

CHAPTER ONE

1. INTRODUCTION

1.1. BACKGROUND

The field of neuropsychology is considered a fairly new area of study in the general profession of psychology. It has been through a transition in the role it has played over time from diagnosing to now including treatment and rehabilitation. As with most fields of psychology, assessment lies at the core of the practice of neuropsychology. The role of assessment also has evolved in the same way that the field has grown with the way in which assessment results are used, broadening as the field of study grows. Neuropsychological assessment is now known to be useful in diagnosis of cognitive deficits and brain related disorders, treatment planning and care of the patient as well as in research (Lezak, Howieson & Loring, 2004)

Assessment in neuropsychology guides the way in which neuropsychologists practice their field and how test batteries are used in these assessments. This means that, in order to achieve the goals of assessment, the tools being used must fit the society in which they are being used. Most tests used in neuropsychology are made by neuropsychologists and psychometricians in various fields and are accompanied by detailed manuals providing the information to establish the validity and reliability of the tests and normative information against which test results may be compared. This is the information that allows clinicians to compare their test candidates against the scores of a normal population of similar people (Kaplan and Saccuzzo, 2001).

The use of standardised psychological tests relies on norms which are a range of performance expected from people of a certain population taking into account different demographic variables such as age, education, gender as well as culture. These variables do not remain constant in different parts of the world or even countries and may vary depending on where they are being used. In view of the

fact that most psychological tests are made in the western world, the norms published with these tests may not be applicable to other countries as there may be wide variations in characteristics of the general population such as education, and ethnicity. Acculturation to the concept of testing may also affect test performance (Byrd et al, 2005) and Zambia is a country where the concept of psychological testing may not be a familiar trend especially in the process of diagnosis and treatment.

Among the demographic variables that have been studied, education and age have for a while been known to have an effect on most psychological tests (Ardila et al, 2000, Heaton et al, Tombaugh et al, 1999). This paper particularly focuses on these two variables and their effects on neuropsychological testing in Zambia. Some studies have shown that people who are more educated will show less susceptibility to dementia and may not often show age related decline (Lezak et al, 2004). Studies have further shown that as a person grows older the brain becomes smaller and it functions less well, it is therefore important for neuropsychologists to be aware of this change when assessing patients as doing otherwise may give a wrong interpretation of normal aging and brain impairment (Hestad et al, 1998). In consideration of this, using norms that are not graded can easily result in older patients being misclassified as neuropsychologically impaired (Zillmer & Spiers, 2001).

The relationship between education and performance on neuropsychological functioning has been known to be both potent and pervasive. This has clearly been demonstrated for verbal tests, but has also showed up on almost every other test involving cognitive abilities including those that were previously thought to be relatively unaffected by schooling. Education can influence test performances to such an extent that poorly educated but cognitively stable persons may get lower scores than mildly impaired but better educated patients (Lezak et al, 2004).

Bearing in mind these factors it is important that the tests that are used for neuropsychological assessment fully meet the criteria and are applicable to a range of individuals inclusive of those from non-western countries such as

Zambia. In order to make tests useful and appropriate to different kinds of populations and in order to have tests that will have little sources of inequity that may result in incorrect diagnoses, too much or too little rehabilitation, it is important to come up with norms for tests that are applicable for that country or culture (Ogden et al, 2003).

It may be hypothesized then that individuals who engage in cognitively stimulating tasks such as those in formal education, tend to have higher results on cognitive tasks on neuropsychological tests. Therefore, in the strict sense, people attending school are highly stimulated in the tasks usually included in psychological and neuropsychological tests. It is also not surprising to find that the highest scores in cognitive tests are obtained at an earlier age because young people are more stimulated to learn and generally have a high functioning cognitive system (Ardila et al, 2000). This therefore, implies that people who are younger and have a higher level of education will be expected to do better on neuropsychological tests. This makes it imperative to correct for such trends in test performance so that the sensitivity (which is the ability of a test to correctly identify abnormal functioning in an individual) of the test may be maintained without compromising its specificity (which is the ability of a test to correctly identify a normal individual or one from another clinical population as intact with respect to the test under consideration) (Lezak et al, 2004).

The concept of education as an important construct that affects performance on neuropsychological tests has been agreed on by other researchers (Tombaugh, et al 1999, Ardila et al 2000); however, it has been a great challenge to find a measure to estimate the level of educational attainment. In an African country like Zambia this poses an even greater challenge as there are few psychometrically sound assessment tools that may be used to measure this construct.

It is with such an understanding that the Zambia Achievement Test one of the few locally developed and normed tests was incorporated in this research. The *Zambia Achievement Test (ZAT)* is an individually administered test constructed to quantify academic achievement for the purpose of identifying academic

difficulties in Zambian children in grades 1 through 7. Even though the test was made for children it can also be used for adults as the items contain words used in everyday language and the test is normed on grade level.

The English version of the test will be used in the battery and the subtest to be used is the reading recognition subtest which will serve as a measure of reading ability (*see Appendix F*). This is because reading level has been proved to be a good measure of educational attainment and a way to correcting discrepancies in number of years of schooling achieved and also as a measure of predicting performance on neuropsychological tests (O'Bryant et al, 2007; Ryan et al 2005). Although the ZAT only measures level of ability up to the Seventh Grade, it still serves as a good measure of educational attainment as research has shown that most discrepancies between years of schooling and reading ability on performance on neuropsychological tests are among people with less than eight years of education (Ostrosky-Solis et al, 1998).

Discrepancies in reading level and educational attainment have been seen to have an effect on neuropsychological test performance and it has been suggested that levels of reading be used rather than years of schooling as the latter tend to be overestimated and a person with a particular number of years of education may actually perform two or one year below their reported years of schooling and may end up being classified as impaired even when they are not (Ryan et al, 2005; Bryant et al, 2007).

The test battery that will be used to measure performance on neuropsychological tests is the Zambia Neurobehavioural Test Battery with 14 tests split into 7 neuropsychological domains. These include the following:

- a) **The Visual Episodic Domain** comprising the Brief Visual Memory Test Revised – Learning and delayed recall.
- b) **The Verbal Episodic Domain** comprising the Hopkins Verbal Learning Test Revised – learning and delayed recall.
- c) **The Verbal Fluency Domain** comprising the Controlled Word Association Test – FAS, Category Fluency Test (Animals and Actions) and the Stroop Word.

- d) **Speed of Information Processing** comprising Trail Making Test Part A, Colour Trails One, WAIS Digit Symbol, WAIS Symbol Search and Stroop Colour.
- e) **The Executive Functioning Domain** comprising the Colour Trails 2, Halstead Category Test, Wisconsin Card Sorting Test and Stroop Colour – Word.
- f) **The Working Memory and Attention Domain** comprising the Paced Auditory Serial Addition Test and the Spatial Span
- g) **The Motor Dexterity Domain** comprising the Grooved Pegboard Test, dominant and non-dominant hand.

1.2. Study Justification

The study investigated the relationship of education and age on the Zambia Neurobehavioral Test Battery with the Zambia Achievement Test (ZAT) as a measure of educational attainment. It looked at whether there were significant differences in levels of performance among individuals of different levels of educational attainment. Literature has shown that there is a discrepancy in reported years of schooling, attained level of education and that reading level is a better predictor of educational attainment as it seems to show the knowledge strategies and skills needed to perform well on traditional neuropsychological tasks (Manly et al, 2002).

Considering that neuropsychological testing will play an integral part in the diagnosis, treatment and rehabilitation of neuropsychological differences, it is important to pick a measure that will attenuate differences in levels of performance among individuals of different backgrounds. Differentiating between reported years of schooling and reading level as determined by the ZAT will offer a guideline on which is a better predictor of performance on neuropsychological tests.

1.3. Objectives of the study

1.3.1. General Objective

To find out the relationship of age and education with neuropsychological test performance.

1.3.2. Specific Objective

1. To determine whether reported years of schooling is a good predictor of performance on neuropsychological tests.
2. To establish whether reading level as determined by ZAT scores is a better predictor of performance on neuropsychological tests than reported years of schooling.
3. To establish whether age accounts for differences in performance on neuropsychological tests.
4. To determine whether increased education level will offer protection against age related decline on neuropsychological test performance.

1.4. Hypotheses

1. Reading level will be a better predictor of performance on neuropsychological tests than reported years of schooling.
2. Reading level will have more effect on verbal tests such as the Stroop test, COWAT – FAS and the Category Fluency Tests than reported years of schooling.
3. Age will have more effect on performance on tests of abstraction/executive functioning, working memory and speed of information processing than reported years of schooling and reading ability.
4. Increased education level will offer protection against age related decline on neuropsychological test performance.

1.5. Identification of Variables

1.5.1. Dependent Variable

The dependent variable in this study was performance on the various neuropsychological tests.

1.5.2. Independent Variables

The independent variables included:

- Age – age at last birthday
- Years of Schooling – the reported number of years of schooling completed
- ZAT score – reading level of performance achieved on the ZAT reading comprehension test

CHAPTER TWO

2. Literature Review

This chapter contains a review of literature on how education and age relate to performance on neuropsychological tests. It will begin by looking at studies that give sufficient evidence that reading level is a better predictor of performance on neuropsychological tests than reported years of schooling. It will then look at how age has various effects on performance on various neuropsychological tests. It will further consider research that has been done on tests used in the Zambia Neurobehavioural Battery and how these particular tests are affected by education and age.

There has been a change in the educational system of Zambia from the time of independence to date. The Ministry of Education has reported a drop in the quality of education being offered in Zambia today. There is a report of reduced numbers of teachers in schools resulting in high pupil to teacher ratios, and inadequate facilities such as books and desks to facilitate the learning process (MoE, 2008). With these problems being cited in the Zambian educational system it may be expected that individuals going through school may complete the required years of schooling but that may not guarantee that the knowledge acquired in those years will correspond with the number of years they have spent in school. This therefore implies that a person may have had 12 years of schooling but will perform at the level of a 10th or 11th grader. This then poses a challenge of interpretation of test results based on reported years of schooling. In such cases it would not be uncommon to find major differences in performance among people with the same reported years of schooling.

It was then with such an understanding that the traditional pattern of basing performance on reported years of schooling began to fall out of favour as reading ability offered a better understanding of what it is that individuals actually obtained in the years that they spent in school. This is because basing interpretation of test performance on reported years of schooling assumes that

people with a given number of years of schooling will function at a similar cognitive level which may not be the case if there are variations in quality of education received by different people. The use of reported years of schooling as a measure of educational attainment may result in a person with poor quality of education performing at a lower level and appearing to have an impairment which may not be the case. On the contrary a person with good quality of education may perform very well and an impairment not detected in the case where it may be present.

There has been evidence reported that reading ability takes into account all different factors that reported years of schooling do not consider in the analysis of test results and is a better indicator of academic achievement (Wilkinson, 1993).

2.1. Reading level as a predictor of performance on neuropsychological tests

There has been overwhelming research in support of reading ability as a measure of educational achievement rather than reported years of schooling. Manly, Touradji, Tang, and Stern (2003) undertook a study in the US to find the effect of literacy and memory decline among elders of different ethnic groups with an age range of between 65 and 80 years of age. These researchers concluded that reported years of schooling did not reflect the actual level of competence in educational abilities or their quality of education. In their work, they recruited 136 older people and these were assessed using the Selective Reminding Test in which they had to learn 12 unrelated words and each participant was given six trials. The levels of literacy were based on performance on a reading recognition test, the Wide Range Achievement Test – version 3 (WRAT-3). The results obtained showed that both reported years of schooling and literacy as assessed on the WRAT-3 accounted for baseline performance but literacy levels had a stronger effect on delayed recall. This finding was in line with the hypothesis that literacy levels would be a better predictor of educational attainment than reported years of schooling.

Baird, Ford and Podell (2007), found that African Americans performed lower than European Americans on neuropsychological tests. However, these

differences were almost eliminated when t scores were interpreted based on performance on reading level of the two groups. This study shows the importance of the correction of reading level as a measure of education and it would make the use of norms more applicable to a wider range of populations than basing it on issues such as race, culture or ethnicity in this case.

In assessing neuropsychological test performance among Caribbean-born and U.S.-born African American elderly people, Byrd, Sanchez & Manly (2005) looked at the effect of age, education and reading level. In this study, they considered the predictive power of age, education and reading level on neuropsychological tests. The results obtained showed that reading level was a better predictor of performance on neuropsychological tests than either age or reported years of education on three neuropsychological domains which were language, memory and executive functions. Significant correlations were only obtained from the U.S. born group for education, age and reading level, whereas, among the Caribbean born participants, significant effects were only seen on reading level which is in support of the notion that reading level is a better predictor of cognitive functioning than reported years of education. The findings of this study give a clear indication of how an index of education based on number of years of schooling may not consider the different levels of cognitive functioning.

Considering that neuropsychological assessments are highly useful it is important that the diagnosis given is accurate. In most instances it has been observed that, due to differences in quality of education received by individuals of different ethnic backgrounds, African Americans were mostly classified as being impaired even in cases where they were not when results were interpreted based on reported years of schooling. It is with this observation that Manly, Jacobs, Touradji, Small and Stern (2002) undertook a study to show that reading level reduces the difference in neuropsychological test performance. They looked at whether reading level would reduce differences seen between African American older people and white older people who were matched on reported years of schooling. The results indicated that the scores obtained by African Americans were lower than those of white older people when based on reported years of schooling. However, when

reading level was considered by looking at performance on the Wide Range Achievement Test – Version 3 (WRAT -3), there was a significant reduction of differences in performance on most neuropsychological tests. This further gives evidence that reading level is a better measure of educational attainment than reported years of schooling.

