAP-Q). The Language Experience and Proficiency Questionnaire (LEAP-Q) is a questionnaire that focuses on obtaining information regarding the examinee's language skills ranging from the number of languages the examinee speaks; the acquisition of the languages, the level of competence displayed in language use and the proficiency of each language. "Factor analyses revealed consistent factors across two studies which have suggested that the Leap-Q was internally valid. Multiple regression and correlation analyses recognized criterion-based validity and proposed that self-reports were reliable indicators of language performance therefore justifying the Leap-Q as a valid, reliable and competent tool for assessing the language profiles of multilingual, neurologically intact adult population in research settings" (Marian et al, 2007, p.940). NOTE: The LEAP-Q was slightly amended to include factors that the participants would relate to such as the Matric, National Diploma and B-Tech educational options (see Appendix C).

4.5 Procedure

Ethical clearance was obtained through the Human Research Ethics Committee (non-medical) (see Appendix A) from the University of the Witwatersrand. Potential participants were provided with full information about the nature of the study by means of a participant information sheet (see Appendix D). The potential participants were handed a consent form (see Appendix E) which they needed to sign to confirm that they agreed to be part of the research and understood the nature of the research. The assessments took place in a quiet environment so as to limit disturbances and enable the participants to perform to the best of their abilities.

The battery of tests was administered to each participant individually. Seeing as this study forms part of a bigger research project, the battery included a larger set of tests that were administered by two fully trained MA in Research Psychology by Coursework and Research Report students. The test battery took about an hour and fifteen minutes to an hour and a half to complete and were conducted in the following order:

1. Biographical Questionnaire
2. The Leap-Q
3. The Montreal Cognitive Assessment (MoCA)
4. RAVLT Trials II –VI
5. WMS-IV Visual Reproduction (VR) Test II
6. Delis-Kaplan Executive Function System (D-KEFS) Design Fluency Test
7. WAIS- IV Letter Number Sequencing (LNS) Subtest
8. The Controlled Oral Word Association Test (COWAT)
9. Stroop Word-Colour Interference Test (SWCIT)
10. RAVLT Delayed and Recognition Trials
11. WMS-IV Visual Reproduction Test Recognition Trial

Once the assessments had been completed, the researcher then scored the protocols and had them moderated by the research supervisor and a research team member.

NOTE: Please see Appendix F for the descriptions of the assessments that were used as part of the bigger project (which focused on addressing the relation between language experience and cognitive functioning in terms of the manner in which being a multilingual could potentially affect one’s memory and executive functioning abilities in the South African context with regards to test performance) but had not been mentioned in the instruments section of this report.

4.6 Ethical Consideration

Ethical clearance to conduct this research was obtained from the Psychology Department on the behalf Human Research Ethics Committee of the University of the Witwatersrand (non-medical). The intention for which the research was being conducted was thoroughly explained to the potential participants. Each individual was given clear insight into the qualifications of the researcher and reassurance of ability the researcher possessed to conduct the battery of tests on them.

The research implemented and upheld the principle of autonomy via voluntary participation by which the participants were given a participant information sheet which provided full disclosure regarding the aims and activities of the research so as to make an informed decision as to whether they would be willing to participate or not. They were informed that “they had the right to withdraw from the research study at any given point in which they felt the need to do so without any consequences to them” (Terre Blanche et al, 2010, p.67).

The participants were guaranteed non-maleficence during the study. The participants were not harmed in any manner (physically or emotionally) while they were part of this study. However, there was the potential risk for fatigue and frustration due to being in a testing environment for a long period of time, therefore, if any participant had experienced these sorts of difficulties during the administration, the researcher would have interrupted the session and provided the participants with an opportunity to take a break in order to regroup and the administration would have reconvened at the participants convenience.

The participants were asked to sign a consent form which served as verification that the participants were actively willing to take part in the research; they were consenting adults and understood the purpose of research.

The researcher informed the participants that only partial anonymity would be guaranteed due to the face-to-face nature of the test sessions. However, information that could be lead to them being identifiable would not be used in any written report or protocol so as to protect the identities of the participants and preserve their confidentiality. There were no direct benefits for the participants being a part of the study and there were minimal risks posed to them.

5. Results

The results of this research were determined by means of utilising the SPSS software and running a statistical analysis of the raw data. The analysis made use of the measures of central tendency (the mean) as well as measures of variation such as the minimum, maximum, standard deviation and skewness for the independent variables as well as the dependent variables.

The independent variable being language experience consisted of the following factors: the number of languages known, the number of languages used in (school) instruction, the percentage of time exposed to each language that the participant spoke, the percentage of time the participant preferred reading a text in each of their known languages, the participant's gender, the participant's age category, the participant's highest level of education as well as the participant's first three dominant languages (namely L1, L2 and L3).

The dependent variables of this research being verbal working memory and visual and verbal long-term memory consisted of the following measures; the RAVLT test including trial 2, 3, 4, 5, 6, delayed and recognition, the WAIS- IV Letter-Number Sequencing Subtest and the WAIS-IV Visual Reproduction Subtest including Visual Reproduction 2 and the recognition trials.

This section consists of three parts; part one includes of the descriptions of the frequencies of the independent variables and dependent variables, part two contains the multiple regression analyses of the dependent variables and part three comprises of the results of the residual statistics.

5.1 Descriptions

In the following tables (table 1 and 2), the frequencies and percentages of the demographics variables and IV's are presented.

Table 1: Description of Frequency of Demographic Information

Variable	N(30)	Frequency	Percentage
Gender			
Female		18	60
Male		12	40
Age Categories			
1(18-20)		7	23.3
2(21-23)		11	36.7
3(24-25)		12	40
Highest Level of Education			
1(12 Years)		9	30
2(15 Years)		9	30
3(16 Years)		12	40

The results indicate that there were more women forming part of the sample than men by a 60 to 40% ratio. The age category proved to be represented by category three consisting of 24 and 25 year olds as opposed to the other two age categories. 40% of the sample possessed post-graduate degrees (Honours/B-tech level) as the highest level of education category indicates that there were more people in that category as opposed to the equal number of participants who had either only obtained Matric certificates (level 1) or junior Bachelor's degrees and National Diplomas (level 2).

The results in Table 2 describe the frequencies of the language variables. In terms of the total number of languages that participants knew, the criteria to participate in the research stipulated that the participants had to be able to speak a minimum of three of the eleven official South African languages. A significant 36.7% of the sample indicated to being able to speak four of the official languages, while 3.3% of the sample could speak seven and nine of the official languages.

Table 2: Description of Frequency of Language Variables

Variable	N(30)	Frequency	Percentage
Number of Languages Known			
3		8	26.7
4		11	36.7
5		7	23.3
6		2	6.7
7		1	3.3
9		1	3.3
Number of Languages of Instruction			
1		21	70
2		8	26.7
3		1	3.3
Dominant Language 1			
Sesotho		10	33.3
English		9	30.0
Setswana		4	13.3
IsiZulu		4	13.3
Sepedi		1	3.3
Xitsonga		1	3.3
IsiXhosa		1	3.3

Table 2: Descriptions of Frequency of Language Variables continued…

Variable	N(30)	Frequency	Percentage
Dominant Language 2			
English		14	46.7
IsiZulu		5	16.7
Sesotho		3	10
Setswana		3	10
Sepedi		2	6.7
Tshivenda		1	3.3
IsiXhosa		1	3.3
Afrikaans		1	3.3
Dominant Language 3			
IsiZulu		12	40
English		6	20
Sesotho		6	20
Sepedi		2	6.7
Setswana		2	6.7
Tshivenda		1	3.3
Afrikaans		1	3.3

With regards to the number of languages of instruction (these are the languages that the sample were educated in), 70% of the sample were only educated in one language (namely English) while 26.7% of the sample were educated in two languages at separate periods in their educational careers and 3.3% were educated in three languages also at separate periods in their educational careers.

The participants were asked to identify three languages with which they considered to be their most dominant languages. The majority of the sample indicated that Sesotho (33%) and English (30%) were their first dominant languages. English (46.7%) and isiZulu (16.7%) were chosen by the sample as their most dominant second language. Dominant language 3 saw three languages such as English (40%), Sesotho (20%) and isiZulu (20%) being the sample's third most dominant languages.

Table 3 indicates the descriptive statistics for the Dependent Variables of this research.

Table 3: Descriptive Statistics for Verbal Working Memory and Visual and Verbal Long-Term Memory

Scale	N (30)	Min	Max	Mean	Std. Dev	Skewness
RAVLT						
Trial 2		4	13	8.37	2.125	-5.477
Trial 3		5	14	10.50	2.224	-.44
Trial 4		7	14	10.80	1.669	.387
Trial 5		9	15	11.57	1.455	.039
Trial B		2	9	5.77	1.654	.054
Trial 6		5	14	9.90	2.280	.188
Delayed		4	15	10.53	2.738	-.271
Recognition		11	15	14.20	1.095	1.437
VR						
II		14	40	29.47	7.371	-.546

Table 3: Descriptive Statistics of Verbal Working Memory and Visual and Verbal Long-Term Memory continued…

Scale	N(30)	Min	Max	Mean	Std. Dev	Skewness
Recognition		4	7	6.00	1.017	-.632
LNS		13	24	19.10	2.869	-.060

Table 3 represents the descriptive statistics of the dependent variable measures namely the RAVLT assessment tool from trial 2 to the recognition trial, the Visual Reproduction assessment tool including trial II and the recognition trial and the Letter-Number Sequencing subtest from the WAIS-IV tool. The table indicates that a majority of the sample's results were asymmetrically distributed and did not meet the expected pattern of distribution, meaning that the skewness was not normally disturbed as the values are not close to zero and the distribution indicates that the tail of the distribution is more stretched on the side below the mean.

5.2 Multiple Regression Analysis

A multiple regression analysis was run on the data in order to study the separate and collective contributions of the independent variables which constitute of Language Experience to the variation of the dependent variables which consist of Verbal Working Memory and Visual and Verbal Long-Term Memory (Terre Blanche et al, 2010).

Table 4: Multiple Regression Coefficients of the RAVLT

Model	Unstandardised Coefficients		Standardised Coefficients			Collinearity Statistics	
	B	Std. Error	Beta	t	Sig.	Tolerance	VIF
Trial 2							
Number of languages known	.268	.669	.170	.401	.696	.200	5.007
Number of languages of Instruction	.712	1.112	.183	.641	.534	.441	2.265
% Time exposed to Lang	.007	.049	.037	.149	.884	.584	1.713
% Time exposed to Lang	.114	.053	.688	2.133	.054	.347	2.880
% Time exposed to Lang	-.049	.056	-.275	-.884	.394	.374	2.675
Exp Lang 5 or more % of time	.159	.225	.428	.708	.492	.099	10.118
Chose to Read Lang1 % Time of time	-.165	.187	-1.938	-.883	.395	.007	133.478
Chose to Read Lang2 % Time of time	-.156	.207	-.911	-.755	.465	.025	40.295
Chose to Read Lang3 % Time of time	-.237	.211	-2.126	-1.125	.283	.010	98.901
Chose to Read Lang4 % Time of time	-.217	.225	-962	-.963	.355	.036	27.626
Chose to Read Lang5 % Time of time	-.338	.288	-.559	-1.173	.264	.159	6.293
Gender	-.969	1.262	-.227	-.767	.458	.412	2.426
Highest Education level	-.620	.968	-.246	-.640	.534	.244	4.106
Age Category	.809	.903	.301	.896	.388	.319	3.135
Dominant Language 1	.268	.200	.380	1.344	.204	.451	2.216
Dominant Language 2	.217	.278	.271	.782	.450	.301	3.326
Dominant Language 3	.045	.267	.056	.168	.870	.323	3.093
Trial 3							
Number of languages known	1.584	.646	.962	2.452	.031	.200	5.007
Number of languages of Instruction	-.868	1.074	-.213	-.808	.435	.441	2.265
% Time exposed to Lang	.075	.047	.365	1.560	.138	.584	1.713
% Time exposed to Lang	.039	.052	.226	.760	.462	.347	2.880
% Time exposed to Lang	-.049	.054	-.260	-.907	.383	.374	2.675
Exp Lang 5 or more % of time	-.371	.217	-.954	-1.709	.113	.099	10.118

Table 4: Multiple Regression Coefficients of the RAVLT continued…

	Unstandardised Coefficients		Standardised Coefficient			Collinearity Statistics	
Model	B	Std. Error	Beta	t	Sig.	Tolerance	VIF
Chose to Read Lang1 % Time of time	-.118	.181	-1.328	-.655	.525	.007	133.478
Chose to Read Lang2 % Time of time	-.154	.200	-.854	-.767	.458	.025	40.295
Chose to Read Lang3 % Time of time	-.121	.204	-1.036	-.594	.564	.010	98.901
Chose to Read Lang4 % Time of time	.066	.217	.282	.305	.765	.036	27.626
Chose to Read Lang5 % Time of time	-.377	.278	-.596	-1.355	.201	.159	6.293
Gender	-.223	1.120	-.050	-.183	.858	.412	2.426
Highest Education level	-1.536	.936	-.584	-1.642	.127	.244	4.106
Age Category	1.543	.873	.549	1.767	.103	.319	3.135
Dominant Language 1	.108	.193	.147	.563	.584	.451	2.216
Dominant Language 2	.151	.269	.180	.561	.585	.301	3.326
Dominant Language 3	.090	.285	.108	.350	.733	.323	3.093
Trial 4							
Number of languages known	.539	.528	.437	1.022	.327	.200	5.007
Number of languages of Instruction	-.102	.877	-.033	-.161	.910	.441	2.265
% Time exposed to Lang	.050	.038	.327	1.308	.215	.584	1.713
% Time exposed to Lang	.038	.042	.295	.912	.380	.347	2.880
% Time exposed to Lang	-.066	.044	-.466	-1.491	.162	.374	2.675
Exp Lang 5 or more % of time	-.165	.177	-.565	-.930	.371	.099	10.118
Chose to Read Lang1 % Time of time	-.115	.148	-1.724	-.781	.450	.007	133.478
Chose to Read Lang2 % Time of time	-.163	.163	-1.205	-.994	.340	.025	40.295
Chose to Read Lang3 % Time of time	-.116	.167	-1.327	-.699	.498	.010	98.901
Chose to Read Lang4 % Time of time	.012	.178	.070	.070	.946	.036	27.626
Chose to Read Lang5 % Time of time	-.227	.227	-.479	-1.000	.337	.159	6.293

Table 4: Multiple Regression Coefficients of the RAVLT continued…

	Unstandardised Coefficients		Standardised Coefficient			Collinearity Statistics	
Model	B	Std. Error	Beta	t	Sig.	Tolerance	VIF
Gender	1.067	.996	.319	.1071	.305	.412	2.426
Highest Education level	-.606	.764	-.307	-.793	.443	.244	4.106
Age Category	.597	.713	.283	.837	.419	.319	3.135
Dominant Language 1	-.072	.157	-.129	-.455	.657	.451	2.216
Dominant Language 2	.014	.219	.022	.064	.950	.301	3.326
Dominant Language 3	-.073	.211	-.116	-.345	.736	.323	3.093
Trial 5							
Number of languages known	.892	.407	.829	2.190	.049	.200	5.007
Number of languages of Instruction	1.191	.677	.447	1.758	.104	.441	2.265
% Time exposed to Lang	-.008	.030	-.057	-.258	.801	.584	1.713
% Time exposed to Lang	.067	.032	.593	2.066	.061	.347	2.880
% Time exposed to Lang	-.051	.034	-.417	-1.507	.158	.374	2.675
Exp Lang 5 or more % of time	-.102	.137	-.399	-.742	.472	.099	10.118
Chose to Read Lang1 % Time of time	-.046	.114	-.797	-.408	.691	.007	133.478
Chose to Read Lang2 % Time of time	-.091	.126	-.776	-.408	.691	.025	40.295
Chose to Read Lang3 % Time of time	-.117	.129	-1.533	-.912	.380	.010	98.901
Chose to Read Lang4 % Time of time	.005	.137	.034	.038	.970	.036	27.626
Chose to Read Lang5 % Time of time	-.136	.175	-.328	-.773	.454	.159	6.293
Gender	.321	.769	.110	.417	.684	.412	2.426
Highest Education level	.170	.590	.099	.288	.778	.244	4.106
Age Category	-.140	.550	-.076	-.255	.803	.319	3.135
Dominant Language 1	-.030	.122	-.061	-.244	.811	.451	2.216
Dominant Language 2	.144	.169	.263	.852	.411	.301	3.326
Dominant Language 3	-.016	.163	-.029	-.098	.923	.323	3.093
Trial 6							
Number of languages known	.031	.658	.018	.047	.964	.200	5.007
Number of languages of Instruction	1.015	1.094	.243	.928	.372	.441	2.265
% Time exposed to Lang	.030	.048	.141	.616	.549	.584	1.713
% Time exposed to Lang	.056	.052	.317	1.071	.305	.347	2.880

Table 4: Multiple Regression Coefficients of the RAVLT continued….

	Unstandardised Coefficients		Standardised Coefficient			Collinearity Statistics	
Model	B	Std. Error	Beta	t	Sig.	Tolerance	VIF
% Time exposed to Lang	-.090	.055	-.467	-1.638	.127	.374	2.675
Exp Lang 5 or more % of time	.140	.221	.351	.634	.538	.099	10.118
Chose to Read Lang1 % Time of time	-.196	.184	-2.144	-1.065	.308	.007	133.478
Chose to Read Lang2 % Time of time	-.224	.204	-1.216	-1.099	.293	.025	40.295
Chose to Read Lang3 % Time of time	-.266	.208	-2.224	-1.283	.224	.010	98.901
Chose to Read Lang4 % Time of time	-.093	.221	-.383	-.418	.683	.036	27.626
Chose to Read Lang5 % Time of time	-.499	.283	-.770	-1.761	.104	.159	6.293
Gender	-.161	1.242	-.035	-.130	.899	.412	2.426
Highest Education level	-.941	.953	-.349	-.987	.343	.244	4.106
Age Category	1.123	.889	.390	1.263	.230	.319	3.135
Dominant Language 1	.043	.196	.056	.217	.832	.451	2.216
Dominant Language 2	.355	.274	.413	1.299	.218	.301	3.326
Dominant Language 3	.309	.263	.360	1.175	.263	.323	3.093
Trial B							
Number of languages known	1.472	.512	1.202	2.877	.014	.200	5.007
Number of languages of Instruction	-.709	.851	-.234	-.833	.421	.441	2.265
% Time exposed to Lang	-.017	.037	-.109	-.466	.664	.584	1.713
% Time exposed to Lang	.045	.041	.353	1.114	.287	.347	2.880
% Time exposed to Lang	-.032	.043	-.231	-.757	.464	.374	2.675
Exp Lang 5 or more % of time	-.132	.172	-.455	-.766	.458	.099	10.118
Chose to Read Lang1 % Time of time	-.151	.143	-2.280	-1.057	.312	.007	133.478
Chose to Read Lang2 % Time of time	-.204	.159	-1.529	-1.289	.222	.025	40.295
Chose to Read Lang3 % Time of time	-.191	.161	-2.202	-1.185	.259	.010	98.901
Chose to Read Lang4 % Time of time	-.122	.172	-.698	-.711	.491	.036	27.626

Table 4: Multiple Regression Coefficients of the RAVLT continued…

Model	Unstandardised Coefficients B	Unstandardised Coefficients Std. Error	Standardised Coefficients Beta	t	Sig.	Collinearity Statistics Tolerance	Collinearity Statistics VIF
Chose to Read Lang5 % Time of time	-.274	.220	-.583	-1.245	.237	.159	6.293
Gender	.949	.966	.286	982	.345	.412	2.426
Highest Education level	-.916	.741	-.486	-1.236	.240	.244	4.106
Age Category	.178	.691	.085	.257	.801	.319	3.135
Dominant Language 1	.117	.153	.213	.765	.459	.451	2.216
Dominant Language 2	.076	.213	.122	.357	.727	.301	3.326
Dominant Language 3	-.066	.204	-.106	-.323	.752	.323	3.093
Delayed							
Number of languages known	1.247	1.069	.616	1.167	.266	.200	5.007
Number of languages of Instruction	.408	1.778	.081	.230	.822	.441	2.265
% Time exposed to Lang	.074	.078	.293	.950	.361	.584	1.713
% Time exposed to Lang	.034	.085	.158	.395	.700	.347	2.880
% Time exposed to Lang	4546E-5	.089	.000	.001	1.000	.374	2.675
Exp Lang 5 or more % of time	-.229	.359	-.478	-.638	.536	.099	10.118
Chose to Read Lang1 % Time of time	.038	.299	.345	.127	.901	.007	133.478
Chose to Read Lang2 % Time of time	.028	.331	.128	.086	.933	.025	40.295
Chose to Read Lang3 % Time of time	.023	.337	.158	.067	.947	.010	98.901
Chose to Read Lang4 % Time of time	.173	.360	.596	.481	.639	.036	27.626
Chose to Read Lang5 % Time of time	-.290	.461	-.373	-.630	.540	.159	6.293
Gender	.-093	2.018	-.017	-.046	.964	.412	2.426
Highest Education level	-.534	1.549	-.165	-.345	.736	.244	4.106
Age Category	1.138	1.444	.329	.788	.446	.319	3.135
Dominant Language 1	.109	.319	.120	.342	.738	.451	2.216
Dominant Language 2	.372	.445	.360	.837	.419	.301	3.326
Dominant Language 3	.286	.427	.278	.671	.515	.323	3.093

Table 4: Multiple Regression Coefficients of the RAVLT continued…

Model	Unstandardised Coefficients		Standardised Coefficient	t	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
Recognition							
Number of languages known	.199	.217	.246	.918	.377	.200	5.007
Number of languages of Instruction	.004	.361	.002	.010	.992	.441	2.265
% Time exposed to Lang	-.032	.016	-.316	-2.015	.067	.584	1.713
% Time exposed to Lang	.014	.017	.160	.788	.446	.347	2.880
% Time exposed to Lang	-.008	.018	-.084	-.431	.674	.374	2.675
Exp Lang 5 or more % of time	-.068	.073	-.352	-.925	.373	.099	10.118
Chose to Read Lang1 % Time of time	.084	.061	1.914	1.384	.192	.007	133.478
Chose to Read Lang2 % Time of time	.091	.067	1.031	1.356	.200	.025	40.295
Chose to Read Lang3 % Time of time	.055	.069	.948	.796	.441	.010	98.901
Chose to Read Lang4 % Time of time	.076	.073	.656	1.043	.318	.036	27.626
Chose to Read Lang5 % Time of time	.052	.094	.166	.554	.590	.159	6.293
Gender	.781	.410	.355	1.905	.081	.412	2.426
Highest Education level	.466	.315	.359	1.480	.165	.244	4.106
Age Category	-.203	.293	-.147	-.692	.502	.319	3.135
Dominant Language 1	.172	.065	.474	2.656	.021	.451	2.216
Dominant Language 2	.066	.090	.160	.732	.478	.301	3.326
Dominant Language 3	.244	.087	.592	2.810	.016	.323	3.093

The results of table 4 present the coefficients of the RAVLT that were run against the independent variables. The following factors were analysed: unstandardised coefficients consisting of standard error and B coefficient, standardised coefficients consisting of Beta coefficient, the t coefficient, the level of significance ($P < 0.05$) and the collinearity statistics consisting of tolerance level and VIF. The figures indicate that there is no significance between the independent variables (number of languages known, number of languages of instruction, % of time exposed to languages 1 up to 5 or more, % of time chosen to read in languages 1 up to 5, gender, highest level of education, age category and dominant languages 1 to 3) and the RAVLT trials 2, 6 and the delayed trial. Significance, which is conventionally a probability of up to 0.05 or 5% was found between RAVLT trials 3 (at .031), 5 (at .049) and B (at 0.14) and the number of languages known, while the recognition trial displayed significance with dominant languages 1 (.021) and 3 (at .016).