In another study that sought to have a clearer understanding of the differences in performances on neuropsychological tests among individuals of minority ethnic groups, Ryan, Baird, Rivera-Mindt, Byrd, Monzones and Morgello (2005) investigated the comparability of educational attainment with reading level and examined whether discrepancies in education and reading level accounted for differences in neuropsychological test performance between HIV+ racial-ethnic minority and nonminority participants. In their work, they found that basing performance on reported years of education seemed to inflate the levels of impairment among individuals of minority groups, however, when analysis was done using reading ability there was a significant reduction in the amounts of discrepancies observed.

Rohit, Levine, Hinkin, Abramyan, Saxton, Valdes-Sueiras and Singer (2007) went on to further study the accuracy of reading ability or years of schooling in diagnosing HIV-associated neurocognitive impairment. Their work involved Caucasian and African Americans who were HIV+. The participants were then separated based on whether they were impaired or not using neuropsychological tests that were normed on both reported years of schooling and reading ability using the WRAT 3. The results that were obtained in this study revealed that using reading ability as a determinant of neuropsychological impairment was not only a better predictor but increased both specificity and sensitivity among the Caucasian participants and increased the specificity among the African Americans in determining neurocognitive impairment. This then shows that reading ability not only reduces differences in the process of diagnosis but increases the chances of obtaining better diagnosis.

The studies cited above show that reading level serves as a better measure of educational attainment because it attenuates differences in performance among

individuals with different demographic variables. They have also shown that reading level is a superior assessment of the knowledge, strategy, and skills needed to perform well on traditional neuropsychological tasks, they have further shown that reading level remains a valid estimate of pre morbid ability in mild and questionable dementia.

2.2. Age and education effects on neuropsychological tests

The following studies show an outline of how the variables of age and education have been studied and the trends in performance that have been seen among people with different educational levels as well as those of different ages.

Ryan, Sattler and Lopez (2000) in looking at age effects on the WAIS III indicated that, with advancing age, performance on subtests measuring speed of information processing and perceptual organization change substantially whereas many verbal subtests show minimal or no change and that the findings hold even when level of education is considered across the adult age range. Other studies on the standardisation of the WAIS have shown that when scores were adjusted for the impact of education, Verbal subtests changed minimally with age, whereas Performance subtests showed a progressive decline with age (Kaufman & Lichtenberger, 1999).

Capitani, Barbarotto, and Laicana (1996) approached the concept of the effects of age and education among an Italian population in this way: they proposed that three different patterns of association could be expected between age-related decline and education: (a) Parallelism: The age-related decline runs the same course in different educational groups, that is, no interaction is observed; (b) Protection: The age-related decline is attenuated in well-educated participants; and (c) Confluence: The initial advantage of well-educated groups in middle age is reduced in later life (as cited in Ardilla, et al. 2000). Ardila, Ostrosky-Solis, Rosselli and Gomez (2000) went on and studied these trends in Mexico and found an interaction between age and education, showing that education tends to play an important role in the diagnosis of a cognitive deficit and if not corrected may reduce the sensitivity of the test.

Reitan and Wolfson (1995) looked at the effects of age and education on the General Neuropsychological Scale (GNDS). They sampled 50 brain damaged subjects and 50 controls who were examined on the Halsted Reitan Test Battery. The results obtained showed that age and education had a significant effect on the control group but there was no effect on the brain damaged group, however, there was an interaction observed between the brain damaged group and education and it has been suggested that correcting for age and education should be done carefully among people with brain damage as there could be a misclassification of results obtained. Similar results were found when they assessed the subjects on Wechsler's Adult Intelligence Scale Verbal IQ, Performance IQ and Full Scale IQ (Reitan & Wolfson, 1996). In this study, the results showed that those with a higher education performed better than those with a lower education on all scores but there seemed to be less variation among the brain damaged sample regardless of their educational attainment. In terms of age, the younger controls obtained better scores than the brain damaged sample but an insignificant variation was observed with the older sample whether they belonged to the control sample or brain damaged sample. It was thus suggested in relation to these studies that correcting raw scores on age and education may not be valid for clinical samples.

In assessing the effects of age and education on age and memory across the lifespan Gomez-Perez & Ostrosky- Solis (2006), examined 521 Spanish-speaking subjects with an age range of 6 – 85 years of age and an education range of 0 – 22 years of schooling. The NEUROPSI attention and memory neuropsychological test battery was used. The results obtained showed that memory and attention were affected by age and education but the trends were different among the children and the adults. In children, it was observed that there was an increase with age in performance on selective and sustained attention, attentional working memory and executive functions. Among adults, memory declined with age and executive functions and attention improved with education. This trend offers a guide in the interpretation of data concerning performance among individuals of different age groups and educational levels based on certain neuropsychological domains.

Mungas, Reed, Farias, and DeCarli (2009) approached the concept of age and education in a slightly different manner by considering how age and education influence the relationship between neuropsychological test scores and brain structure. Their results showed that age was strongly correlated with performance on test scores and when test results were adjusted for age any variations that seemed to exist in the raw data were removed. Since the study incorporated results based on brain structures, the correcting for age on the test scores also took into account the variations that may have been obtained as a result of changes in brain structure. This then means that if test results are corrected for age then they may also be correcting for pathology that is caused by brain degeneration or pathology caused by changes in brain structures as a result of age. Thus, neuropsychologists need to be cautious when correcting for age among older persons as this may reduce the sensitivity of the test in detecting impairment.

Welsh-Bohmer, Ostbye, Sanders, Pieper, Hayden, Tschanz, and Norton (2009) studied neuropsychological performance in advancing age in considering the influences of demographic variables and Apolipoprotein E. They found that advanced age and low education showed poor cognitive performance. They observed that age particularly affected performance on tests of semantic fluency, executive function, and visuomotor integration. Memory was also observed to be sensitive to age but it was inconsistently affected across the education strata; verbal memory was related to age in the higher education strata but showed no such relationship in the lower education group. However, performance on nonverbal memory measures was inversely related to age regardless of education strata. Education was observed to have strong effects on tests of verbal memory, executive function, and expressive language.

It has also been demonstrated that among adults speed of information processing is amongst the first to decline and that in most instances when speed of information processing is corrected for, differences associated with increasing age are reduced. Salthouse, 1991 (see Hestad et al, 1998) reported that when speed of processing is corrected on tests of speed the amount of variance observed due to age reduces from about 19% to almost 5%. This not only shows the importance of correcting not necessarily for speed for information processing

but for age as well and further clarifies that when interpreting test results it will be important to note that younger people will generally perform better than older people.

2.3. Age and educational effects on tests in the Zambia Neurobehavioral Test Battery

Several studies have been done to show that education and age have an effect on performance on the tests contained in the Zambia Neurobehavioral Test Battery.

The tests measuring **Speed of information processing** (WAIS-III Digit Symbol & Symbol Search; Stroop Task; Trail Making Test, Part A and those that measure **Attention/working memory** (Colour Trails 1 & 2; Paced Auditory Serial Addition – PASAT) have been shown to have age and educational effects and have been known to show sensitivity to cognitive decline with tests such as the WAIS-III Digit Symbol and Symbol Search, with decline in performance being seen as early as the 30's in raw scores and a marked decline in scaled scores being seen after the age of 60 (Wechsler, 1997; Ivnik, Malec, Smith et al., 2002b). Education was also seen to have a significant effect on performance among older people (Mazaux et al., 1995).

The tests that measure **Verbal and Visual Episodic domains** are the Hopkins Verbal Learning Test (HVLT) and the Brief Visuospatial Memory Test (BVMt). The Hopkins Verbal Learning Test (HVLT) was seen to have significant age effect but not educational effect in a study of older patients (Vanderploeg, Schinka, Jones, et al., 2000).

Tombaugh, Kozak and Rees (1999) in obtaining normative data by age and education on the COWAT (FAS) and Category Verbal Fluency Test (Animal Naming) found that regression analyses performed on scores from individuals who had completed both verbal fluency tests demonstrated that for FAS education accounted for more variance than age (education 21.7% vs. age 11.8%) while for Animal Naming the opposite relationship existed (education 13.6% vs. age 23.4%). The Zambia Neurobehavioral Test Battery contains both the FAS and the Category Verbal Fluency Test (Animal Naming) similar variations may be

expected in the Zambian population although these variations have been said to mostly occur among people whose mother tongue is English (Tombaugh et al, 1999). It would therefore, be important to investigate the trends in Zambia where most people are not native English speakers.

Finally, the tests of **Abstraction/executive functioning** which include the Wisconsin Card Sorting Test and Halsted Category Test are those that are mostly associated with conditions that affect the frontal lobe of the human brain. A lot of research examined the effects of age and performance on the Category Test, (Heaton et al., 1991; Leckliter and Matarazzo, 1989; Spreen and Strauss 1998) and all show that there is a significant increase in the number of errors made on the category test after the age of 40, which is initially gradual then increases rapidly after the age of 60, however subjects with less than 12 years of education are seen to have a rapid increase in errors even after the age of 40. Age effects on the Wisconsin Card Sorting Test have been seen from the age of 70 (Boone, et al., 1993; Boone, Miller et al., 1990; Haarland, Vranes, et al 1987 as cited in Lezak et al 2004). The effects have further been attributed to poor use of feedback information, impaired working memory and reduction in speed of information processing for adults 60 to 86 years of age (Fristoe et al., 1997).

CHAPTER THREE

3. METHODOLOGY

This chapter outlines the methods that were used in the process of data collection as well as that of analysing the data.

The data was collected as part of a larger project to create norms for Neuropsychological Tests contained in the Zambia Neurobehavioural Test Battery.

3.1. Study Design

The study was a cross sectional study. It involved participants taking neuropsychological tests that assessed the functioning of their brain and nervous system. They were also required to answer a series of questionnaires that would give information on their neurological well being, psychiatric history and drug abuse as well as functioning in their daily living. The final questionnaire was used to collect any other demographic information that may not have been obtained in any of the other questionnaires. This process ensured that all relevant information concerning each client was collected for the current study as well as any subsequent studies that may use the data collected in this study.

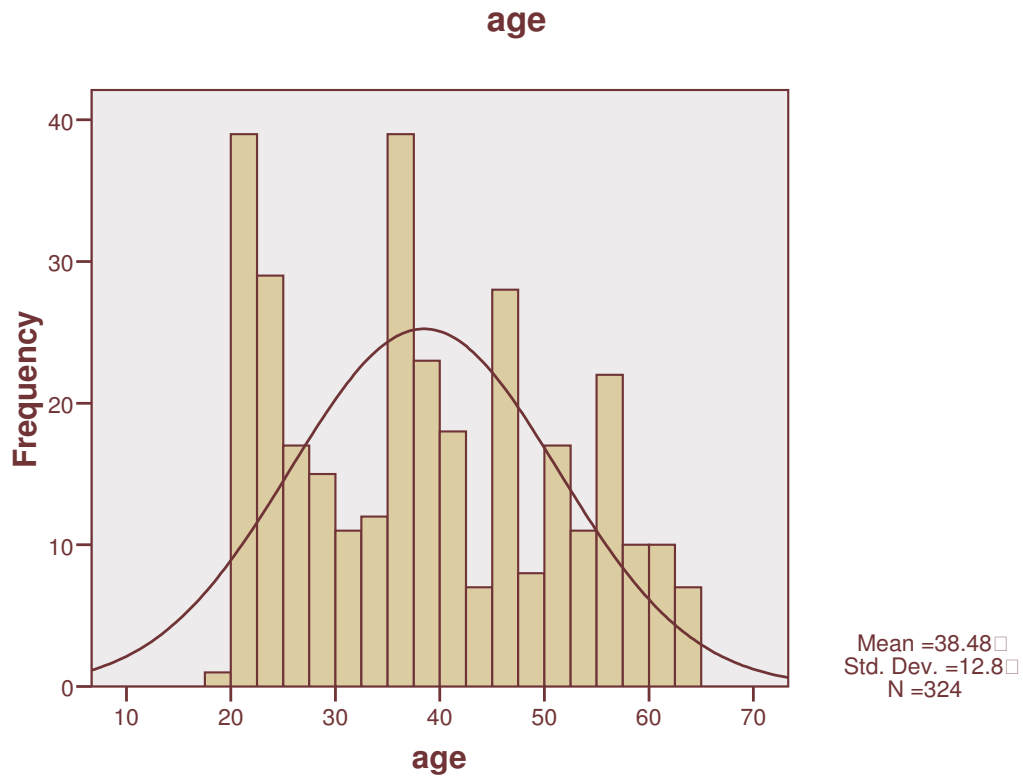
3.2. Study Population

The study population included all Zambians from the age of 20 to 65, from both rural and urban areas of the country.