Table 5: Multiple Regression Coefficients of the Visual Reproduction Subtest

	Unstandardised Coefficients		Standardised Coefficients			Collinearity Statistics	
Model	B	Std. Error	Beta	t	Sig.	Tolerance	VIF
II							
Number of languages known	-1.859	2.301	-.341	.808	.435	.200	5.007
Number of languages of Instruction	-.934	3.827	-.069	-.244	.811	.441	2.265
% Time exposed to Lang	-.068	.168	-.101	-.408	.691	.584	1.713
% Time exposed to Lang	.271	.184	.437	.1478	.165	.347	2.880
% Time exposed to Lang	-.153	.192	-.246	-.797	.441	.374	2.675
Exp Lang 5 or more % of time	.796	.774	.617	1.029	.324	.099	10.118
Chose to Read Lang1 % Time of time	-1.020	.644	-3.455	-1.586	.139	.007	133.478
Chose to Read Lang2 % Time of time	-1.210	.713	-2.032	-1.698	.115	.025	40.295
Chose to Read Lang3 % Time of time	-.984	.726	-2.540	-1.355	.200	.010	98.901
Chose to Read Lang4 % Time of time	-.893	.744	-1.143	-1.153	.271	.036	27.626
Chose to Read Lang5 % Time of time	-1.897	.991	-.905	-1.913	.080	.159	6.293
Gender	6.835	4.345	.462	1.573	.142	.412	2.426
Highest Education level	-5.670	3.333	-.650	-1.701	.115	.244	4.106
Age Category	1.394	3.109	.150	.448	.662	.319	3.135
Dominant Language 1	1.021	.687	.417	1.486	.163	.451	2.216
Dominant Language 2	1.123	.957	.404	1.174	.263	.301	3.326
Dominant Language 3	-.795	.919	-.287	-.864	.404	.323	3.093
Recognition							
Number of languages known	.176	.310	.234	.569	.580	.200	5.007

Table 5: Multiple Regression Coefficients of the Visual Reproduction Subtest continued…

	Unstandardised Coefficients		Standardised Coefficients			Collinearity Statistics	
Model	B	Std. Error	Beta	t	Sig.	Tolerance	VIF
Number of languages of Instruction	.286	.516	.154	.554	.590	.441	2.265
% Time exposed to Lang	-.028	.023	-.303	-1.256	.233	.584	1.713
% Time exposed to Lang	.047	.025	.597	1.908	.081	.347	2.880
% Time exposed to Lang	-.044	.026	-.516	-1.713	.112	.374	2.675
Exp Lang 5 or more % of time	.020	.104	.114	.194	.849	.099	10.118
Chose to Read Lang1 % Time of time	-.176	.087	-4.321	-2.030	.065	.007	133.478
Chose to Read Lang2 % Time of time	-.198	.096	-2.405	-2.056	.062	.025	40.295
Chose to Read Lang3 % Time of time	-.203	.098	-3.801	-2.075	.060	.010	98.901
Chose to Read Lang4 % Time of time	-.112	.104	-1.040	-1.074	.304	.036	27.626
Chose to Read Lang5 % Time of time	-.323	.134	-1.117	-2.416	.033	.159	6.293
Gender	.502	.586	.246	.856	.409	.412	2.426
Highest Education level	-.753	.449	-.625	-1.675	.120	.244	4.106
Age Category	.125	.419	.098	.299	.770	.319	3.135
Dominant Language 1	.133	.093	.394	1.436	.176	.451	2.216
Dominant Language 2	.019	.097	.066	.198	.846	.301	3.326
Dominant Language 3	.172	.129	.449	1.336	.206	.323	3.093

Table 5 indicates the coefficients of the VR (II and Recognition) measure. The same independent variables (as in Table 5) were run in a multiple regression analysis against the VR measure. Significance was found to exist between with the % of time chosen to read in language 5 VR Recognition (at .033). No significance was found between VR II and any of the independent variables.

Table 6: Multiple Regression Coefficients of the Letter-Number Sequencing Subtest

Model	Unstandardised Coefficients		Standardised Coefficients	t	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
LNS							
Number of languages known	.156	.888	.074	.176	.863	.200	5.007
Number of languages of Instruction	.239	1.477	.046	.162	.874	.441	2.265
% Time exposed to Lang	-.046	.065	-.173	-.708	.493	.584	1.713
% Time exposed to Lang	.030	.071	.132	.417	.684	.347	2.880
% Time exposed to Lang	-.029	.074	-.120	-.393	.701	.374	2.675
Exp Lang 5 or more % of time	-.439	.299	-.875	-1.470	.167	.099	10.118
Chose to Read Lang1 % Time of time	.058	.248	.503	.233	.820	.007	133.478
Chose to Read Lang2 % Time of time	.057	.275	.248	.209	.838	.025	40.295
Chose to Read Lang3 % Time of time	.093	.280	.617	.332	.746	.010	98.901
Chose to Read Lang4 % Time of time	.345	.299	1.136	1.155	.270	.036	27.626
Chose to Read Lang5 % Time of time	-.089	.383	-.109	-.233	.820	.159	6.293
Gender	1.762	1.678	.306	1.050	.314	.412	2.426
Highest Education level	.136	1.287	.040	.106	.917	.244	4.106
Age Category	.778	1.200	.215	.648	.529	.319	3.135
Dominant Language 1	.668	.265	.702	2.520	.027	.451	2.216
Dominant Language 2	.569	.369	.525	1.540	.150	.301	3.326
Dominant Language 3	.312	.355	.289	.878	.397	.323	3.093

The LNS Subset was only found to display significance with dominant language 1 (at .027) of all the independent variables when run through a multiple regression analysis.

5.3 Residual Statistics

Tables 7.1, 7.2, 7.3; 8.1, 8.2, 8.3; 9.1, 9.2 and 9.3 reflect the results of the residual statistics of the analysis that was run on the data in order to establish the nature (correlation) and potential strength of the relationship between the variables. The tables are presented in sets of three including the model of summary table, the ANOVA table and the residual statistics table.

Table 7.1: Model of Summary of the RAVLT

					Change Statistics				
Model	R	R^2	Adjusted R^2	Std. Error of Estimate	R Square Change	F Change	df1	df2	Sig. F Change
Trial 2	.753[a]	.567	-.047	2.174	.567	.924	17	12	.571
Trial 3	.794[a]	.631	.108	2.101	.631	1.206	17	12	.378
Trial 4	.750[a]	.563	-.057	1.716	.563	.908	17	12	.583
Trial 5	.811[a]	.657	.171	1.324	.657	1.352	17	12	.302
Trial 6	.797[a]	.635	.119	2.140	.653	1.230	17	12	.364
Trial B	.762[a]	.581	-.012	1.664	.581	.980	17	12	.527
Delayed	.577[a]	.333	-.612	3.477	.333	.352	17	12	.976
Recognition	.910[a]	.828	.584	.706	.828	3.396	17	12	.018

NOTE: Variables sharing a letter in their superscript (a/ b) indicate that the difference between the means is not statistically different.

Table 7.2: ANOVA of the RAVLT

Model	Sum of Squares	df	Mean Square	F	Sig.
Trial 2					
Regression	74.230	17	4.366	.924	.571[b]
Residual	56.737	12	4.728		
Total	130.967	29			
Trial 3					
Regression	90.506	17	5.324	1.206	.378[b]
Residual	52.994	12	4.416		
Total	143.500	29			
Trial 4					
Regression	45.459	17	2.674	.908	.583[b]
Residual	35.341	12	2.945		
Total	80.800	29			
Trial 5					
Regression	40.317	17	2.372	1.352	.302[b]
Residual	21.050	12	1.754		
Total	61.367	29			
Trial 6					
Regression	95.762	17	5.633	1.230	.364[b]
Residual	54.938	12	4.578		
Total	150.700	29			
Trial B					
Regression	46.139	17	2.714	.980	.527[b]
Residual	33.228	12	2.769		
Total	79.367	29			
Delayed					
Regression	72.397	17	4.259	.352	.976[b]
Residual	145.070	12	12.089		
Total	217.467	29			
Recognition					
Regression	28.811	17	1.695	3.396	.018[b]
Residual	5.989	12	.499		
Total	34.800	29			

Table 7.3 Residual Statistics of the RAVLT

Scale	N	Minimum	Maximum	Mean	Std. Deviation
Trial 2					
Std. Residual	30	-1.154	1.457	.000	.643
Stud. Residual	29	-1.567	2.356	.000	1.023
Cook's Distance	29	.000	.545	.117	.155
Centered Leverage Value	30	.269	.967	.567	.190
Trial 3					
Std. Residual	30	-1.289	1.093	.000	.643
Stud. Residual	29	-2.346	2.26	.059	1.078
Cook's Distance	29	.000	2.761	.215	.535
Centered Leverage Value	30	.269	.967	.567	.190
Trial 4					
Std. Residual	30	-1.301	1.226	.000	.643
Stud. Residual	29	-1.558	1.807	.037	.996
Cook's Distance	29	.000	1.605	.145	.314
Centered Leverage Value	30	.269	.967	.567	.190
Trial 5					
Std. Residual	30	-1.557	1.304	.000	.643
Stud. Residual	29	-2.198	2.107	.027	1.017
Cook's Distance	29	.000	.764	.132	.205
Centered Leverage Value	30	.269	.967	.567	.190
Trial 6					
Std. Residual	30	-1.386	1.386	.000	.643
Stud. Residual	29	-2.198	2.107	.027	1.017
Cook's Distance	29	.000	.764	.132	.205
Centered Leverage Value	30	.269	.967	.567	.190
Trial B					
Std. Residual	30	-1.189	1.625	.000	.643
Stud. Residual	29	-1.614	2.626	.083	1.087
Cook's Distance	29	.000	2.858	.192	.537
Centered Leverage Value	30	.269	.967	.567	.190
Delayed					
Std. Residual	30	-1.152	1.035	.000	.643
Stud. Residual	29	-1.936	2.145	.055	1.101
Cook's Distance	29	.000	1.581	.198	.346
Centered Leverage Value	30	.269	.967	.567	.190
Recognition					