3.2.1. Study Sample

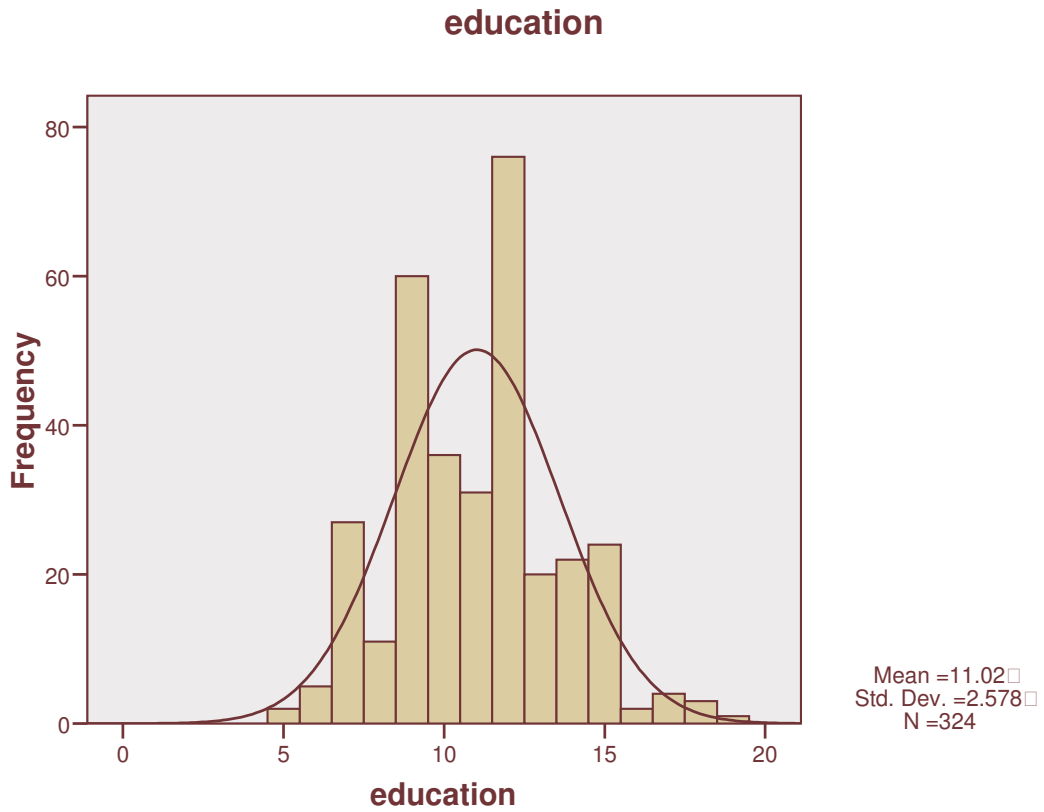
A total of 324 participants were recruited in the study. They consisted of HIV negative Zambian adults from the ages of 20 to 65 years, from both rural and urban areas of Zambia. They were about equally distributed in terms of gender and had a range of 5years to 13+ years of education.

Figure 1 - Age



The figure above shows the distribution of ages recorded in the study sample Age ranged from 19 to 65 years. Ages were grouped into 2-year age-range categories high frequencies were obtained in the age ranges of 20-22, 22-24, 36-38 & 46-48 years. The mean age was 38.48 with a standard deviation of 12.8, the total number of participants was N=324.

Figure 2 – Education



The above graph gives the descriptive analysis of the education variable. Reported years of schooling ranged from 5 years of education to 19 years of education. The mean number of years of schooling was 11.02 with a standard deviation of 2.58 with N= 324. The highest number of years of schooling reported was 12 years of education. The peaks at levels 7, 9 and 12 reflect the grades at which national public examinations are set as criteria for progression to the next level.

3.3. Sampling Procedure

The Zambian Census report of 2002 was used as a guide to the population of the country as well as a distribution of the ages and educational qualifications in the rural and urban areas. With this guide random sampling was used to recruit 324 subjects in different ages and educational levels from both urban and rural areas.

The participants were recruited through health centres in urban and rural areas under the District Health Management Board (DHMB) after consent was obtained from the Biomedical Research Ethics Committee and Ministry of Health (*See Appendices A and B*). The District Health Management Board of each district was approached to obtain permission to have access to the different health centres in their catchment areas. The DHMB also gave a guide on which clinics are classified as urban and which were classified as rural clinics. The areas that were included in this study were Lusaka District as the only urban centre; the rural districts included – Chongwe, Chibombo and Kafue Districts.

The participants were required to take an HIV test through the participating health centres which also served as a contribution to the national Voluntary Counselling and Testing (VCT) campaign. During the post test counselling the participants who tested negative for HIV were requested to take part in the research and referred to the researcher who issued an informed consent form (*See Appendix C*) to request them to take part in the study and they were then included in the study. However, this did not necessarily mean they were included as some dropped out of the study due to failure to meet some of the screening criteria such as the use of the English language (as assessed by the Wide Range Achievement Test), psychiatric and neurological confounding factors.

3.4. Instruments

Several instruments were used in the process of data collection. They included neuropsychological tests assessing different domains of the functioning of the brain and nervous system and questionnaires that gave demographic information, psychiatric and drug abuse history as well everyday functioning. A brief description of these items is outlined below.

3.4.1. Neuropsychological Measurements

The Zambia neurobehavioral test battery was used in this study (*See Appendix G*). It is a test battery that assesses seven cognitive domains. These domains as well the test used to assess them are as follows:

- a) **Speed of information processing** – this domain included Digit Symbol & Symbol Search which are both adapted from Wechslers Adult Intelligence Scale the two tests make up the Processing speed index of the WAIS-III. In the Digit symbol, the participant is asked to match a symbol with a specific digit. The participant is asked to complete the task within 120seconds without stopping or changing the answers. In the symbol search, the participant is asked to look at two symbols on the left and state whether any of them are on the right by answering “YES” or “NO” on the spaces provided. The Stroop Task being used for the current study was revised by Golden and Freshwater 2002. The colour card (C) in particular measures processing speed. The sheet consists of a series of ‘X’s printed in green, red and blue. The participant is asked to name the colour as quickly as possible while maintaining accuracy and the subject is given 45 seconds to complete the task. Trail making test Part A consists of encircled numbers from 1 to 25 randomly spread across a sheet of paper. The object of the test is for the subject to connect the numbers in order, beginning with 1 and ending with 25, in as little time as possible. The Trail Making Test (TMT) is a brief, easily administered tool that is widely used to measure motor speed, visual attention, and cognitive flexibility. It requires a variety of mental abilities including visual scanning, motor function, and letter and number recognition (Reitan, 2009).

The Colour trails test Part 1 is designed to minimize the influence of language so that it can be used in cross-cultural settings. The test has all odd-numbers circled pink and all even-numbers circled yellow; it shows all numbers from 1 to 25, alternating between pink and yellow circles (Strauss, Sherman & Spreen, 2006). The participant is required to move from a pink one to a yellow two, to a pink three and so on until they reach 25. The amount of time taken to complete the task is recorded.

- b) Verbal Episodic Memory** – it included the Hopkins Verbal Learning Test – Revised which is a test of learning ability and delayed recall on verbal information across trials. It also measures an individual’s capacity to retain, reproduce and recognize information after delay (Strauss, Sherman and Spreen 2006:760). The HVLT-R to be used in the Zambia Neurobehavioural Battery is comprised of 12 nouns with four words drawn from three semantic categories i.e. four words each from four legged animals, precious stones and human dwellings. Some changes have been made to adapt the words to make the test to the Zambian situation. For instance the original items such as Emerald, Sapphire, Jade and Pearl have been replaced with Copper, Iron, Lead and Zinc respectively. (Cherner et al 2007).
- c) Visual Episodic Domain** - The Brief Visuospatial Memory Test – Revised (BVMT-R) measures visual learning and memory using a multiple-trial list learning paradigm. Like the HVLT –R, it also measures immediate and delayed recall (Strauss, Sherman and Spreen, 2006). When administering the test, the participant is presented with an 8 x 11 – inch card containing six simple geometric visual designs in a 2 x 3 matrix, for 10 seconds and after that the participant is required to reproduce as many of the designs as possible on a blank sheet of paper in the same location as they appeared on the display.
- d) Abstraction/executive functioning** – consisted of the Wisconsin Card Sorting Test – 64 Item. The test was originally meant as a test of “abstract behaviour and shift of set”. It was originally created as 60 card test with one to four symbols which are a triangle, a star, cross or circle in red, green, yellow or blue. All cards are different and there are no two identical cards. In the test the test taker is supposed to match one of the cards at the bottom to those that are shown among the four (Lezak, 2004). There are three principles in the way the cards are matched and these may be the colour, the shape or the number of items on the card e.g. four (regardless of the colour or the shape of the items). The feedback given for each response is either “right” or “wrong”, indicating whether the card has been matched correctly.

The Halstead Category test (Standard Category Test) was developed by Halsted (1947) to assess the ability to conceptualise qualities such as size, shape, number,

position and colour. In its original form it had 336 items with 9 subtests. Reitan in 1948 reduced the subtests to 7 with 208 items. Each subtest has a different principle which may be odd stimulus, number of objects, spatial position, a combination of different principles etc. To complete the test, the participant must rely on feedback based on correct or incorrect guesses to show what the principle in that subtest is.

The Stroop Word- Colour task CW which equally measures executive function consists of names of colours printed in an incongruent ink colour. The client is given 45 seconds to name the colour while suppressing the automatic response to read the word.

- e) **Verbal Fluency** – this was assessed using the Controlled Oral Word Association Test - (COWAT–FAS) whose purpose is to evaluate the spontaneous production of words within a limited amount of time (Straus, Sherman, Spreen, 2006). The participant is asked orally to produce as many words as possible, beginning with a given letter in a trail of three. Examinees are allowed 60 seconds for each trial and are not allowed to generate nouns such as name of a person “Gerald” or a place “Lusaka” and the Category Fluency Test (Animals and Actions) where the test taker is asked to mention as many names of animals as they can think of in 45 seconds and the same time is allowed for the actions where one is asked to mention as many things as possible that human beings do.

The Stroop Word is a test that contains the words of red, green, and blue repeated randomly in a 10 X 10 matrix (Straus, Sherman, Spreen, 2006). In this task, the participant is asked to read the words as fast as they can with 45 seconds. If they finish reading before time ends, then they go to the first item and begin reading again.

- f) **Attention/working memory** - this domain included the Paced Auditory Serial Addition Test (PASAT) as cited in (Strauss, Sherman & Spreen, 2006), the PASAT was devised by Gronwall et al. (Gronwall, 1977; Gronwall & Sampson, 1974; Gronwall & Writson, 1974 as cited in Strauss, Sherman & Spreen, 2006) to provide an estimate of speed of information processing. Paced Auditory Serial Attention Test is meant to measure attention deficits including concentration, speed of processing, mental calculation, and mental tracking. It is sensitive for

diagnosing cognitive impairment in individuals 16 years old and up. The participants are given a number every 3 seconds and are asked to add the number they just heard with the number they heard before.

The Spatial Span adapted from Wechsler's Memory Scale – third edition) has 10 cubes in which the participant is required to follow a sequence of tapping the blocks both forwards and backwards. Wilde and Strauss (p323, 2002) highlight the assumptions of the Wechsler spatial span test as “(a) Spatial span is a visual analogue of the Digit Span, (b) the working memory demands of the Spatial Span backwards are greater than in the forward condition, and (c) Spatial Span is a valid measure of visual-spatial memory”.

- g) Motor Dexterity**– this was assessed with the Grooved Pegboard Test (Dominant & Non-Dominant Hand trials. The “Grooved Pegboard (GP) task measures eye-hand coordination and motor speed” (Strauss et al., 2006:1061). This procedure measures performance speed in a fine motor task and by examining both sides of the body, it allows for inferences to be drawn regarding possible lateral brain damage (Swiercinsky, 2001).

The GP consists of a metal board with a matrix of 25 holes with randomly positioned slots. Pegs have a ridge along one side and must be rotated to match the hole before they can be inserted in the board. The participants' task is to insert the pegs in the holes as fast as they can in sequence without skipping any slot.

- h) Screening Test** – was the Hiscock Memory. The test has been designed to clinically identify an individual thought to be purposefully feigning or faking memory impairment (Prigatano & Amin, 1993). The 18-item HDMT which is a part of the Zambia Neurobehavioural test battery is a forced-choice visual memory task used clinically to detect factitious sensory or perceptual impairment and also applied to cases of claimed memory loss, on which participants view (and are asked to remember) a successive series of 5-digit numbers for 5 seconds each, which are presented singly on a 7.6 X 12.7 cm note cards attached to an easel.

3.4.2. Reading Ability

The Wide Range Achievement Test Version Three (WRAT-3) Blue Word Reading List (*See Appendix E*) which apart from measuring reading ability also served as screening for literacy and proficiency in the English Language. The WRAT is one of the widely used measure of academic achievement among neuropsychologists, it is used for both children and adults and ranked one the most used reading tests (Steven and Price, 1999). The participant is required to read words which are in order of increasing difficulty. A minimum of five correctly pronounced words was required to prove knowledge of the English language.

3.4.3. Psychiatric and Drug Abuse assessment

Beck Depression Inventory Version 2 (BDI -II)

Depression symptoms were assessed using the Beck Depression Inventory (II) which is a 21-item self report scale. On each item there are 4 response options of perceived severity within a period of two weeks. Administration of the BDI takes about 10 minutes.

Alcohol and Drug abuse was assessed using the Chinese Substance Use questionnaire. The questionnaire contains a list of drugs and alcohol and the participant is required to state which ones and how much they have used in the last three months. It further requires the participant to state details of the frequency of use and the quantities for each drug or alcohol stated to have been used.

3.4.4. Everyday Functioning Assessment

The assessment of everyday functioning was done through the Activities of Daily Living Scale (ADL) questionnaire, and the Patient's Assessment of Own Functioning Inventory (PAOFI). The ADL questionnaires assesses how an individual functions in their daily lives and is mainly used in finding the effects of dementia which is both senile or as a result of HIV. The PAOFI is a 41-item questionnaire in which the participant gives information on whether the respondent has difficulty with language, memory and communication. It also

considers motor skills, sensory and perceptual skill and other cognitive and intellectual functions as well as engaging in social interaction. The two instruments (ADL and PAOFI) work in complimentary fashion to assess any neuropsychological impairment that leads to disturbance in the everyday functioning of an individual.