Table 7.2 ANOVA of the RAVLT continued…

Scale	N	Minimum	Maximum	Mean	Std. Deviation
Std. Residual	30	-1.149	1.663	.000	.643
Stud. Residual	29	-1.780	2.057	-.072	1.029
Cook's Distance	29	.000	.764	.133	.188
Centered Leverage Value	30	.269	.967	.567	.190

Tables 7.1, 7.2 and 7.3 describe the regression significance and the relationship of the RAVLT to the independent variables. Table 7.1 presents the results of the model of summary which consists of the R value, R-squared value, adjusted R-squared value, the standard error of estimate, R-squared change, F-change value, df1 value, df2 value and the significance F-change value. According to the results, the only significant regression that exists is for the RAVLT Recognition trial at .018. The other trials, namely; trial 2, 3, 4, 5, 6, B and the delayed displayed no significant regression equations. The R-squared values for trials 2 (.567), 3 (.631), 4 (.563), 5 (.657), 6 (.635), B (.581), and Recognition (.828) are all above 50% while the Delayed trial value is .333. The ANOVA results in Table 7.2 indicate the significant regression equation for the Recognition trial ($F(17, 12) = 3.396$, $p < .018$). The other 6 trials as well as the delayed trial do not predict any sort of significant regression with the independent variables. Table 7.3 purports the residual statistics which includes the minimum, maximum, mean and standard deviation values. The statistics of the standard residual, studentised residual, cook's distance and centered leverage value all provide crucial information relating to the scatterplot graph which signifies the strength and whether a relationship exists between the dependent and independent variables or not as well as to decipher if there are outliers or drastic anomalies such as influential outliers and to assess the influential point.

Table 8.1: Model of Summary of the Visual Reproduction Subtest

					Change Statistics				
Model	R	R^2	Adjusted R^2	Std. Error of Estimate	R Square Change	F Change	df1	df2	Sig. F Change
II	.757[a]	.573	-.031	7.485	.573	.948	17	12	.551
Recognition	.770[a]	.593	.015	1.009	.593	1.027	17	12	.493

Table 8.2: ANOVA of Visual Reproduction Subtest

Model	Sum of Squares	df	Mean Square	F	Sig.
II					
Regression	903.225	17	53.131	.948	.551[b]
Residual	672.242	12	56.020		
Total	1575.29	29			
Recognition					
Regression	17.777	17	1.046	1.027	.493[b]
Residual	12.223	12	1.019		
Total	30.000	29			

Table 8.3: Residual Statistics of the Visual Reproduction Subtest

Scale	N	Minimum	Maximum	Mean	Std. Deviation
II					
Std. Residual	30	-1.384	1.692	.000	.643
Stud. Residual	29	-2.004	2.528	-.044	1.010
Cook's Distance	29	.000	1.201	.151	.300
Centered Leverage Value	30	.269	.967	.567	.190
Recognition					
Std. Residual	30	-1.387	1.188	.000	.643
Stud. Residual	29	-2.031	1.914	-.016	1.028
Cook's Distance	29	.001	.826	.122	.180
Centered Leverage Value	30	.269	.967	.567	.190

The model of summary table (table 8.1) does not indicate that there is any predicted significant regression equation from the Visual Reproduction Subset. The R-squared values for the VR II and Recognition are .500, .573 and .593 respectively. Table 8.2 describes the significance value for VR II is .551 and .493 for the Recognition value which are all not below the set p-value. Table 8.3 explains the strength of the relationship of the VR trials and it shows that the standardised residual minimum values for the VR II and Recognition are -1.384 and -1.387, while the studentised minimum values for both trials are -2.004 and -2.031 each. The standardised maximum values for both trials are 1.692 and 1.188 and the studentised maximum values 2.528 and 1.914.

Table 9.1: Model Summary of the Letter-Number Sequencing Subtest

					Change Statistics				
Model	R	R^2	Adjusted R^2	Std. Error of Estimate	R Square Change	F Change	df1	df2	Sig. F Change
Word	-.762[a]	.580	-.015	2.890	.580	.975	17	12	-.531

Table 9.2: ANOVA of the Letter-Number Sequencing subtest

Model	Sum of Squares	df	Mean Square	F	Sig.
LNS					
Regression	138.484	17	8.146	.975	.531b
Residual	100.216	12	8.351		
Total	238.700	29			

Table 9.3: Residual Statistics of the Letter-Number Sequencing Subtest

Scale	N	Minimum	Maximum	Mean	Std. Deviation
LNS					
Std. Residual	30	-1.525	1.221	.000	.643
Stud. Residual	29	-1.996	1.657	-.030	.998
Cook's Distance	29	.000	.491	.103	.128
Centered Leverage Value	30	.269	.967	.567	.190

Table 9.1 and 9.2 indicate that there is no predicted significant regression equation from the Letter-Number Sequencing Subset and the independent variables as $F(17,12) = (.975, p < .531)$. The R-squared value is .580. Table 9.3 reveal the negative standardised and studentised minimum values which are -1.525 and -1.996. The standardized and studentised maximum values are 1.221 and 1.657 respectively.

6. Discussion

The current research study sought to investigate the relation between language experience, verbal working memory and visual and verbal long-term memory in the South African multilingual context. In order to address the aims of this study, the relationship between the independent variables and dependent variables were explored and understood by means of analysing the results of the descriptive statistics of the language, age and gender variables in comparison with the RAVLT, Visual Reproduction and Letter-Number Sequencing measures. It has been reported that bilingual adults tend to exhibit a higher performance in executive functioning areas relating to memory (Schroeder & Marian, 2012), therefore it was anticipated that the results of this study would present with similar findings to which they did for verbal long-term memory as measured by the RAVLT. However, it was unexpected to find that the results of verbal working memory as well as visual long-term conflicting with the literature. This discussion section will begin by expounding on the descriptive statistics which provide valuable insight on the characteristics and attributes of the sample that was studied and subsequently expand on the findings relating to verbal working memory, visual and verbal long-term and the relation these functions of memory have with language experience.

The descriptive statistics results revealed that the majority of the sample were female, between the ages of 21 and 25 years old and had acquired 16 years of formal education (Honours/ B-Tech level). According to Stats SA (2015) mid-year population estimates, it is reported that 51% of the country’s population is female and this figure is slightly lower than that of this sample in terms of the gender variable as there was an over-representation of females (a 9% difference in comparison with the overall population of the country). With regards to the gender parity ratios, there seems to be a stronger tendency towards an attainment of higher levels of education for females (Stats SA, 2015) than males in all age categories, as observed in the demographic characteristics of this sample.

The criteria of the study required that the participants speak at least three of the eleven official South African languages. The majority of the sample reported to speaking between three and five languages with only two people reportedly speaking eight and nine languages each respectively. With Gauteng having the most migrants in the country at 24.0% in 2015 (Stats SA, 2015), it may explain why there is such a wide distribution of languages spread throughout the province. This finding is significant as it speaks to the variability of language experiences in Gauteng and hints towards the reason as to the difficulty in implementing methodologies that treat the language variable as categorical.

The majority of the sample (70%) reported to being educated or taught in one language throughout their schooling careers which was English. Only 26.7% of the sample was educated in two languages and 3.3% in three languages. According to the literature presented by the Department of Basic Education (2010, p.6), "the Language in Education Policy was developed to maintain the use of the home language as the language of learning and teaching in the early years of learning while also providing access to additional languages as secondary languages". The results of this sample do not substantiate the literature as the majority of sample has expressed that they have only ever been taught in one language (English) from the beginning of their schooling careers while there are reports (see Broeder et al, 1998; Foxcroft & Aston, 2006 & October, 2002) that the South African schooling system endorses bilingualism and multilingualism.

Although there are 11 official languages in South Africa, the distribution in terms of dominance was expected to follow the tendencies reported in the Stats SA Census (2001) and other studies (such as Alexander, 2011) which proved to be the case, as 33.3% of the sample reported that Sesotho was their first dominant language, 30% chose English as their first dominant language and Setswana and isiZulu were each reported at 13.3%. There was a contradiction with the dominant language 2 results as English was reported as 40% of the sample's second dominant language, isiZulu at 16.7%, Sesotho and Setswana at 10% each respectively and Sepedi at 6.7%. The contradiction stems from the Stats SA (2004) Provincial Profile figures which reveal that English is the fourth most spoken language in Gauteng and sixth in South Africa as a whole. These figures do not endorse the results of the sample where English is concerned, as the majority of the sample gravitated towards the use of English as a second language. 40% of the sample chose isiZulu as their dominant language 3, 20% of the sample chose English and Sesotho respectively and 6.7% chose Sepedi and Setswana respectively. Stats SA (2011) census purports that migrants from Kwa-Zulu Natal (who are mainly isiZulu speakers) display the second highest rate of migration to Gauteng. The variety of languages and diversity in language use of this sample purports an enormous challenge with regards to the sampling size and mechanisms; this is due to the unlikeliness of purposive sampling being able to display the representativeness of the linguistic experience of the area especially in small samples such as this one. It is also worthy to note that regional variances were relevant to consider for the variable of language use as it significantly affects the potential for the generalisation of these results even in groups that present with similarities of other demographic criteria (such as age and gender) .

It is vital to note that despite the participants being English second language speakers and despite their abilities to speak a couple of other languages, the assessment of the LEAP-Q item which asked participants to rate on a scale from one to ten their preference of speaking and reading in their second language (English) denoted that almost all of the participants preferred speaking and reading in English when given the choice as opposed to their different first languages and the other languages they had reported that they could speak. As Marian and Fausey (2006) have conveyed, those who speak two languages or more are better at memorising information when it is tested in the same language that it was originally presented in. This is noteworthy information in terms of the current study as the consistent exposure of the sample to English may make it strenuous to adjust to reading, speaking and writing in other languages effectively as well as to translate the information accordingly especially since they would be reading and writing more in English than in their primary languages in most cases.

There was no statistical relation found between language experience and verbal working memory (using the Letter-Number Sequencing Subtest) with regards to this particular sample and as measured by the above-mentioned test, which does not seem consistent with the available body of work that has been published (e.g. Ardila et al, 2015; Baddeley et al, 1998; Bialystok et al, 2005). Although the literature suggests that bi/miltilinguals should have a somewhat advanced ability to mentally manipulate information, it could be hypothesised that this is not necessarily the case for second language English speaking young adults in South Africa which could possibly stem from being educated in English. Studies such as that of Ardila (2003) indicate that bi/multilinguals may actually undergo a taxing amount of strain when processing information in a second language as it is more demanding than when processed in one's primary language. Factors such as the methodological design of the study may have contributed to the unexpected finding as the manner in which verbal working memory was assessed in this context with South African multilinguals who are second language English speakers being tested by means of exclusively English assessments with, taxing cognitive items may have had an implication on the sample and it is possible that the bi/multilingual advantage may be more apparent only in comparison with monolingual counterparts and is not necessarily modified if you can speak more languages. Therefore it is imperative to take the above mentioned factors into consideration when interpreting the reasons behind the lack of a significant relation between the two variables as there be more explanations for the lack of the relation.

The RAVLT Recognition trial displayed a significant relation with the language experience variable of dominant language 3. Verbal memory and learning has a relation with language experience as measured by this particular test and the sample in question. The relation between language experience and verbal long-term memory is supported by the literature (e.g. Kaushanskaya, Gross & Buac, 2014; Kaushanskaya & Marian, 2009a; b; Kaushanskaya & Rechztigel, 2012). It seems that the multilingual, young adults who took part in this study displayed superior recognition skills as they performed significantly well in that trial of the RAVLT. Standing et al (1970) have stated that recognition memory in memory and learning tasks is usually better than recall memory and with extensive exposure and training; people have the capacity to recognise up to approximately 80 items. This could be the reason that there was only a significant relation with the recognition trial and not the other trials. Other intervening factors could have also played a role in the lack of a statistical relation between language experience and verbal long-term memory in the other trials of the RAVLT such as the accessibility of the information from the long-term store in the second language which could have affected the result as the other trials required the participants to verbally reproduce the information as opposed to the recognition trial which required the sample to either agree or disagree to having heard the words that were read out for them.

Although there have been varying findings with regards to the outcomes of bilingualism on verbal learning and memory (e.g. Fernandes, Craik, Bialystok & Kreuger, 2007; Kaushanskaya, Blumenfeld & Marian, 2011; Kroll, Micheal, Tkowicz & Dufour, 2002), bilingual benefits have also been acknowledged on word-learning tasks (e.g. Kaushanskaya & Marian, 2009a; b; Kaushanskaya & Rechztigel, 2012). Another factor which is said to contribute to the effective performance of bilinguals in verbal memory and learning assessments is the level of proficiency of bilingualism. If an individual is a “balanced” bilingual (meaning that they possess a somewhat equal amount of proficiency in both their languages), they would be in a better position to do better than unbalanced bilinguals (those who possess a lower proficiency in one language than another) and monolinguals (Harris, Cullum & Puente, 1995).

The Visual Reproduction Subtest was utilised to examine the potential relation between visual long-term memory and language experience. Visual long-term memory (using the Visual Reproduction Trial II and Recognition) did not display a significant relation with language experience as assessed by this measure for the specific sample that was observed for this study. Although many links have not been found to advocate for a relation between visual memory and multingualism, the literature presented by Friesen, Latman, Calvo and Bialystok (2015, p.700) states there are “positive findings relating to bilingualism impacting selective visual attention in young adulthood which were suggestive of a possible link between an improvement in visual attention theoretically leading to an improved visual memory capability”. This was disproved by this research study, it seems then that the benefit is only on visual attention and not significant for visual memory. This finding is supported by the results of a study conducted on monolingual and bilingual young adults using a visual search task by defining whether a target shape was present among distractor shapes. “Task difficulty was swayed by search type (feature or conjunction) and by the number and discriminability of the distractors. Participants recognised the target more swiftly in the feature searches, when the target was highly discriminable from the distractors and when there were fewer distractors. Importantly, although monolinguals and bilinguals performed consistently on the feature searches, bilinguals were considerably quicker than monolinguals in isolating the target in the more demanding conjunction search, thus presenting evidence for enhanced control of visual attention and visual memory in bilinguals” (Friesen et al, 2015, p.

697). The above mentioned study used a sample of young, bilingual adults (which is similar to the sample of this research study) to establish whether language experience had an effect on visual attention and memory and found a positive correlation, however this particular research study yielded results which contradict the literature. Instead, the findings of this study suggest that the visual long-term memory of young adults in the South African context does not have any relation with their language experience.

There are many challenges which present with conducting cognitive assessments in multilingual settings. These challenges range from administering assessments in English irrespective of whether English is the first or second language of the test-taker (Koch, 2005) to establishing (or not establishing) the discrete categories of the phenomenon that is being studied. In a linguistically rich country such as South Africa where monolingualism is more of an exception than the norm, certain steps have to be taken to create a model that will unveil how to conduct research in this area that will not be based on comparing groups according to the number of languages they speak as that should already be considered a norm. Thus, perhaps research studies such as this one could be the stepping stone (however small) towards the direction of creating a cognitive testing environment which is practical and manageable for multilinguals.

7. Limitations of the Study and Suggestions for Future Research

This research study employed the use of a single-case experimental design in which the participants were only multilingual speakers and were not compared or contrasted with a control group of monolingual counterparts (Smith, 2012) which could have affected the results of the study.

Another limitation of this study relates to the assessment tools that were used in order to conduct the study. Some of the assessment tools were found to present with certain limitations that may have had an impact on the results of the study. The LEAP-Q in particular, presented with a few limitations in terms of this particular study. The participants had difficulty understanding the “Self-Instruction/ Language Lab/ Language Tapes” element of the test. It seems that particular element may be irrelevant in the South African context as a majority of the participants are not familiar with learning languages by means of using tapes; instead most people in South Africa learn languages informally by means of engaging with others. Another element of the test that confused the participants was the section in which they were asked to name and rate the cultures which they identify with. In a multicultural society such as South Africa, it is somewhat confusing to explain the exact definition of culture as in this context; there is a connotation of culture being associated with other factors (such as traditional attire, food, traditional rituals and many more) and not just the linguistic element with which the test does not account for. “In the context of a multicultural society like South Africa, the adaptation of measures and the detection and elimination of bias from measures plays a vital role in transformation process” (Foxcroft & Roodt, 2009, p.89). It would be beneficial for this test to be altered to in the above mentioned regards in order to make it relatable in the South African context. It must be considered that the LEAP-Q is a self-reporting measure and therefore there was no tangible way of gaging the actual level of proficiency of the participant’s languages. It may be substantial in future to assess the proficiency of all the languages the participants report to be capable of speaking in order to improve the validity of the linguistic experience assessment as well as to source formal measures of language proficiency. Furthermore, it would be recommended that the English proficiency of the participants be matched with the proficiencies of their other languages in order to establish the effect of speaking more than two languages. In terms of the other tests that were administered in this study (such as the RAVLT, Visual Reproduction and Letter-Number Sequencing subtests), it may be fitting to use a variety of other tests such as the California Auditory Learning Test (CAVLT for memory and learning), the Automated Working Memory Assessment (AWMA for working memory) and the WMS (for the full assessment on memory) to assess the same functions for future reference in order to combat problems that may present from the main tests used.

The sample size can be considered as having been too small, which reduces the ability to generalise the findings. Another concern is that there could have possibly been a sampling bias affecting the results as the sampling method that was implemented was purposive. "The objective is to choose a sample that will be linguistically and demographically characteristic of the population about which the researcher aims to make inferences on" (Terre Blanche et al, 2010, p.49) which in this case is the young multilingual adult South African population. It would be advantageous for future research studies to increase the sample size to a number that aids the generalizability of the results. Perhaps the findings of the study could have yielded a different set of results had random sampling been applied.

The sample only consisted of African first language speakers in the Johannesburg area of Gauteng. It would be interesting to have a sense of the extent of the language experience of people from a variety of provinces in the country in order to achieve a higher variability of language experience. It may be beneficial for future studies to consider focusing on more than one region. It would also be recommended to extend the sample in order for it to better illustrate the linguistic landscape of South Africa and represent the greater population.

The non-standardisation of the assessment environment could be viewed as a limitation. The participants were assessed in venues that were convenient for them and therefore the assessments were conducted in a variety of locations. Although the researcher ensured that the venues were conducive for assessments to take place (meaning they were quiet, well-lit and well ventilated venues), the variety of venues may have played a role in the variance of score (Foxcroft & Roodt, 2009). Perhaps future studies may look into conducting the assessments in one standard venue in order to reduce the environmental effect.

The fully battery of tests took about an hour and fifteen minutes to an hour and a half to complete. In order to reduce the effects of fatigue, which could potentially be viewed as an extraneous variable, perhaps it could be recommended that “assessment sessions which are longer than an hour be split into two sessions as care should be taken to ensure that the length of the assessment session is planned in such a way that fatigue resulting from too many assessment measures in succession does not play a detrimental role in performance” (Foxcroft & Roodt, 2009, p.113).

The final limitation stems from the assessor/researcher bias. Although the assessor had received the appropriate amount of training to carry out the battery of assessments, it is still not extensive professional training and therefore it could have impacted the participant’s results.

8. Conclusion

This research was designed to explore the role of the multilingual experience on verbal working memory and visual and verbal long-term memory as studied on second language English speaking South African young adults. It emerged from the findings that the only positive significant difference that was found was between verbal long-term memory (the recognition trial) which was measured by the RAVLT and language experience (dominant language 3) which contradicts the literature and supporting literature as statistically significant relations were also expected for visual long-term memory as measured by the Visual Reproduction subtest and for verbal working memory as measured by the Letter-Number Sequencing subtest. The multilingual experience of South Africans is a compelling phenomenon to research as it is difficult to reduce the linguistic complexities and intricacies in South Africa to a methodology that does justice to the phenomenon. Although this research study is a small step, it has to be taken into consideration in order to fully grasp the effects that the multilingual experience has on people's lives in different contexts such as education and cognitive testing realms as an attempt to examine the issue in different ways. A majority of South Africans find themselves having to maintain their first/native/dominant languages in the midst of being expected to speak a second language such as English well in order to succeed in academic and business institutions. It must be taken into regard that important factors such as age, gender, educational level and self-reported language proficiency contributed to the results. This research did not focus on the actual language proficiency of the participant's languages, but rather the experiences they faced in different contexts with the number of languages they reported to being able to speak and the effect these languages had on the their memory functioning in the midst of the testing measures that were utilized in this study.

9. References

Abutalebi, J., & Green, D.W. (2007). Bilingual language production: The neurocognition of language representation and control. *Journal of Neurolinguistics, 20*, 242–275.

Alexander, N. (1989). *Language policy and national unity in South Africa/ Azania*. Cape Town: Buchu Books.

Alexander, N. (2011). After apartheid: The language question. In Ian Shapiro and Kahreen Tebeau, Eds,. After apartheid: The second decade. *University of Virgina Press*.

Ardila, A. (2003). Language representation and working memory with bilinguals. *Journal of Communications Disorders, 36*, 233-240.

Ardila, A.,Castellanos, C., Cremisini, E., Cruz-Vargas, C., Guayara, C., Hernandez, S., Mato, I., Mueller, S., & Yero, B. (2015). Lexical knowledge and working memory in second-generation Spanish/English bilinguals. *International Journal of Language and Linguistics, Vol 2*, No.3.

Atkinson, R.C., & Shiffrin, R.M. (1968). Chapter: Human memory: A proposed system and its control processes. In Spence, K.W., & Spence, J.T. *The Psychology of Learning and Motivation.* (Volume. 2). New York: Academic Press, pp.89-195.

Atkinson, R.C., & Shiffrin, R.M. (1971). The control of short-term memory. *Scientific American, 225*, 8-90.

Baddeley, A.D., Hitch, G. (1974). Working memory. In G.H Bouwer (Ed.), *The psychology of learning and motivation: Advances in research and theory* (*Vol. 8*, pp. 47-89). New York: Academic Press.