The neurobehavioral questionnaire was also used to assess the neurological stability and to check for any cofounds that may be present in the process of assessment as well as during data interpretation.

3.4.5. Demographic Information

In order to obtain information on the different demographics, a questionnaire containing all the required demographic information was administered. It included information on age, education, sex, rural/urban (location), social economic status and number of languages spoken (*See Appendix D*).

3.5. Data Collection

The data was collected by 9 researchers all of whom were pursuing a Master of Science in Clinical Neuropsychology. Each researcher collected data from 36 participants making a total of 324.

Once permission was obtained from the District Health Management Board the sampled clinics were approached to recruit participants who were of a particular age and educational level as was stated in the sampling frame. The recruited participants were then screened for HIV to ensure that they were HIV negative. When the test was done, the clients were referred to the researchers for neuropsychological assessment.

Each client was assessed using the instruments stated above and the entire testing process took 3:30hrs to 4hours. Each researcher collected data at an average rate of 3 participants per day. The researcher then gave the informed consent form to the participant and once consent was obtained, they administered the WRAT and ZAT tests to assess for fluency in the English language. Any clients who were not able to read either the ZAT or WRAT score beyond the first line of first two items were not included in the study. They were then given the Neurobehavioural Medical Screen to assess for Neurobehavioural well being and any who were

found to have confounding factors such as psychiatric illness or neurological disorders of any sort were not included in the study. Then finally the researcher administered all the tests included in the battery.

3.6. Data Analysis

The following statistical analyses were performed with the assistance of The Statistical Package for Social Sciences (SPSS).

- 1) Descriptive Analyses were performed for the independent and selected dependent variables to obtain means and standard deviations.
- 2) In order to determine whether reading ability would be a better predictor of performance on neuropsychological tests than reported years of schooling and age, hierarchical multiple regression was used.
- 3) In order to establish whether reading ability would have more effect on verbal test than age and reported years of schooling hierarchical multiple regression was used.
- 4) To determine whether age would affect performance on neuropsychological tests, hierarchical multiple regression were used.
- 5) To establish whether schooling offers protection against age related decline on neuropsychological test performance, Multivariate Analysis of Variance was used.

CHAPTER FOUR

4. RESULTS

This chapter outlines the results that were obtained in the study. It shows the various analyses that were carried out in the study.

4.1. Section 1 - MEANS and STANDARD DEVIATIONS

Figure 3 – ZAT Scaled Scores

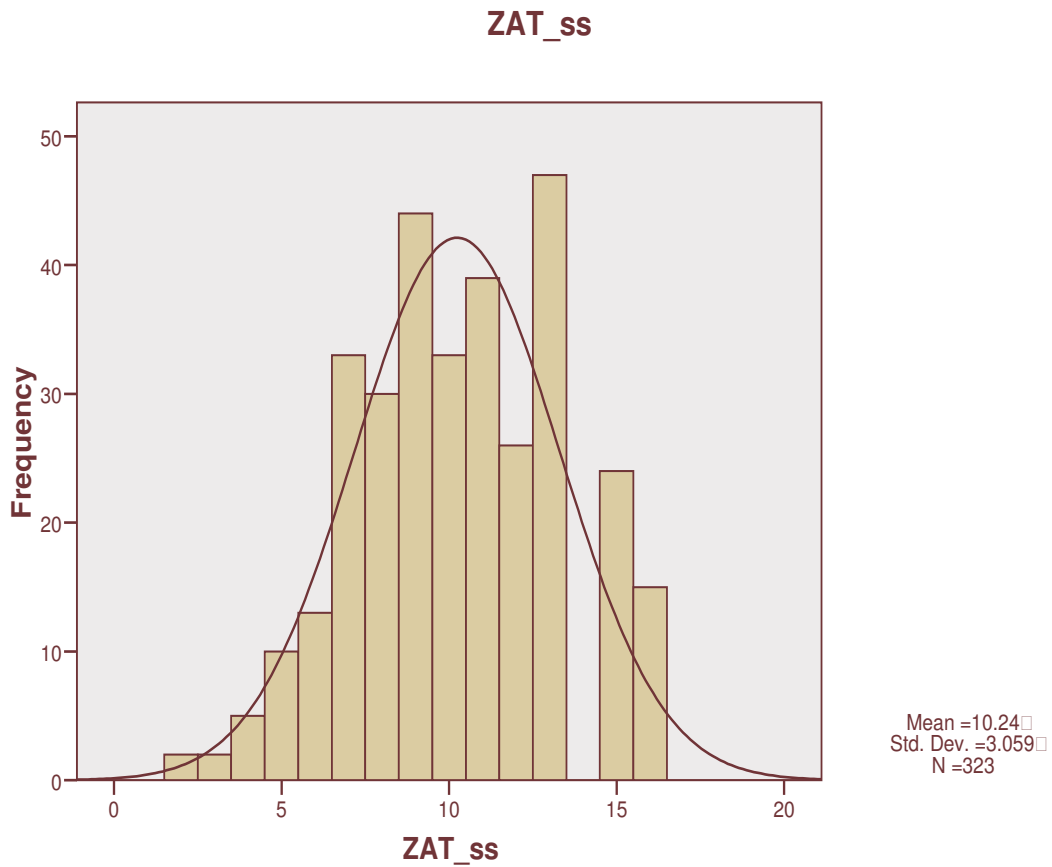


Figure three shows scaled scores on the Zambia Achievement Test Reading Recognition Sub Test. The subtest had a total of 20 items. In this context scaled scores were used to normalise the scores in the sample. The mean score was 10.24 with a Standard Deviation of 3.1 with N= 323 due to a missing variable in the sample.

This shows that the majority of people did well and clustered around the midpoint with numbers increasing around the scaled score of 13 with no reported score of 14.

Table 1: Zero order correlations: Age, Reported years of schooling, ZAT and WRAT

	Years of Schooling	Age	ZAT	WRAT
Years of Schooling		-.133 P = .017	.474 P = .0001	.196 P = .0001
Age	-.133 P = .017		.005 P = .933	.044 P = .428
ZAT	.474 P = .0001	.005 P = .933		.363 P = .0001
WRAT	.196 P = .0001	.044 P = .428	.363 P = .0001	

Zero order correlation analysis were run to explore the relationship between age, reported years of schooling and reading ability (ZAT and WRAT). The associations obtained were generally low as shown in table three above however; all the correlations were significant at .01 with the exception of age by ZAT scores which was not significant. ZAT scores had a higher correlation with years of schooling than WRAT scores reporting of $r=.474$ and $r=.196$ respectively. Age had a negative correlation with reported years of schooling with $r=-.133$.

4.2. Section Two: Predictors of Test Performance

In order to find out what are the best predictors for performance on neuropsychological tests hierarchical multiple regression was used. In this analysis, the predictors were entered in an order chosen by the researcher in terms of which variable is more likely to give the best predictor of performance on neuropsychological tests. This method is preferred as it shows the amount of variance accounted for by each variable that is entered into the equation when performing the analysis.

Table 2: Model One - Hierarchical regression Analysis for effects of age, years of schooling and reading level on neuropsychological tests

Variable	B	SEB	B	B	SEB	B	B	SEB	β
	Step 1			Step 2		Step 3			
Age	-0.064	0.007	0.442*	-0.055	0.006	0.838*	-0.058	0.006	0.401*
Years of Schooling				0.309	0.032	0.431*	0.203	0.034	0.283*
Reading Level							0.185	0.029	0.307*
R²	0.195			0.378			0.450		
ΔR^2	0.195			0.183			0.072		

***P < 0.001**

The results shown in table two show that all three predictors were significant with $P < .0001$ in predicting performance on the neuropsychological test battery. In step three, age accounted for the highest beta weight recording .401 and 19.5% of the variance, while reading level showed more significance than reported years of education with a beta weight of .307 and an additional 0.72% of the variance over and above age and reported years of schooling. This then shows that reading level is a better predictor of performance on neuropsychological tests than reported years of schooling. The results also indicate that when all three variables are entered in the analysis an R^2 0.450 is obtained implying that the variance accounted for is up to 45%. This is more than what is obtained when only age (Step 1) was entered or age and schooling (Step 2) were included accounting for 19.5% and 37.8% of the variance respectively.

Table 3: Model Two - Hierarchical regression Analysis for effects of age, years of schooling and reading level on the neuropsychological test battery

Variable	B	SEB	B	B	SEB	β	B	SEB	β
	Step 1			Step 2			Step 3		
Age	-0.064	0.007	0.442*	-0.055	0.006	0.838*	-0.058	0.006	0.401*
Reading Level (ZAT)				0.266	0.026	0.441*	0.185	0.029	0.307*
Years of Schooling							0.203	0.034	0.283*
R²	0.195			0.390			0.450		
ΔR^2	0.195			0.195			0.060		

* $P < 0.001$

The results shown in table three show the extent to which reading level is a better predictor of performance on the test battery than reported years of schooling. All three predictors were significant with $P < .0001$ in predicting performance on the neuropsychological test battery. However, like in the first model, age accounted for the highest beta weight recording .401 and 19.5% of the variance, reading level (ZAT) still recorded a higher beta weight than reported years of schooling with a beta weight of .307 and a variance in this case of 19.5%. This then shows that reading level still remains a better predictor of performance on neuropsychological tests than reported years of schooling. The results also indicate that when all three variables are entered in the analysis an R^2 0.450 is obtained implying that the variance accounted for is up to 45% similar to the results that were obtained in the first model.

Table 4: Model One: Hierarchical regression Analysis for effects of age, years of schooling and reading level (WRAT) on the neuropsychological test battery

Variable	B	SEB	B	B	SEB	B	B	SEB	β
	Step 1			Step 2			Step 3		
Age	-0.064	0.007	0.442*	-0.055	0.006	0.383*	-0.056	0.006	0.382*
Years of Schooling				0.301	0.032	0.431*	0.301	0.033	0.420*
Reading Level (WRAT)							0.009	0.008	0.052
R²	0.195			0.377			0.380		
ΔR^2	0.195			0.182			0.003		

* $P < 0.001$

Table four above shows the effect of age, years of schooling and reading level (WRAT) on the neuropsychological test battery. The results showed that in this model, years of schooling was a better predictor of performance on the test battery. In the table above age and years of schooling reported a P value $<.0001$ while reading level reported a P value of $.252$. In this model, years of schooling reported a beta weight of $.420$ adding a variance of 18.2% while reading level using the WRAT only added a further 0.3% over and above age and years of schooling with a beta weight of $.052$. In this model, the total amount of variance that was explained was 38% unlike in the first model with the Zambia Achievement Test (ZAT) which explained a total variance of 45% . For this sample, then, ZAT was a more powerful predictor of performance on the neuropsychological test battery than the WRAT.

Table 5: Multiple regression analyses: Predictors of neuropsychological test performance per domain.

Variable	B	SEB	β
Visual Episodic Memory			
Age	-.092	.012	-.390*
Schooling	.104	.067	.088
Reading Level	.199	.056	.200*
	Step 1	Step 2	Step 3
R ²	.162	.196	.227
Δ R ²	.162	.034	.031
Verbal Episodic Memory			
Age	-.061	.011	-.272*
Schooling	.169	.065	.153*
Reading Level	.189	.054	.203*
	Step 1	Step 2	Step 3
R ²	.087	.149	.181
Δ R ²	.087	.062	.032
Verbal Fluency			
Age	-.207	.008	-.153*
Schooling	.303	.044	.345*
Reading Level	.260	.037	.352*
	Step 1	Step 2	Step 3
R ²	.041	.302	.398
Δ R ²	.041	.261	.096

*P<.05

Table 5: Multiple regression analyses: Predictors of neuropsychological test performance per domain. (cont.)

SIP			
Age	-.076	.008	-.420*
Schooling	.198	.046	.175*
Reading Level	.199	.038	.263*
	Step 1	Step 2	Step 3
R²	.204	.323	.376
ΔR²	.204	.119	.053
Executive Functioning			
Age	-.052	.008	-.320*
Schooling	.141	.046	.175*
Reading Level	.139	.038	.204*
	Step 1	Step 2	Step 3
R²	.119	.192	.224
ΔR²	.119	.073	.032
Working Memory			
Age	-.040	.010	-.207*
Schooling	.188	.055	.195*
Reading Level	.230	.046	.282*
	Step 1	Step 2	Step 3
R²	.056	.164	.225
ΔR²	.056	.108	.061

*P<.05

Table 5: Multiple regression analyses: Predictors of neuropsychological test performance per domain. (cont.)

Motor			
Age	.066	.011	-.300*
Schooling	.294	.063	.270*
Reading Level	.023	.053	.025
	Step 1	Step 2	Step 3
R²	.114	.192	.192
ΔR²	.114	.078	.000

*P<.05

In order to find the effects of reading, schooling and age on the different test domains of neuropsychological functioning, hierarchical multiple regression analyses were run (Table 5) following the design of model 1 (Table 2). Effects of schooling were strongest on the tests of verbal fluency with a beta value of 0.345, followed by working memory with 0.195 and speed of information processing with 0.175. Minimal effects of schooling were found on the visual and verbal episodic memory domains, executive functioning and motor domains. Additional variance accounted for by ZAT scores over and above age and schooling was greatest for tests of verbal fluency, speed of information processing and working memory. However, ZAT scores did not account for any additional variance on the motor domain. Effects of age were strongest on Speed of information processing followed by Visual Episodic Memory then Executive Functioning. It is important to bear in mind that age in Step 1 is still confounded with effects of schooling and reading level. These results are in support of the third hypothesis stating that age will have an effect on tests of executive functioning and speed of information processing. The results also indicate that age had an effect on the visual episodic memory domain, which was not expected.