Baddeley, A.D. (1989). The psychology of remembering and forgetting. In T. Butler (Ed.), *Memory: History, culture and the mind*. London: Basil Blackwell.

Baddeley, A.D., & Gathercole, C. (1998). The phonological loop as a language learning device. *Psychological Review, Vol. 105*, No.1, 158-173.

Baddeley, A.D., & Logie, R.H. (1999). Working memory: The multiple-component model. In A. Miyake & P.Shah (Eds.), *Models of working memory (pp. 28-61)*. New York: Cambridge University Press.

Baddeley, A.D. (2000). Short-term and working memory. In E. Tulving & F.I. Craik (Eds.), *The Oxford handbook of memory* (pp. 77-92). New York: Oxford University Press.

Baddeley, A.D. (2000a). The episodic buffer: A new component of working memory. *Trends in Cognitive Sciences*, 4,417-423.

Baddeley, A.D. (2001). Is working memory still working? *American Psychologist*, 56 (11), 851-864.

Baddeley, A.D., & Wilson, B.A. (2002). Prose recall and amnesia: Implications for the structure of working memory. *Neuropsychologia*, 40, 1737-1743.

Baddeley, A.D. (2003). Working memory: Looking back and looking forward. *Neuroscience*, 4, 829-839.

Baddeley, A.D. (2007). *Working memory, thought, and action*. Oxford: Oxford University Press.

Baddeley, A.D., Hitch, G.J., & Allen, R.J. (2009). Working memory and binding in sentence recall. *Journal of Memory and Language*, 61, 438-456.

Baker, C. (1993). *Foundation of bilingual education and bilingualism*. Clevedon: Multilingual Matters.

Baker, C. (2007). *A parent's and teacher's guide to bilingualism*. Clevedon, UK: Multilingual Matters LTD.

Bethlehem, D., De Picciotto, J. & Watt, N. (2003). Assessment of verbal fluency in bilingual Zulu-English speakers. *South African Journal of Psychology*, 33 (4), 236-240.

Bialystok, E., Craik, F.I.M., Grady, C., Chau, W., Ishii, R., Gunji, A., & Pantev, C. (2005). Effect of bilingualism on cognitive control in the Simon Task: Evidence from MEG. *Neuroimage* 24 (2005) 40-49.

Bialystok, E., Craik, F.I.M., Green, D.W., & Gollan, T.H. (2009). Bilingual minds. Association for Psychological Science. *Psychological Science in the Public Interest.* 10 (3), 89-129.

Blumenfeld, H.K., & Marian, V. (2011). Bilingualism influences inhibitory control in auditory comprehension. *Cognition* 118, 245-257.

Bousfield, W.A., Eterson, J., & Whitmarsh, G.A. (1957). The effects of colour and uncoloured pictorial representations on the learning at stimulus words. *Journal of Applied Psychology*, 41, 165-168.

Braver, T., Barch, DM., Keys, BA., Carter, CS., Cohen, JD, Kaye, JA., Janowski, JS., Taylor, SF., Yesavage, JA., Mumenthaler, MS., Jaguat, WJ and Reed, BR. (2001). Context processing in older adults: Evidence for a theory relating cognitive control to neurobiology in healthy aging. *Journal of Experimental Psychology: General*, 130: 746-763.

Brito, N.H., Grenell, A., & Barr, R. (2014). Specificity of the bilingual advantage for memory: Trilingual toddlers. *Frontiers in Psychology*, 5, 1-12. doi: 10.3389/fpsyg.2014.01369.

Broeder, P., Extra, G., & Maartens, J. (1998). Durban language survey. In G. Extra & J. Maartens (Eds.), Multilingualism in a multicultural context. Case studies on South Africa and Western Europe. Tilburg: Tilburg University Press. *Studies in Multilingualism 10*.

Chomsky, N. (1965). *Aspects of the theory of syntax*. Cambridge, MA: MIT Press.

Chomsky, N. (1972). *Language and mind (2nd ed.)*. New York: Harcourt Brace Jovanovich.

Collier, V.P. (1987). Age and rate of acquisition of second language for academic purposes. *Tesol Quarterly*, 23, 617-641.

Collier, V.P. (1989). How long? A synthesis of research on academic achievement in second language. *Tesol Quarterly*, 23, 509-531.

Collier, V.P. (1995). Acquiring a second language for school: Directions in language & education. *National Clearinghouse for Bilingual Education*. Vol.1, No.4.

Constitution of the Republic of South Africa. (1996). *Act No 108*.

Cosentino, S.A., Stern, Y., Sokolov, E., Scarmeas, N., Manly, J.J., Tang, M.X., Schupf, N., & Mayeaux, R.P. (2010). Plasma b-amyloid and cognitive decline. *Archives of Neurology*, 67: 1485-1490.

Costa, A.S., Fimm, B., Friesen, P., Soundjock, H., Rottchsky, C., Gross, T., Eitner, F., Reich, A., Schulz, J.B., Nasreddine, Z.S., & Reetz, K. (2012). Alternate-form reliability of the

Montreal Cognitive Assessment screening test in a clinical setting. *Dementia and Geriatric Cognitive Disorders*, 33: 379-384.

Cummins, J. (1977). Cognitive factors associated with the attainment of intermediate levels of bilingual skills. *Modern Language Journal*, 61, 3-12.

Cummins, J. (1981b). The role of primary language development in promoting educational success for language minority students. In California State Department of Education (Ed.), Schooling and language minority students: A theoretical framework. *Evaluation, Dissemination and Assessment Center*, California State University, Los Angeles.

Daneman, M., & Merikle, P.M. (1996). Working memory and language comprehension: A meta-analysis. *Psychonomic Bulletin & Review*, 3(4), 422-433.

Department of Basic Education. (2009). National examinations and assessment: Report on the national senior certificate examination results. Department of Basic Education, Pretoria.

Department of Basic Education. (2010). The status of the language of learning and teaching (lolt) in South African public schools: A quantitative overview. Department of Basic Education, Pretoria.

De Paula, J.J., Melo, L.P.C., Nicolato, R, de Moraes, E.N., Bicalho, M., Hamdan, A.C., & Malloy-Diniz, L.F. (2012*).* Reliabilty and construct validity of Rey-Auditory Verbal Learning Test in Brazilian elders. *Rev Psiq Clin.* 2021, 39 (1): 19-23.

Dickov, A., Vuckovic, N., Martinovic-Mitrovic, S., Savkovic, I., Dragin, D., Dickov, V., Mitrovic, D., & Budisa, D. (2012). Disorder verbal memory in alcoholics after delirium tremens. *European Review for Medical and Pharmacological Sciences*, 16: 1052-1060.

Dosher, B. A. (2003). Working memory. In L. Nadel (Ed.), *Encyclopedia of cognitive science* (Volume. 4, pp. 569- 577). London: Nature Publishing Group.

Fernandes, M.A., Craik, F., Bialystok, E., & Kreuger, S. (2007). Effects of bilingualism, aging and semantic relatedness on memory divided attention. *Canadian Journal of Experimental Psychology*. 61(2):128-41.

Friesen, D.C., Latman, V., Calvo, A., & Bialystok, E. (2015). Attention during visual search: The benefit of bilingualism. *International Journal of Bilingualism*. 19(6): 693-702. doi: 10.1177/1367006914534331.

Foxcroft, C.D., & Aston, S. (2006). Critically examining language bias in the South African adaptation of the WAIS-III. *SA Journal of Industrial Psychology*. 32 (4), 97-102.

Foxcroft, C.D., & Roodt, G. (2009). *Introduction to psychological assessment in the South African context* (3rd Ed.). Cape Town, South Africa: Oxford University Press.

Francis, W.S. (1999). Cognitive integration of language and memory in bilinguals: Semantic representation. *Psychological Bulletin*, 125(2), 193-222.

Frost, N. (1972). Encoding and retrieval in visual memory tasks. *Journal of Experimental Psychology*, 95, 317-326.

Golden, C. J., & Golden, Z. L. (2002*).* Patterns of performance on the Stroop Color and Word Test in children with learning, attentional and psychiatric disabilities. *Psychology in the Schools*, 39(5), 489 – 495.

Gomez-Ruiz, M.I. (2010*).* Bilingualism and the brain: Myth and reality. *Neurologia.* 2010; 25 (7): 443- 452.

Groth-Marnat, G. (2009). *Handbook of psychological assessment.* (5th Ed.). John Wiley & Sons, Inc., Hoboken, New Jersey.

Hacksley, M., Jeffery, C., Mesthrie, R., Reddy, T., & Wildsmith-Cromarty, R. (2007). Towards a nuanced view of multilingualism. On behalf of the *English National Language Body of the Pan South African Language Board*.

Harris, J.G., Cullum, C.M., & Puente, A.E. Effects of bilingualism on verbal learning and memory in Hispanic adults. *Journal of the International Neuropsychological Society*. 1:10-16.

Hedden, T., & Gabrieli, J.D.E. (2004*).* Insights into the ageing mind: A view from cognitive neuroscience. *Nature Reviews; Neuroscience.* Volume 5.

Hedden, T., & Yoon, C. (2006). Individual differences in executive processing predict susceptibility to interference in verbal working memory. *Neuropsychology*, 20: 511-528.

Herz, R.S., & Engen, T. (1996). Older memory: Review and analysis. *Psychonomic Bulletin and Review*, 3, 300-313.

Hoops, S., Nazem, S., Siderowf, A. D., Duda, J. E., Xie, S. X., Stern, M. B., & Weintraub, D. (2009). Validity of the MoCA and MMSE in the detection of MCI and dementia in Parkinson disease. *Neurology,* 7(3), 1738 -1745.

Jessner, U. (1999). Metalinguistic awareness in multilinguals: Cognitive aspects of third language learning. *Language Awareness*, Vol. 8, Issue 3-4.

Kaushanskaya, M., & Marian, V. (2009a). Bilingualism reduces native-language interference during novel-word learning. *Journal of Experimental Psychological Learning, Memory & Cognition*. 35, 829-835.

Kaushanskaya, M., Blumenfeld, H.K., & Marian, V. (2011). The relationship between vocabulary and short-term memory measures in monolingual and bilingual speakers. *International Journal of Bilingualism*. Dec; 15 (4): 408-425.

Kaushanskaya, M., & Rechtzigel, K. (2012).Concreteness effects in bilingual and monolingual word learning. *Psychonomic Bulletin Review*. 19, 935-941, doi: 10.3758/s13423-012-0271-5.

Kaushanskaya, M., Gross, M., & Buac, M. (2014). Effects of classroom bilingualism on task shifting, verbal memory and word learning in children. *Department of Communication Sciences and Disorders,* University of Wisconsin-Madison.

Koch, E. (2005). Evaluating the equivalence, across language groups, of a reading comprehension test used for admissions purposes. *Unpublished doctoral thesis*, Nelson Mandela Metropolitan University, Port Elizabeth, South Africa.

Kroll, J.F., Michael, E., Tokowicz, N., Dufour, R. (2002). The development of lexical fluency in a second language. *Second Language Research*. 18:137-171.

Lezak, M. (2004). *Neuropsychological assessment*. (4th Ed.). New York, Oxford University Press.

Lhermitte, F. (1983). Utilization behavior and its relation to lesions of the frontal lobes. *Brain*, 106: 237-255.

Luckett, K. (1995). National additive bilingualism: Towards a language plan for South African education. In Heugh K, Siegruhn A, Pluddemann P (Eds.). *Multilingual Education for South Africa,* 73-78. Johannesburg: Heinemann.

Mandler, J.M., & Johnson, N.S. (1977). Remembrance of things parsed: Story structure and recall. *Cognitive Psychology*, 9:111-51.

Mandler, J.M., & Parker, R.E. (1976). Memory for descriptive and spatial information in complex pictures. *Journal of Experimental Psychology: Human Learning and Memory*, 2, 38-48.

Mandler, J.M., Seegmiller, D., & Day, J. (1977). On the coding of spatial information. *Memory and Cognition*, 5, 10-16.

Marian, V., & Kaushanskaya, M. (2007*).* Language context guides memory content. *Psychonomic Bulletin & Review*. 14 (5), 925-933.

Marian, V., Blumenfeld, H.K., & Kaushanskaya, M. (2007). The language experience and proficiency questionnaire (leap-q): Assessing language profiles in bilinguals and multilinguals. *Journal of Speech, Language and Hearing Research*. Volume 50 (940-967).

Marian, V., & Fausey, C. M. (2006). Language-dependent memory in bilingual learning. *Applied Cognitive Psychology*, 20, 1-23.

Marian, V., & Neisser, U. (2000). Language-dependent recall of autobiographical memories. *Journal of Experimental Psychology: General*, 129, 361-368.

May, C. P., & Hasher, L. (1998). Synchrony effects in inhibitory control over thought and action. *Journal of Experimental Psychology: Human Perception and Performance*, 24, 363-379.

Medalia, A., & Revheim, N. (2002). *Dealing with cognitive dysfunction associated with psychiatric disabilities: A handbook for families and friends of individuals with psychiatric disorders*. New York State Office of Mental Health Family Liaison Bureau.

Mesulam, MM. (2002). The human frontal lobes: Transcending the default mode through contingent encoding. In DT Stuss and RT Knight (Eds*), Principles of Frontal Lobe Function*. New York: Oxford University Press, pp. 8-30.

Miyake, A., Friedman, N.P., Emmerson, M.J., Witzki, A.H., Howerter, A., & Wager, T.D. (2000). The unity and diversity of executive functions and their contributions to complex “frontal lobe” tasks: A latent variable analysis. *Cognitive Psychology*, 41 (1): 49-100.

Morris, N., & Jones, D.M. (1990). Memory updating in working memory: The role of the central executive. *British Journal of Psychology*. Vol.81, Issue 2, 111-121.

Nasreddine, Z.S., Phillips, N.A., Bedirian, V., Charbonneau, S., Whitehead, V., Collin, I., Cummings, J.L., Chertkow, H. (2005). The Montreal cognitive assessment, MoCA: A brief screening tool for mild cognitive impairment. *Journal of American Geriatric Society*, 53: 695-699.

Nutter-Uham, K.E., Saykin, A.J., Rabin, L.A., Roth, R.M., Wishart, H.A., Pare, N., & Flashman, L.A. (2008). Verbal fluency performance in amnestic MCI and older adults with cognitive complaints. *Archives of Clinical Neuropsychology*, 23; 229-241.

October, M. (2002). Medium of instruction and its effect on matriculation examination results for 2000, in Western Cape secondary schools: A study of examination results in relation to home language and language medium. *Masters mini- dissertation*. University of Cape Town. Cape Town.

Prior, A., & Gollan, T.H., (2010). What monolinguals reveal about bilingual language control: Task- and language-switching in monolinguals, Spanish-English and Mandarin-English bilinguals. *Manuscript submitted for publication*.

PsychCorp. (2001). *Delis Kaplan Executive Function System*. USA: Pearson.

Raaijmakers, J.G.W., & Shiffrin, R.M. (2003). Models vs descriptions: Real differences and language differences. *Behavioural & Brain Sciences*, 26, 753.

Richardson-Klavehn, A.R., & Bjork, R.A. (2003). Memory, long-term. In L. Nadel (Ed.), *Enclyclopedia of Cognitive Science* (Volume. 2, pp. 1096-1105). London: Nature Publishing Group.

Ross, M., Xun, W. Q. E., & Wilson, A. E. (2002). Language and the bicultural self. *Personality & Social Psychology Bulletin*, 28, 1040-1050.

Ross, T. P., Calhoun, E., Cox, T., Wenner, C., Kono, W., & Pleasant, M. (2007). The reliability and validity of qualitative scores for the Controlled Oral Word Association Test. *Archives of Clinical Neuropsychology*, 22, 475–488.

Ruff, R. M., Light, R. H., Parker, S. B., & Levin, H. S. (1996). Benton controlled oral word association test: Reliability and updated norms. *Archives of Clinical Neuropsychology*, 11(4), 329-338. doi: 10.1093/arclin/11.4.329.

Salgado J, Abrantes SSC, Freitas D, Souza W, Oliveira J, Moreira L, et al. (2011). Applicability of the Rey Auditory-Verbal Learning Test to an adult sample in Brazil. *Rev Bras Psiquiatr.* [online]. Ahead of print, p. 0-0. Epub.

Sattler, J.M., & Ryan, J.J. (2009).*Assessment with the WAIS-IV*. Jerome M. Sattler, Publisher, Inc.

Scheck, P., & Nelson, T.O. (2003). Metacognition. In L. Nadel (Ed.), *Enclyclopedia of Cognitive Science* (Vol. 3, pp. 11-15). London: Nature Publishing Group.

Schiffman, H. F. (2005). Bilingualism in South Asia: Friend or foe? (The persistence of English in post-colonial societies: Structural reasons vs. neo-colonial 'hegemony' or linguistic 'imperialism'. *ISB4: Proceedings of the 4th International Symposium on Bilingualism*, ed. James Cohen, Kara T. McAlister, Kellie Rolstad, and Jeff MacSwan, 2104-2114. Somerville, MA: Cascadilla Press.

Schimdt, F.L. (1996). Statistical significance testing and cumulative knowledge in psychology: Limitations for training of researchers. *American Psychological Association.* Vol.1, Issue 2.

Schinka, J.A., Loewenstein, D.A., Raj, A., Schoenberg, M.R., Banka, J.L., Potter, H., Duara, R. (2010). Defining mild cognitive impairment: Impact of varying decision criteria on neuropsychological diagnostic frequencies and correlates. *American Journal of Geriatric Psychiatry*, 18: 684-691.

Schroeder, S.R., & Marian, V. (2012). A bilingual advantage for episodic memory in older adults. *Journal of Cognitive Psychology (Hove).* 2012: 24 (5): 591-601.

Shepard, R.N. (1967). Recognition memory for words, sentences and pictures. *Journal of Verbal Learning and Verbal Behaviour*, 6, 156-163.

Smith, E.E., & Jonidas, J. (1999). Storage and executive processes in the frontal lobes. *Science*, 283 (5408), 1657-1661.

Smith, J.D. (2012). Single-case experimental designs: A systematic review of published research and current standards. *Psychological Methods*, 17 (4): doi: 10. 1037/a0029312.

Spedo, C.T., Foss, MP., Elias, A.H.N., Pereira, D.A., dos Santos, P.I., Ribeiro, G.N.D., Balarini, F.B., Barreira, C.M.A., Neto, O.P., & Barreira, A.A. (2013). Cross-cultural adaptation of Visual Reproduction subtest of Wechsler Memory Scale Fourth Edition (WMS-IV) to a Brazilian context. *Clinical Neuropsychiatry*, 10(2), 111-119.

Standing, L., Conezio, J., & Haber, R.N. (1970). Perception and memory for pictures: Single-trial learning of 2500 visual stimuli. *Psychonomic Science*. 19 (2): 73-74.

Stats SA. (2001). National census 2001. Statistics South Africa, Pretoria.

Stats SA. (2004). Provincial profile 2004*: Gauteng*. Statistics South Africa, Pretoria.

Stats SA. (2011). National census 2011. Statistics South Africa, Pretoria.

Stats SA. (2015). Mid-year population estimates 2015. Statistics South Africa, Pretoria.

Strauss E, Sherman EMS, Spreen O. A. (2006). *Compendium of Neuropsychological tests.* (3rd Ed.), New York: Oxford University Press.

Sternberg, R.J. (2009). *Cognitive psychology*. (Fifth Ed.). Wadsworth: Cengage Learning.

Swanson, J. (2005). The Delis-Kaplan Executive Function System. *Canadian Journal of School Psychology*, 20(1).

Terre Blanche, M.T., Durrheim, K., & Painter, D. (2010). *Research in practice: Applied methods for the social sciences*. (Second Ed.). UCT Press.

Tulving, E. (2000b). Memory: An overview. In A. E. Kazdin (Ed.). *Encyclopedia of Psychology* (Volume. 5, pp. 161-162). Washington, DC: American Psychology Association.

Tulving, E., & Craik, F.I.M. (Eds.) (2000). *The Oxford handbook of memory*. New York: Oxford University Press.

Vally, Z. (2011). HIV-associated neurocognitive disorders. *The South African Journal of Psychiatry*, 17(4), 98 -105. doi:10.7196/sajp.294.

Van der Elst, W., Van Boxtel, M. P. J., Van Breukelen, G. J. P., & Jolles, J. (2006). The Stroop Color-Word Test Influence of age, sex, and education; and normative data for a large sample across the adult age range. *Assessment*, 13(1), 62-79. doi: 10.1177/10731911052834.

Viswanathan, M., Martin, M.M., & Bialystok, E. (2002). Two languages are better than one: Bilingualism and aging effects on inhibitory control. Poster presented at the 43rd annual meeting of the *Psychonomic Society*, Kansas City. MO, 2002.

Wechsler, D. (2014). *Wechsler Adult Intelligence Scale- Fourth Edition*. *Adaptation for South Africa derived from the UK adaptation*. Pearson, Inc; PsychCorp; JvR Psychometrists.

10. Appendices

10.1 Appendix A: Ethics Certificate

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

HUMAN RESEARCH ETHICS COMMITTEE (SCHOOL OF HUMAN & COMMUNITY DEVELOPMENT

CLEARANCE CERTIFICATE	PROTOCOL NUMBER: MPSYC/15/016 IH
PROJECT TITLE:	Exploring the relation between language experience, verbal working memory and visual and verbal long-term memory.
INVESTIGATORS	Motlhabane Otsile
DEPARTMENT	Psychology
DATE CONSIDERED	04/08/15
DECISION OF COMMITTEE*	Approved

This ethical clearance is valid for 2 years and may be renewed upon application

DATE: 17 June 2015

CHAIRPERSON
(Professor Brett Bowman)

cc Supervisor: Ms Aline Ferreira Correia
Psychology

DECLARATION OF INVESTIGATOR (S)

To be completed in duplicate and **one copy** returned to the Secretary, Room 100015, 10th floor, Senate House, University.

I/we fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure be contemplated from the research procedure, as approved, I/we undertake to submit a revised protocol to the Committee.

This ethical clearance will expire on 31 December 2017

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

10.2 Appendix B: Biographical Questionnaire
Participant ID/NO:

Demographic Information:

- Age…..
- Gender…..
- Highest level of education……
- Profession…..
- Occupation…..
- Number of languages spoken…..
- Is English your first language?
- Was English your medium of instruction in high school?