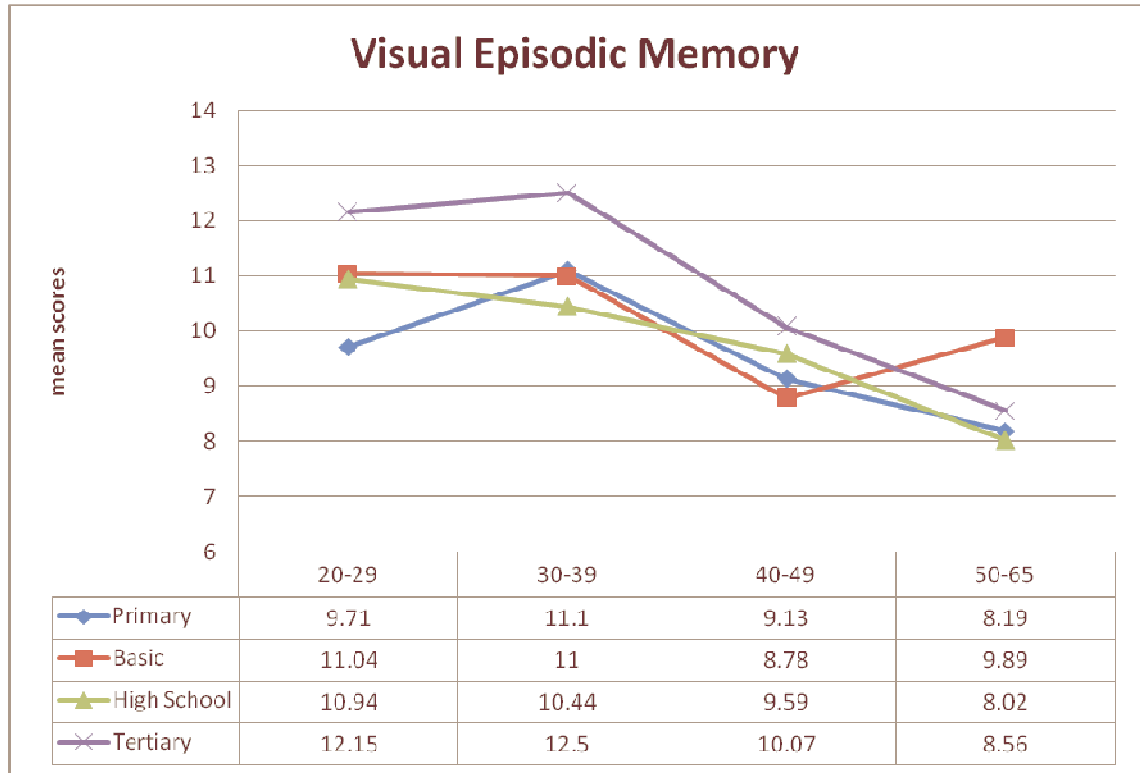
Table 6: Partial Correlation Values: Age, Reported years of education and Reading ability

Domain	Age	Reported years of schooling	Reading ability
Visual Episodic Memory	-.400**	.087**	.196**
Verbal Episodic Memory	-.285**	.145**	.193**
Verbal Fluency	-.192**	.361**	.370**
Speed of Information Processing	-.465**	.237**	.281**
Executive Functioning	-.338**	.170**	.199**
Working Memory	-.226**	.189**	.271**
Motor	-.313**	.253**	.024**

**Correlation Significant at 0.01 levels (2-tailed)

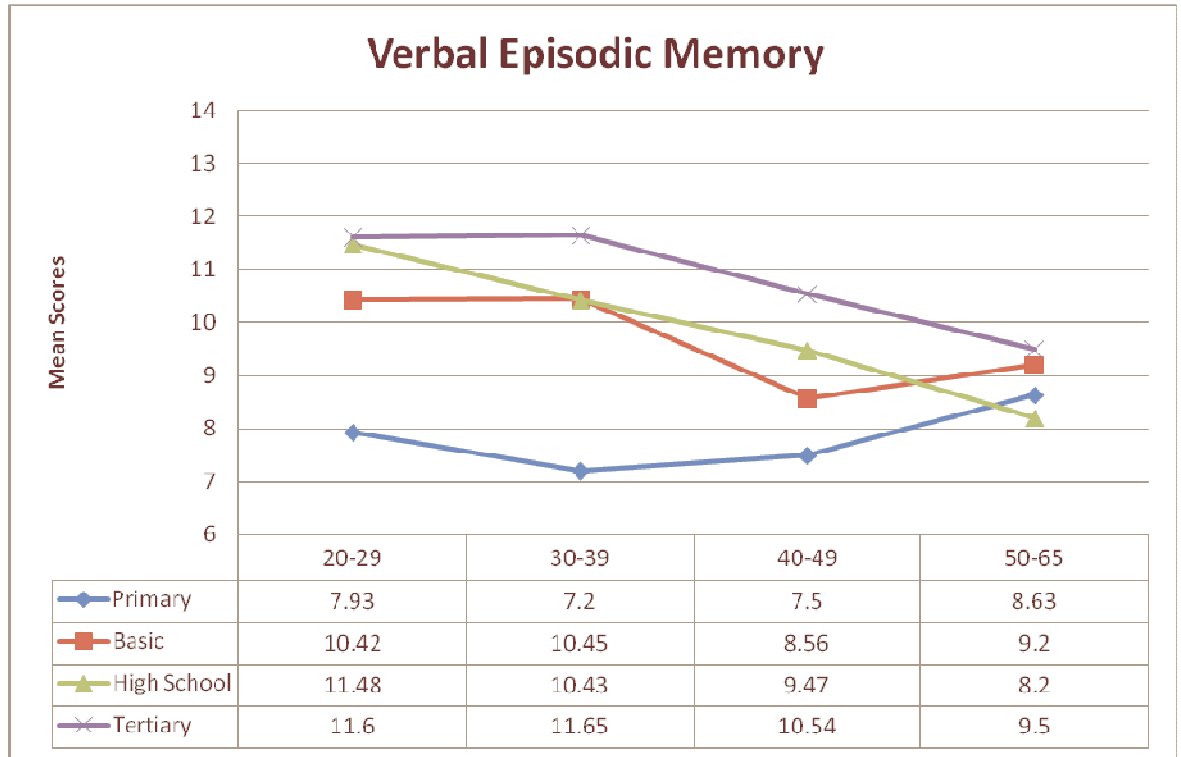
Partial correlation analyses were run to explore the relationship between age, reported years of education and reading ability and the different domains of the neuropsychological tests. The associations obtained were generally low as shown in table three above. However, all the correlations were significant at .01. All the domains correlated negatively with age with the highest correlation being obtained in the Speed of Information processing domain with $r = -.465$. In the reported years of schooling domain the highest correlation obtained was in the fluency domain with $r = .361$. Reading ability correlated the highest with the Fluency domain as well with $r = .370$. All associations between reported years of schooling, reading ability and all seven domains were positive and significant with $P < .01$

Figure 4 – Mean Scores in the Visual Episodic Domain According to Age and Education



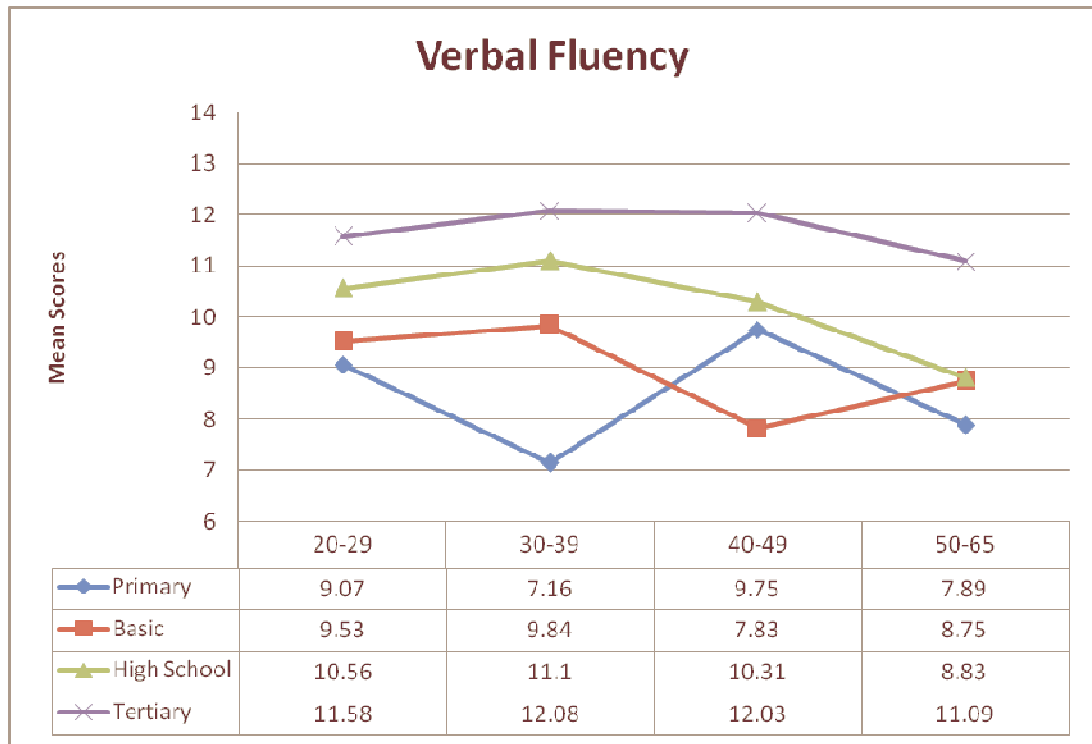
Figures four through eleven, show the mean scores and standard deviations for the different neuropsychological domains by age and educational group. Generally, the scores show an increase with education and a decrease with age. This pattern was observed in most of the domains. However, in the visual episodic domain, it was observed that the basic education group in 50-65years group performed better than all the other educational groups.

Figure 5 – Mean Scores in the Verbal Episodic Domain According to Age and Schooling



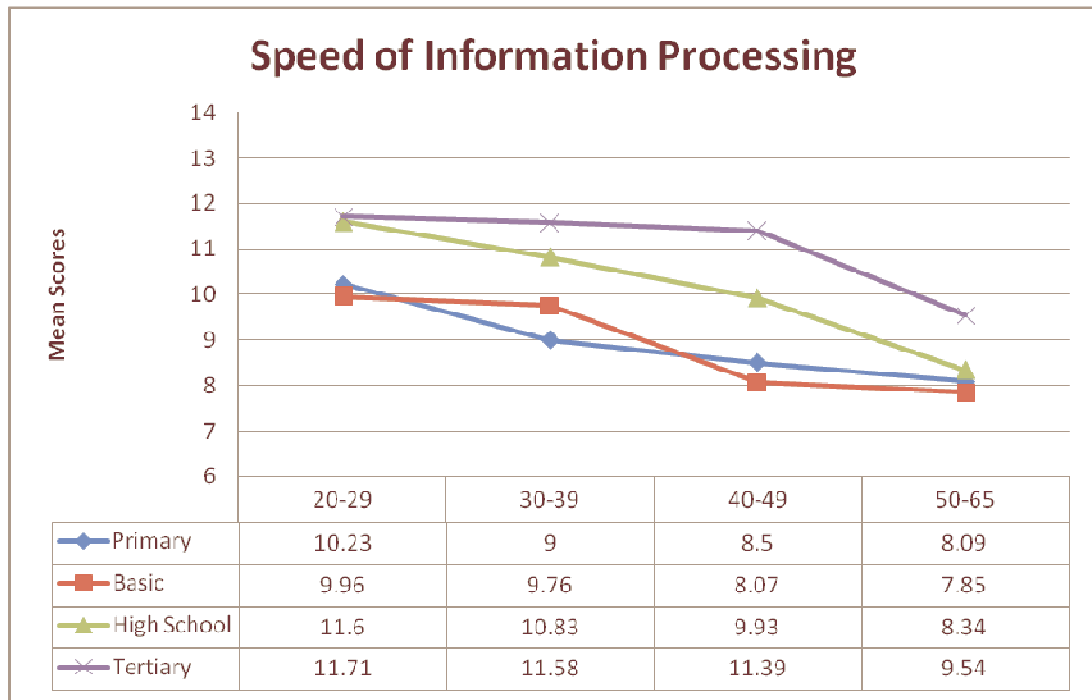
In the Verbal Episodic domain, it was observed that there was a general increase in scores with increased levels of education and a decrease with increased age. However, in the primary and basic education groups, the age group 40-49 years seemed to record lower scores than the 50-65years age group; similarly, the primary and basic education groups in the 50-65yrs age group performed better than the high school group in the 50-65yrs group.