	Grade	Public/Private School	Rural/Urban School	Language
Primary School				
High School				
University				

- Are you currently taking any medication and for how long have you been doing so?
- Have you ever been diagnosed with any neurological disorder?

- Have you been hospitalized this year? If so, for what reason?
- Have you ever had a concussion or head injury?

10.3 Appendix C: Language Experience and Proficiency Questionnaire

Appendix (p. 1 of 2). Language Experience and Proficiency Questionnaire.

Last Name		First Name		Today 's Date	
Age		Date of Birth		Male ☐	Female ☐

(1) Please list all the languages you know in order of dominance:

1 Language A	2 Language B	3 Language C	4 Language D	5 Language E

(2) Please list all the languages you know in order of acquisition (your native language first):

1 Language A	2 Language B	3 Language C	4 Language D	5 Language E

(3) Please list what percentage of the time you are currently and on average exposed to each language.
(Your percentages should add up to 100%):

List language here:	Language A	Language B	Language C	Language D	Language E
List percentage here:					

(4) When choosing to read a text available in all your languages, in what percentage of cases would you choose to read it in each of your languages? Assume that the original was written in another language, which is unknown to you.
(Your percentages should add up to 100%):

List language here	Language A	Language B	Language C	Language D	Language E
List percentage here:					

(5) When choosing a language to speak with a person who is equally fluent in all your languages, what percentage of time would you choose to speak each language? Please report percent of total time.
(Your percentages should add up to 100%):

List language here	Language A	Language B	Language C	Language D	Language E
List percentage here:					

(6) Please name the cultures with which you identify. On a scale from zero to ten, please rate the extent to which you identify with each culture.

List cultures here	Culture A	Culture B	Culture C	Culture D	Culture E

(7) How many years of formal education do you have?____

Please check your highest education level:

Less than Matric ☐
Matric ☐
National Diploma (Three Years) ☐

B-Tech ☐
Undergraduate ☐
Honours ☐

Masters ☐
PhD/MD/JD ☐
Other: ☐

Appendix (p. 2 of 2). Language Experience and Proficiency Questionnaire.

(1) On a scale from zero to ten, please select your level of proficiency in speaking, understanding, and reading Language X:

Speaking		Understand spoken Language		Reading	

(2) On a scale from zero to ten, please select how much the following factors contributed to you learning Language X:

Interacting with friends		Listening to radio/music	
Interacting with family		Reading	
Watching TV		Language-lab/self-instruction	

(3) Please rate on a scale from zero to ten, the extent to which you are currently exposed to Language X in the following contexts:

Interacting with friends		Language tapes/self instruction	
Interacting with family		Watching TV	
Reading		Listening to the radio	

10.4 Appendix D: Participant Information Sheet

Psychology
School of Human & Community Development

Private Bag 3, Wits 2050, South Africa. Telephone: +27 11-717-4500/2/3/4. Fax: +27-11-717-4559

Participant Information Sheet

Introduction

Good day. Our names are Maritza Lubbe and Otsile Motlhabane and we are students at the School of Human and Community Development, at the University of the Witwatersrand studying towards a degree in MA in Psychology by Coursework and Research Report. For the purpose of our studies, we are required to undertake research. We would like to invite you to participate in our research entitled: *"Exploring the Relation between Language Experience and Verbal Working Memory and Visual and Verbal Long-Term Memory."*

You have been contacted by me or by other members of the research team because you are a healthy adult who has not been diagnosed with any form of traumatic brain injury or any other form of neurological disorder.

Purpose and significance of the research

Procedure

If you agree to participate, you will be invited to take part in a set of neuropsychological tests that consists of different types of activities which include amongst others; answering questions, doing drawings, remembering information and solving different types of problems. These tools are frequently used by psychologists all over the world when conducting psychological assessments. The assessment will include a brief demographical questionnaire which you will be required to fill in to give an indication of your suitability to participate in this study. This process will take approximately an hour to an hour and half. The testing will take place at a time and place of your convenience.

Research agreement

You will not receive any compensation, monetary or otherwise, for participating in the study. There will be no other benefits to participation in this research. No risks to participation in this study are anticipated. However, the cognitive testing might elicit distress if some tasks are perceived as difficult, however, I would therefore like to stress that your participation in this research is entirely voluntary and you may withdraw from it at any point. You may also refrain from answering any particular question with no negative consequences. If you experience any distress associated with the assessment process, please note that we will immediately stop with the assessment to give you an opportunity to rest and regroup and we will continue at a time which is convenient for you.

Your identity as a participant will be only known to us, the researchers and our supervisor. The test protocols will be stored in a locked file cabinet and the results stored in a password protected computer. Only our supervisor and we will have access to these files. To protect confidentiality, your name or other personal identification data will not be used. Instead, an identification number will be used in each protocol.

Prior to participating in the study it is required that you completed the attached consent form. This will be kept separately from the rest of the data for the purpose of confidentiality. The consent form will be made available to the university authorities should a random audit process require this.

The M.A. research reports resulting from this research will be available in the library of the University of the Witwatersrand, which offers access to material on the world-wide web. The findings will also potentially be published in scientific journals. If you wish to have access to the results, you may request so by contacting me. The results are expected to be ready in 2016.

Enquiries

Should any matters require further clarification please do not hesitate to call or email us at:

Maritza Lubbe
Cell: 082 8133 134
Email: marz.lubbe@gmail.com

Otsile Motlhabane
Cell: 072 276 9556
Email: otsile.motlhabane@gmail.com

You may also contact our research supervisor, Ms. Aline Ferreira Correia,

telephonically at 011 717 4527 or via email at Aline.FerreiraCorrei@wits.ac.za

10.5 Appendix E: Consent Form

Psychology
School of Human & Community Development

Private Bag 3, Wits 2050, South Africa. Telephone: +27 11-717-4500/2/3/4. Fax: +27-11-717-4559

Informed Consent Form

I am a consenting adult person between the ages of 19 and 25 years. I confirm that I have read and understand the information provided in the information sheet in relation to the research entitled: *"Exploring the Relation between Language Experience and Verbal Working Memory and Visual and Verbal Long-Term Memory".* I have been informed about what the research entails and what is required from me. I also understand that:

- My participation is completely voluntary.
- I may withdraw from the research at any time with no negative consequences for me.
- My results and identity will be kept anonymous and the information will be kept in a password secure file, in a password secured computer and the protocols of the tests will be kept in a locked cabinet, both only accessible to the researchers and the supervisor.
- My participation will be treated with confidentiality.
- No rewards will be offered or provided for my participation.
- No risks are associated with participation, however I have been given a break or the opportunity to reconvene my assessment session at a time of my convenience should I become distressed or tired by the assessment process.
- I have received contact details of the researchers (Maritza Lubbe and Otsile Motlhabane) and the supervisor (Aline Ferreira Correia).

Participant's name: ______________________________

Participant's signature: ______________________________

Researcher's name: ______________________________

Researcher's signature: ______________________________

Date: ______________________________

10.6 Appendix F: Assessments Forming Part of the Bigger Study

Montreal Cognitive Assessment (MoCA)

The MoCA is a brief cognitive screening instrument originally developed to detect mild cognitive impairment (MCI) (Nasreddine, Phillips, Bedirian, Charbonneau, Whitehead, Collin, Cummings & Chertkow, 2005). It assesses several cognitive domains, including attention, executive functions, language, memory and orientation, with a maximum of 30 points (Costa et al, 2012).

The MoCA takes approximately 15 minutes to complete and the test is presented in a single page format. The functions that will be used to assess executive functioning will be the adapted trail making test, in order to test mental flexibility; the phonemic fluency task to assess verbal fluency, the two-item verbal abstraction task to look at abstract thinking and problem solving and finally the clock drawing test in order to asses planning (Vally, 2011). The MoCA has been found to have a good test-retest reliability, inter-rater reliability, and convergent validity (Hoops, 2009), despite the test's well-established psychometric properties, there are still limitations concerning its use in longitudinal studies or clinical follow-up (Costa et al, 2012).

Controlled Oral Word Association Test (COWAT)

The COWAT- FAS has been used as a measure of both language (Schinka, Loewenstein, Raj, Schoenberg, Banko, Potter & Duara, 2010; Cosentino, Stern, Sokolov, Scarmeas, Manly, Tang, Schupf & Mayeaux, 2010) and executive function (Nutter-Upham, Saykin, Rabin, Roth, Wishart, Pare & Flashman, 2008; Hedden & Yoon, 2006) domains. This test requires that the individual name as many words as possible that begin with a given letter, namely F, A and S. Sixty seconds are allotted for each letter. Individuals cannot use proper names or numbers and cannot use words with different tenses or endings once the root word has been given (Lezak, 2004).

The inter-rater reliability for the COWAT is excellent with scores ranging between .8 and .9; so was the test-retest reliability was .84 (Ross, Calhoum, Cox, Wenner, Kono &

Pleasant, 2007). The face validity and reliability of the measure are both positive attributes of the COWAT. Norms for the measure were established for various ages, ranging all the way from very young to very old, differential levels of education, ethnicities and geographic diversity. However it should be noted that it was shown that a higher level of education tended to result in a generally higher score and this should be taken in high regard when interpreting this research data (Ruff, Light, Parker, & Levin, 1996).

Delis-Kaplan Executive Function System (D-KEFS) - Design Fluency Test

In the Design Fluency Test the participant is given 60 seconds to generate as many unique designs as they can within the given guidelines. The test consists of three conditions, each requiring a different set of instructions; however that all rely on the same premise. The participant is asked to connect an array of dots using four straight lines that will then create a design. This design he/she creates needs to be different each time. In the second and third condition some of the dots are filled and some are empty. Working from this arrangement participants are then asked to create their designs by connecting just empty dots in the second condition and to alternate between filled and empty dots in the third condition (PsychCorp, 2001).

The D-KEFS was standardized in accordance with the 2000 U.S. census and using an all U.S. citizen sample (Swanson, 2005). The test has not been standardized for the South African population as yet although it displays a moderately good internal consistency and good test-retest reliability (Swanson, 2005).

The Stroop Word Colour Interference Test (SWCIT)

The Stroop Colour and Word Test is made up of three trials. First a participant is expected to read the names of colours, printed in black ink. In the second trial the participant is requested to report the different colours of ink rows of “X’s” are printed in. For the final trial the participant has to name the colour words that are printed on the page, however these words are printed in different colours (Golden & Golden, 2002). In this test, the basic task takes the shape of reading names of colours, whereas the analogous task sees these printed names of colours now being printed in incongruent ink colours to the written word. This different time score between the two activities is known as "the Stroop interference effect" (Van der Elst, Van Boxtel, Van Breukelen & Jolles, 2006).

This "Stroop interference effect" as referred to by Van der Elst et al., (2006) will act as a measure for executive functioning in this research. Specifically it will test cognitive flexibility and control. It has however been found that demographic variables considerably influence the SWCIT scored. Therefore some caution must be applied when analysing the results of the South African population. Van der Elst et al (2006), report that the test-retest reliability of the SWCIT is significant with the word trail coefficient at .83, the colour trail coefficient at .74 and the word-colour trail coefficient at .67. Construct validity for SWCIT was tested for with interference scores and these scores correlated well with measures of attention and prepotent response inhibition (May and Hasler, 1998).