Figure 6 – Mean Scores in the Verbal Fluency Domain According to Age and Schooling



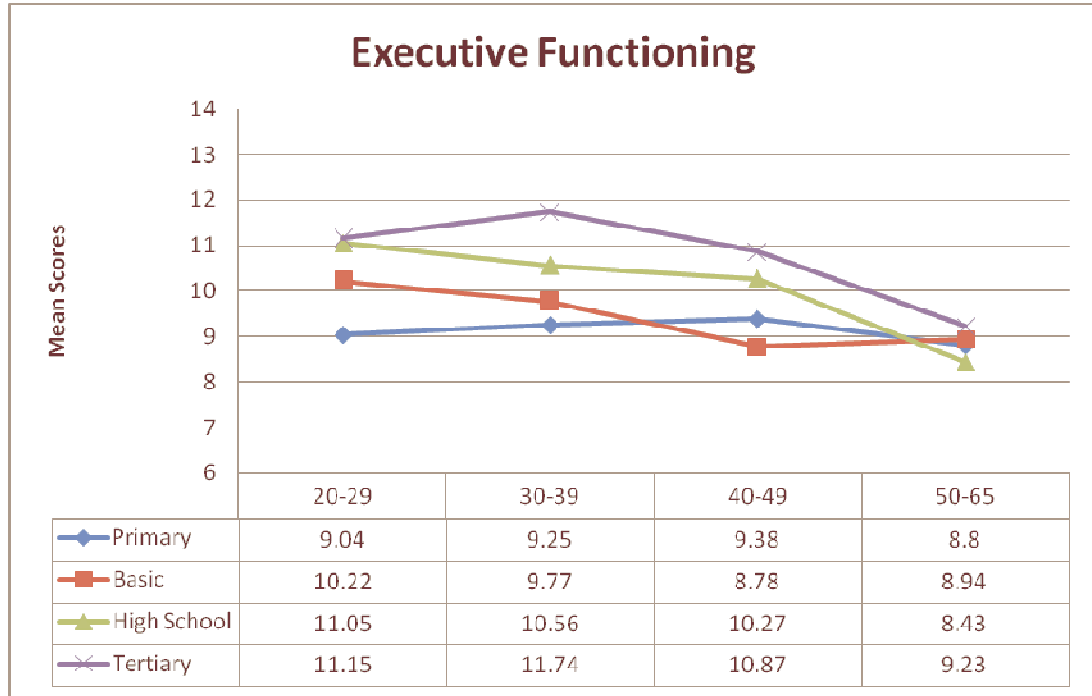
In the fluency domain the 30 – 39 years age group with primary education recorded the lowest scores. All other groups showed a trend of increased scores with higher education and reduced scores with increased age. In this domain, the effect of schooling was significant with the tertiary education group obtaining the highest scores. A statistically significant interaction was observed in this domain as reported in the MANOVA.

Figure 7 – Mean Scores in the Speed of Information Processing Domain According to Age and Schooling



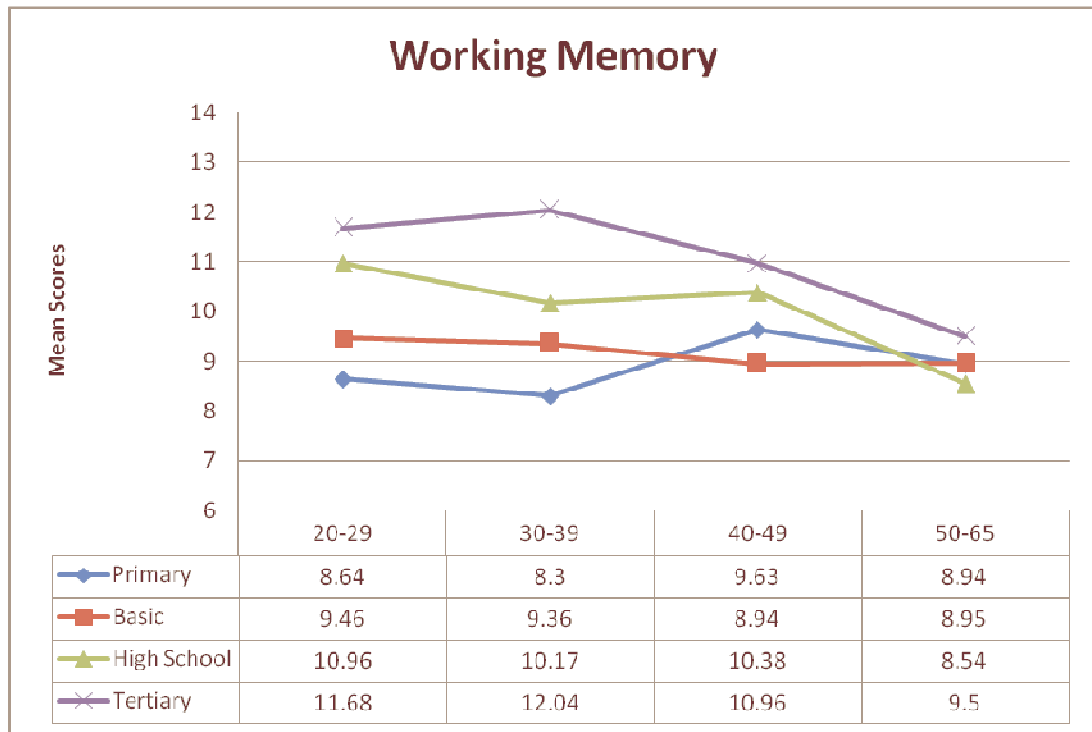
In the Speed of Information processing domain, there was a significant effect of age and education with reduced scores with increasing age and increased scores with increasing education. However, the 40-49 yrs age group with basic education recorded lower scores than their colleagues with primary education.

Figure 8 – Mean Scores in the Executive Functioning Domain According to Age and Schooling



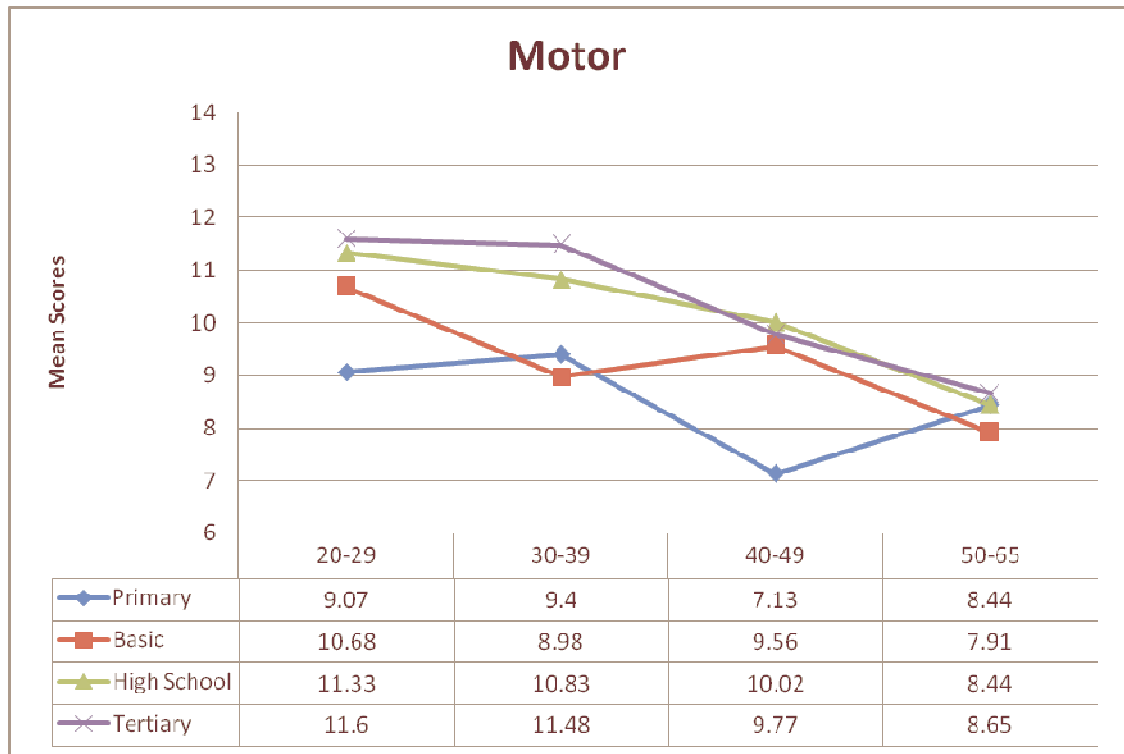
In the executive functioning domain, there was an observed effect of schooling, the age effect was not clearly observed. In the 50-65 years age group, the primary and basic education group had scores better than the high school education group, but the tertiary education group still maintained the highest scores even in this age group.

Figure 9 – Mean Scores in the Verbal Episodic Domain According to Age and Schooling



In the working memory domain, there was an effect of age observed with scores getting lower with increasing education. The schooling effect could also somewhat be observed with the tertiary group also performed significantly better than the other educational groups. In the 40-49 years age group however, the primary age group performed better than the basic education group.

Figure 10 – Mean Scores in the Motor Domain According to Age and Schooling



In the motor dexterity domain, the effect of schooling was not clear with different education groups varying in their performance. The effect of age was observed with scores generally declining with an increase in age especially in the high school and tertiary groups. The basic and primary education groups did not have a clear decline as a result of age.

Table 7 - Multivariate Analysis of Variance – MANOVA

Domain									
	Education			Age			Education *Age		
	<i>F</i>	<i>p</i>	η^2	<i>F</i>	<i>p</i>	η^2	<i>F</i>	<i>p</i>	η^2
Visual	2.97	.032	.028	17.43	.0001	.145	.522	.859	.015
Verbal	8.05	.0001	.073	7.41	.005	.041	1.56	.126	.044
Fluency	29.7	.0001	.224	4.36	.006	.040	1.92	.049	.053
SIP	16.79	.0001	.141	20.12	.0001	.164	.902	.524	.026
Executive Functioning	7.70	.0001	.070	9.72	.0001	.086	1.52	.138	.043
Working Memory	7.19	.0001	.065	7.41	.0001	.067	1.02	.427	.029
Motor	9.67	.0001	.086	3.82	.010	.036	1.53	1.37	.043

Note: *F* = F ratio; *p*= significance level - $p < .05$; η^2 = Effect Size; Key: Visual – Visual Episodic Memory, Verbal- Verbal Episodic Memory, Fluency – Verbal Fluency, SIP – Speed of Information Processing, Motor – Motor Dexterity

A multivariate analysis of variance shown in table 7 was done to find out the influence of age and years of schooling on the different domains. The results showed that both age and education seemed to have an effect on the different neuropsychological domains and all were significant at $p < .05$. However, high *F* ratios were only observed in two domains for both the age and years of schooling variable. In the years of schooling variable the highest *F* ratios were observed in the Fluency and Speed of Information Processing Domains with $F = 29.70$ and 16.79 respectively.

In the age variable the highest F ratios were observed like expected in the third hypothesis in Speed of Information Processing Domain and Executive functioning and all were significant at $p < 0.05$ with the exception of Motor dexterity. However, age also had an effect on the Visual Episodic Memory domain accounting for 20.12 and 17.43 an effect which was not previously hypothesised.

It was also observed that years of schooling did not give protection against age related as stated in the fourth hypothesis with the exception of the verbal fluency domain ($F(9,308) = 1.92, p < .049, \text{partial } \eta^2 = .052$). Figure six shows the mean scores obtained in this domain clearly indicating the interaction between schooling and age. In order to correct for error as a result of multiple analyses the Bonferroni adjustment was used in the analysis.

CHAPTER FIVE

5. DISCUSSION

The aim of this research was to find out the influence of age and education on neuropsychological test performance with the use of the Zambia Achievement Test Reading Comprehension subtest as a measure of educational attainment. The primary focus of the research was to determine which variable serves as a better predictor of performance on the Zambia Neurobehavioural Test battery as well as the influence of age on performance on the neurobehavioral test battery.

The first hypothesis stated that reading ability would be a better predictor of performance on neuropsychological tests than age and reported years of schooling. The hypothesis was supported by the results obtained. In the hierarchical regression carried out it was observed that both age and reported years of schooling served as predictors of performance on neuropsychological tests. However, over and above this reading ability as measured by the ZAT reading recognition subtest accounted for a higher variance than the previous two variables.

The importance of using reading ability as a measure of educational attainment and as a predictor of performance on neuropsychological tests has over the years been highly supported as already cited in the literature (Manly, et al, 2003; Wilkinson, 1993; Baird, et al, 2007; Byrd et al, 2005 and Manly et al, 2002). It establishes that although age and schooling are both important in obtaining more sensitive and specific results on neuropsychological tests, reading ability adds more predictive power as it takes into account extraneous variables that are not reflected in the other variables especially reported years of schooling in this case. The results also showed that reading ability had consistent predictive power on almost all domains with the exception of motor ability in which reading ability was not a significant predictor of performance.

Using reading ability as a measure of educational attainment may not only give an indication of levels of performance but is more likely to give better diagnosis in conditions such as HIV related Dementia as reported by Rohit et al, (2007) and

Ryan et al (2005) who argue that using test results corrected for reading ability will increase the specificity and sensitivity of the tests and reduce levels of reported impairment. In cases where only reported years of schooling was used as a measure of educational attainment, results tended to inflate the levels of impairment resulting in wide variations among individuals of different backgrounds. With the understanding that HIV is a growing epidemic in Zambia, a sensitive and specific method of diagnosis would be needed. Although the participants in the study were HIV negative these results will serve as a guide in the diagnosis of HIV related dementia.

In the second hypothesis, it was hypothesised that reading level would have more effect on verbal tests such as the Hopkins Verbal Learning Test – Revised, the COWAT – FAS, Category Fluency test and the Stroop Word test. The hypothesis was confirmed with the results indicating that reading ability was significant and accounted for more beta weight than reported years of schooling in the Verbal Episodic Memory. The results obtained in this analysis as indicated in Table 2 showed that tests affected the most by reading ability were in the fluency domain which include the COWAT –FAS (animals and actions) and the Stroop word. These showed an R^2 of 39.8% with reading ability on its own accounting for a beta weight of 0.352, higher than both age with -.153 and reported years of schooling with .345. However, it is important to note that reported years of schooling also accounted for additional variance over and above reading. Comparing models 1 and 2 we see that when the last predictor entered in Step 3 is reading level indexed by the ZAT score an additional 7% of the variance is accounted for, whereas when the last predictor entered is years of schooling an additional 6% is accounted for. This suggests that both variables make an equally important contribution to scores in the neuropsychology test battery.

These results add to other research which show that the ability to read affects how individuals perform on neuropsychological tests (Manly et al, 2002; Cox, et al 1997). In their work, it is said that the ability to read would affect their ability to produce words automatically and have the phonological ability to perform well on an automatic reading test such as the Stroop Word.

Previous research has equally established how education has an effect on performance on verbal tests (Ryan et al, 2000; Reitan & Wolfson, 1996). The results obtained in this study are in support of this but it is important to further correct test results based on reading ability as this takes into account other factors such as automatic reading and phonetic ability which is not specifically indexed by reported years of schooling. Also, considering that English is not a native language for most people in Zambia, and the tests in the Zambia Neurobehavioural Battery are in English, the correction for reading ability would give a more specific result as it takes into account the English phonological ability which may be a confounding factor in the results.

The third hypothesis looked at the influence of age on the different domains of the neuropsychological tests. The results showed that age had a negative effect on all the neuropsychological test domains. It also appeared to have a high effect on tests of Visual Episodic Memory, Speed of Information processing and executive functioning.

Age appeared to have a high effect on tests of Visual Episodic Memory, Speed of Information processing and executive functioning. Regression analysis on these tests revealed that age affected the Speed of Information processing domain recording the highest beta weight of $-.420$, followed by the Visual episodic Memory domain with a beta weight of $-.390$ and executive functioning accounting for $-.320$ of the beta weight in this domain. The reading ability and schooling variables seemed to account for less predictive power in this analysis, with reported years of education emerging as an insignificant predictor in the Visual Episodic Domain. In the executive functioning domain all three domains showed significant predictive power with a P value of $<.05$. Reading level accounted for more beta weight than reported years of schooling with $.204$ and $.175$ beta weight respectively.

In the Verbal Episodic Memory domain age had a beta weight of $-.272$ which was followed by reading ability with $.203$ and reported years of schooling accounting for $.153$ of the beta weight. In the last domain which is the Motor domain, age accounted for $-.300$, with reported years of schooling having a beta weight of $.270$ and reading ability reporting a beta weight of $.025$. Age and reported years of

schooling both reported were significant predictors of performance while reading ability was insignificant.

Individuals of different age performed differently on different tests as shown by the results obtained. Studies over the years have shown these variations and the importance of correcting for age cannot be overlooked. Hestad et al, (1998) note that as a person grows older the brain functions less well than when a person is younger. This trend has been particularly noted in the three domains stated above as they have reported the highest variance as compared to the other domains. The results are also in line with previous research which stated that Speed of Information processing is one of the first to decline among individuals (Salthouse, 1991 (cited by Hestad et al, 1998). Partial correlations obtained have also shown a similar pattern with highest r scores being obtained in the Speed of Information Processing $r=-.46.5$, with Visual Episodic Memory $r=-.40$, then Executive Functioning and Motor Dexterity both accounting for $r=-.313$. The negative correlations reflect a decline in performance with increase in age, considering that the sample consisted of a normal sample, this decline then cannot be attributed to other diseases such as dementia but simply age-related decline. It also demonstrates that the process of cognitive decline takes a different pattern in the different domains with some being affected more than others.

The final hypothesis looked at whether schooling would offer protection against age related decline. In this analysis, Multivariate Analysis of Variance was used to assess the proportion of variance accounted for by differences between age and educational groups, the MANOVA also yielded F ratios, significant levels and effect size per domain for age, schooling and the interaction of schooling with age.

In considering the influence of age and schooling on the different neuropsychological tests, it was observed that there was an increase in performance in all the groups as they advanced in their schooling but there was also a reduced performance with an increase in age. This result was not unexpected as has been highlighted in previous research (Capitani, et al, 1996; Ardilla, et al, 2000; Reitan & Wolfson, 1995; Reitan & Wolfson 1996; Gomez-Perez & Ostrosky-Solis, 2006, Mungas, et al, 2009 & Welsh-Bohmer, et al, 2009)

where there was a reduction in test performance with advancing age. It is particularly noted that the tests most sensitive to age include Speed of Information processing, executive functioning, working memory and Visual Episodic Memory which is consistent with the findings in this study.

In observing the protective factor that schooling might offer the aging group, a trend was observed in which there was an age related decline in some cases. However, in five out of all seven domains it was observed that the group with primary education in the 40 – 49 years age group did better than their colleagues of the same age group but with basic education. The domains in which this trend was observed were the Visual Episodic Domain, Fluency, Speed of Information Processing, Executive Functioning and Working Memory.

In certain cases however, it was observed that the 30 to 39 years age group performed better than the 20 to 29 years age group. Amongst the primary education group, it was observed in the Visual Episodic domain, Executive Functioning and Motor domains; in the Basic education group it was the Verbal and Fluency domains. The High School group only showed this trend in the Fluency Domain. In the tertiary education group, a similar trend was observed in the Fluency, Verbal Episodic Memory, Executive Functioning and Working Memory domains.

This reveals phenomena which appear different from what has been documented in previous research where low scores are expected in the lower education strata (primary education) and can be attributed to lower cognitive stimulation (Ardila et al, 2000). However, other literature attributes this trend to a secular change effect or the concept of sharing educational experiences and therefore, the differences may not only be attributed to age and education but may be affected by another confounding factor (Baltes & Schaie, 1974; Shaie, 1994; Shaie & Baltes, 1977 see Ardila et al, 2000). This factor may, in the case of Zambia, be attributed to a reduction in the quality of education being received. In the case of the first results where the primary age group in the 40-49 years performed better than the basic education group; it may be argued that the primary education group may have received quality of education that was better or equal to what their colleagues with basic education were receiving. The Ministry of Education in Zambia has

also recorded a reduction in the quality of education received in the last few years (MoE, 2008); this trend was however, only noticed in certain domains and a conclusive factor of a secular change may not be the only factor influencing this change. The differences in performances in the different educational groups may be attributed to a problem in the sampling process.

The effects of schooling were observed more in the Verbal Fluency Domain ($F(3,308) = 29.70, p = .0001, \eta = .224$) and the Speed of Information Processing Domain ($F(3,308) = 16.79, p = .0001, \eta = .141$). These results were not unexpected as individuals with more schooling have been known to be more stimulated in cognitive tasks that involve speed. Also spontaneous response is also a factor that may be attributed to educational stimulation (Ardila, et al, 2000). In this study, all the tests were administered in English and although it is the official language in Zambia, it is not usually used in the home but rather in schools and the work place. The verbal fluency domain contains test items that require the production of English words; therefore it is understandable that a high educational effect was observed in this domain by individuals who more frequently use English either at work or at school. When considering the effect of education on the Speed of Information Processing Domain, it may be argued that this is a concept of a Western educational system which encourages doing things quickly which is a cultural value that is stressed in urban western cultures rather than a traditional Zambian concept (Serpell, 1977; Wober, 1974). Therefore, it is not surprising that schooling effects are observed in the Speed of Information Domain.

Age effects were observed more in the Speed of Information Processing domain with ($F(3,308) = 20.12, p = .0001, \eta = .164$) and the Visual Episodic Domain ($F(3,308) = 17.43, p = .0001, \eta = .145$). The results are as expected as they reflect domains that normally are affected by age related decline as outlined earlier. The Visual Episodic Domain may mainly be due to low memory functioning as well as poor eyesight as a result of age related decline. Considering that the brain functions less in older age, it is also not surprising that age effects are seen in the Speed of Information Processing domain. It is expected that with an increase in age there is a reduction in the speed at which activities are carried out. Another

explanation for this trend is that most of the people in the later ages may not be engaged in cognitively stimulating tasks as they may have been retrenched or retired from their jobs. Ardila, et al (2000) argue that high scores may be obtained at earlier ages because they are more stimulated to learn and generally have a high cognitive functioning system.

The above findings create a good base on which the age and educational variables may be corrected on the various neuropsychological tests. They also give an indication of what to expect when carrying out neuropsychological assessments among individuals of different ages and educational groups. However, one of the limitations of this study was the limited sample size which would make it difficult for the findings to be generalised to the rest of the *Zambian* population.

CHAPTER SIX

6. SUMMARY, CONCLUSIONS, RECOMMENDATIONS AND SUGGESTIONS FOR FURTHER RESEARCH

6.1. Summary

This study aimed at finding out the influence of age and education on the performance on the Zambia Neurobehavioural Test Battery using the Zambia Achievement Test (ZAT) as a measure of educational attainment. Participants in the research were Zambian adults, drawn from both the rural and urban areas of the country. Educational attainment was indexed by reported years of schooling as well as scores obtained on the ZAT reading recognition subtest. These were then analysed in relation to performance on the various neuropsychological domains. Multiple Regression analysis, Partial Correlation Analysis as well as Multivariate Analysis of Variance were used to analyse these effects.

6.2. Conclusion

Based on the discussion of the results, several conclusions were arrived at from this study. Firstly, the study proved that reading ability is a better predictor of performance on neuropsychological tests than reported years of schooling. The Zambia Achievement Test (ZAT) reading recognition subtests proved to account for more variance than age and reported years of schooling making it a better predictor of performance on neuropsychological tests. It has been shown that even though reported years of schooling does have an influence on the performance on neuropsychological tests, reading ability gives a better prediction and would thus increase the specificity and sensitivity of the results especially in terms of diagnosis of pathology. It has also been shown that the ZAT which was originally a children's test can be used with adults and still produce valid results. The Zambia achievement test in this research proved to be a better predictor of reading ability than the widely used Wide Range Achievement Test (WRAT -4). The WRAT – 4 when used in the analysis added very little predictive power which was not significant, to performance on the Zambia Neurobehavioural Test Battery.

Secondly it was observed that reading level does have an influence on tests in the Verbal Fluency domain. It was observed that the reading which was done in English had an effect on the how individuals performed in the fluency domain. It can be concluded then that an individual's ability to read will affect how well he/she will perform on tests that assess his/her language fluency which in this case is in the English language. This further, emphasizes the importance of correcting test performance based on reading level rather the traditional way of correcting test performance based on reported years of schooling.

The two findings are consistent with recent studies that have sought to find a better method of getting accurate results in the field of neuropsychology. It has been argued that reading level gives more accurate results than just relying on reported years of schooling that may not take into consideration other factors such as teacher-pupil ratio, inadequate facilities such as desks and books, historical experiences and others (Manly, et al, 2003; Wilkinson, 1993; Baird, et al, 2007; Byrd et al, 2005 and Manly et al, 2002).

Thirdly it was observed that age had a negative correlation with performance on the tests. As an individual's age increases, his/her performance on neuropsychological tests reduces. These results show the need to correct for age. A failure to do this would result in diagnosing older people as impaired without taking into account age related decline. It also offers a guide on which tests would be sensitive and would be used to easily diagnose conditions such as dementia. In cases where a neuropsychologist may not want to use the whole battery, he/she would be able to select tests that they know would easily detect the disease rather than using all 14 tests on the battery which may be stressful for the participant.

Finally, this study showed the effects that age and schooling had on the different neuropsychological test domains. It showed the tests that would be most affected by educational attainment as well as age. Even though it has been stated that reading ability is a better predictor of performance on these tests, the concept of education cannot be overlooked as it offers an opportunity for individuals not only to learn how to read and write but also to engage in other cognitive tasks that enable them to perform well on neuropsychological tests.

6.3. Recommendations

Based on the findings stated above, the following recommendations are proposed to help in the practice of neuropsychology in Zambia.

1. All test scores must be corrected for age, education and reading ability, this will help in getting scores that clearly reflect the level of neuropsychological functioning of the individual relative to the appropriate norms.
2. The instructional booklet needs to be edited to include words that are more familiar to most of the Zambian population as this will allow for easier understanding.
3. Extra instruments or questionnaires should be administered preferably on a separate day from the one being used for testing. This will reduce the amount of time spent on one client thus reducing fatigue experienced by the clients.
4. Testing rooms must be set up that are free from distracting noise and activity.

6.4. Challenges Faced During Data Collection

There were several challenges that were faced during the process of data collection, however, only the major ones will be highlighted

1. In certain instances, a participant with low levels of education for example would require almost five hours before the whole process could be completed. This led to clients experiencing a lot of fatigue which may have affected their performance on the tests.
2. Another challenge was that of comprehension of the instructions as well as the questionnaires. Some of the clients even though they met the requirements for fluency in the English language, experienced difficulty understanding some of the words on the questionnaires as well as some of the instructions to carry out the test.

3. Another challenge that was faced was of testing rooms in the different clinics that were sampled. There were limited rooms available for the testing process and some of those which were available were not suitable for carrying out neuropsychological testing as there would be noises and disturbances in some of the rooms. In some though rare cases, the researchers resorted to carrying out the testing process outside and this may affect the validity of some of the test results.
4. The instructional booklet mostly contains American English which is not normally used in the Zambian setting. This made the understanding of the instructions difficult even for people who had high educational levels as they contained some unfamiliar words.
5. The additional questionnaires and material to be administered apart from the test battery made the administration take very long, lasting four to five hours for each client. This caused fatigue amongst the clients and may have affected performance on certain tests particularly those at the end.

6.5. Suggestions For Further Research

This study is the first to be carried out in Zambia with a sample collected from selected parts of the country. Therefore, it would help if the same study could be replicated to more parts of the country and with a larger sample. This would increase the confidence with which findings can be generalised to all people of Zambia.

In this study, the Zambia Achievement Test was used for the first time with an adult sample. It would be valuable to collect standardisation information based on an adult sample and to publish a practical guide on how to administer the test to adults as well as scoring and interpretation of scores on the test.

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APPENDICES

Appendix A – Ministry of Health Approval Letter

All Correspondence should be addressed to the
Permanent Secretary
Telephone: +260 211 253040.5
Fax : +260 211 253344


REPUBLIC OF ZAMBIA
MINISTRY OF HEALTH

In reply please quote:
No.....

NDEKE HOUSE
P. O. BOX 30205
LUSAKA

13th May 2010

School of Medicine,
Department of Pediatrics and Child Health
P.O Box 50110,
Lusaka

Dear Prof. MPS Ngoma,

Re: Request for Authority for Dissertation Proposals in respect of nine Neuro-Psychology Students


The Ministry of Health is in receipt of your request on behalf of Neuro-Psychology Students to conduct research in the following areas:

1. Neuro-cognitive functioning in Hypertension; Measured in battery – A Pilot Study.
2. The Relationship between Literacy and Neuropsychology Test Performance among Adults in Zambia
3. The Relationship Between individual's Number of Languages Spoken and Performance on the Clinical Neuropsychological Test Battery
4. Influence of Education and age in Performance on the Zambia Neurobehavioral Test Battery with the Zambia Achievement Test as a Measure of Educational Attainment.
5. Social Economic Status and Neuropsychological Assessment in Zambia
6. Cultural Influence on Neuropsychological Test in Zambia
7. Effect of Quality of Education on Neuropsychological Tests performance Among Zambian Adults
8. The Relationship between Moderate Alcohol Consumption and Cognitive function
9. Performance of Urban and Rural Adults in Neuropsychological Tests in Zambia

I wish to inform you that following submission of your research proposals and subsequent communication to my Ministry, our review of the same and in view of the ethical clearance, my Ministry has granted you authority to carry out the studies on condition that:

1. The relevant Provincial and District Directors of Health where the study is being conducted are fully appraised
2. Progress updates are provided to MOH quarterly from the date of commencement of the study.
3. The final study report is cleared by the MoH before any publication or dissemination within or outside the country.

Yours sincerely,


Dr. Peter Mwaba
Permanent Secretary

Appendix B – Biomedical Research Ethics Committee Approval Letter



THE UNIVERSITY OF ZAMBIA

BIOMEDICAL RESEARCH ETHICS COMMITTEE

Telephone: 260-1-256067
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Ridgeway Campus
P.O. Box 50110
Lusaka, Zambia

Assurance No. FWA00000338
IRB00001131 of IORG0000774

16 April, 2010
Ref.: 010-04-10

Ms Lisa Kalungwana
Department of Physiological Sciences
School of Medicine
University of Zambia
LUSAKA

Dear Ms Kalungwana,

RE: SUBMITTED RESEARCH PROPOSAL: "INFLUENCE OF EDUCATION AND AGE IN PERFORMANCE ON THE ZAMBIA NEUROBEHAVIORAL TEST BATTERY WITH THE ZAMBIA ACHIEVEMENT TEST AS A MEASURE OF EDUCATIONAL ATTAINMENT"

The above-mentioned research proposal was presented to the Biomedical Research Ethics Committee on 9 February, 2010 where changes/clarifications were recommended. We would like to acknowledge receipt of the corrected version with clarifications. The proposal is now approved.

CONDITIONS:

- This approval is based strictly on your submitted proposal. Should there be need for you to modify or change the study design or methodology, you will need to seek clearance from the Research Ethics Committee.
- If you have need for further clarification please consult this office. Please note that it is mandatory that you submit a detailed progress report of your study to this Committee every six months and a final copy of your report at the end of the study.
- Any serious adverse events must be reported at once to this Committee.
- Please note that when your approval expires you may need to request for renewal. The request should be accompanied by a Progress Report (Progress Report Forms can be obtained from the Secretariat).
- **Ensure that a final copy of the results is submitted to this Committee.**

Yours sincerely,

Dr James Muntali
A/CHAIRPERSON

Date of approval: 16 April, 2010

Date of expiry: 15 April, 2011

Appendix C – Informed Consent Form

Informed Consent Form

Informed Consent for Participants

University of Zambia

Department of Psychiatry

PLEASE READ THIS DOCUMENT CAREFULLY. SIGN YOUR NAME BELOW ONLY IF YOU AGREE TO PARTICIPATE AND YOU FULLY UNDERSTAND YOUR RIGHTS. YOUR SIGNATURE IS REQUIRED FOR PARTICIPATION. FOR THIS PROJECT, YOU MUST BE 20 YEARS OF AGE AND ABOVE TO PARTICIPATE. IF YOU DESIRE A COPY OF THIS CONSENT FORM, YOU MAY REQUEST ONE AND WE WILL PROVIDE IT.

Description of the Study:

You are being invited to take part in this study Standardisation of Neuropsychological Tests in Zambia. You will be required to answer questionnaires and take a group of tests of attention, language, motor functions and memory. The tests will involve answering questions and doing certain activities.

Time Involvement

The whole process will take approximately 2:30 to 3:00 hours to complete.

Risks and Benefits:

- You may experience fatigue due to the length of time required for the testing process. To reduce on this you are free to ask for a short break whenever you require it.
- We cannot guarantee that you will receive any direct benefits from this study though you will have an opportunity to contribute to neuropsychological assessments that will help Zambians in general by participating in this study.

Compensation for Your Time: You will be compensated for your time with a transport and meal allowance of K50, 000.

Participation Rights:

- Participation in this study is purely voluntary so that if you decide to withdraw at any point, there will be no consequences to you.
- All personal identifying information will be kept confidential and the data sheets will be kept in secured lockers in accordance with the standards of the University of Zambia Biomedical Ethics Committee. If the results of this study are required for publication as we hope, your identity will still be kept private.

Signatures

I,.....(name) have read and understood the above information. As the participant in this project, my signature testifies that I understand the consent process and management of confidentiality as indicated above. I also understand that I can withdraw at any time.

Signature of Research Participants:.....Date.....

Name and Signature of Witness.....Date.....

Name and Signature of Researcher.....Date.....

Contacts

If you any further questions about this research please contact:

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Appendix D – Demographics Questionnaire



THE UNIVERSITY OF ZAMBIA
SCHOOL OF MEDICINE
DEPARTMENT OF PSYCHIATRY
P. O. Box 32379, Lusaka, Zambia

NEUROPSYCHOLOGY
DATA COLLECTION QUESTIONNAIRE

FOR OFFICIAL USE ONLY

Date:.....

Clinic/Centre:.....

Examiner:.....

Subject Study Number:.....

INSTRUCTIONS

- A. Please give/tick [✓] the appropriate answer to the question.
- B. All the information you will provide will be used for the purpose of this study only, therefore, provide genuine information and ensure that all questions are carefully answered.

AGE & GENDER

Q1. What is your age?

1.1. 20 – 35 []

1.2. 36 – 45 []

1.3. 46 – 55 []

1.4. 56 and above []

Q2. What is your gender?

2.1. Female []

2.2. Male []

EDUCATION

Q3. What is your highest attained level of education?

3.1. 5 – 7 years []

3.2. 8 – 9 years []

3.3. 10 – 12 yrs []

3.4. 13 years+ []

Q4. In general, what type of pre-tertiary school did you attend?

4.1. Primary []

4.1.1. Community school []

4.1.2. Private school []

4.1.3. Mission []

4.1.4. Public School []

4.2. Secondary []

4.2.1. Community school []

4.2.2. Private school []

4.2.3. Mission []

4.2.4. Public School []

Q5. At these levels of education, approximately how big were your classes?

5.1. Primary

5.1.1. Below 36 []

5.1.2. 36 to 50 []

5.1.3. More than 50 []

5.2. Secondary

5.2.1. Below 36 []

5.2.2. 36 to 50 []

5.2.3. More than 50 []

Q6. How many hours did you spend learning at school per day

6.1. Primary

6.1.1. Less than 4hrs []

6.1.2. 4hrs – 5hrs []

6.1.3. 6hrs and more []

6.2. Secondary

6.2.1. Less than 4hrs []

6.2.2. 4hrs – 5hrs []

6.2.3. 6hrs and more []

Q7. How many hours did you spend studying (in prep) at school per day

7.1. Primary

7.1.1. None []

7.1.2. 1hr []

7.1.3. 2hrs and more []

7.2. Secondary

7.2.1. None []

7.2.2. 1hr []

7.2.3. 2hrs and more []

Q8. With regards the sitting arrangement in your said classes, how adequate where they?

8.1. Primary

8.1.1. No desks []

8.1.2. Few []

8.1.3. Adequate []

8.2. Secondary

8.2.1. No desks []

8.2.2. Few []

8.2.3. Adequate []

Q9. How adequate were the reading materials in your classes?

9.1. Primary

9.1.1. Not available []

9.1.2. Few []

9.1.3. Adequate []

9.2. Secondary

9.2.1. Not available []

9.2.2. Few []

9.2.3. Adequate []

Q10. Did your school have the following:

10.1. Primary school library

10.1.1. Yes []

10.1.2. No []

10.2. Primary school laboratory

10.2.1. Yes []

10.2.2. No []

10.3. Secondary school library

10.3.1. Yes []

10.3.2. No []

10.4. Secondary school laboratory

10.4.1. Yes []

10.4.2. No []

Q11. What were the qualifications of most ($\geq 70\%$) of your teachers:

11.1. Primary

11.1.1. I do not know []

11.1.2. Primary teachers' Certificate []

11.1.3. Secondary teachers' diploma []

11.1.4. Bachelors degree []

11.2. Secondary

11.2.1. I do not know []

11.2.2. Primary teachers' Certificate []

11.2.3. Secondary teachers' diploma []

11.2.4. Bachelors degree []

11.2.5. Masters degree []

Q12. Has your education been helpful in your execution of daily activities?

12.1. Yes []

12.2. No []

Q13. In what four major ways would you say your education has been helpful? (please indicate)

13.1. []

13.2. []

13.3. []

13.4. []

Q14. How often would you say you read (any reading material)?

14.1. Not at all []

14.2. Sometimes (≤ 4 times in a 6 months) []

14.3. Often (at least once in a week) []

14.4. Very often (at least once in a day) []

Q15. If you read, what materials do you most often read?

15.1. Religious materials []

15.2. Political materials []

15.3. Work related materials []

15.4. Anything interesting []

15.5. Anything as the need arise []

Q16. With your currently attained education, are you considering furthering your studies?

16.1. Yes []

16.2. No []

EMPLOYMENT, INCOME, & RESIDENCE

Q17. What are you currently doing?

- 17.1. Unemployed []
- 17.2. Self-employed []
- 17.3. Employed []
- 17.4. Retired []

Q18. What is your occupation?

- 18.1. Unskilled (e. g maid, farm laborer, etc) []
- 18.2. Semi-skilled (e. g plumber, bus driver, etc) []
- 18.3. Skilled (e. g, accountant, physician, etc) []
- 18.4. Specialist (e. g consultant, economic analysts) []

Q19. What is your income per year?

- 19.1. Less than K30 million []
- 19.2. K30 million to less than K60 million []
- 19.3. K60 million to less than K120 million []
- 19.4. K120 million and above []

Q20. Where do you currently live?

- 20.1. Low cost rural area (e. g village) []
- 20.2. High cost rural area (e. g 'boma') []
- 20.3. Low cost urban area (e. g high density area) []
- 20.4. High cost urban area (e. g low density area) []

LANGUAGE & TECHNOLOGY

Q21. What is your mother tongue?

- 21.1. Bemba []
- 21.2. Chewa []
- 21.3. Tonga []
- 21.4. Lozi []
- 21.5. Other (please indicate)..... []

Q22. How much do you use your mother tongue in communicating?

- 22.1. Rarely (just know and use one or two words) []
- 22.2. Sometimes (few times at home) []
- 22.3. Often (in home conversations) []
- 22.4. Very often (in almost all my conversations) []

Q23. Which languages would you say you fluent in and ay what age did you acquired them? (Indicate ONLY 3 or less in the order of fluency)

- | | <u>Language</u> | <u>Age</u> |
|-------|-----------------|------------|
| 23.1. | | |
| 23.2. | | |
| 23.3. | | |

Q24. How much would you say you use the English language in communicating?

- 24.1. Rarely (just know and use one or two words) []
- 24.2. Sometimes (only in formal situations) []
- 24.3. Often (at least in one conversation in a week) []
- 24.4. Very often (in almost all my conversations) []

Q25. How often do you use computers?

- 25.1. Not at all []
- 25.2. Sometimes (less than 4 times in a year) []
- 25.3. Often (at least once in a month) []
- 25.4. Very often (at least once in a week) []

Thank you for your cooperation and contributions

WRAT4

BLUE WORD READING LIST

A	B	O	S	E	R	T	H	U	P	I	V	Z	J	Q	15
cat	in	book	tree	how	animal	hair									7
spell	even	size	finger	felt	laugh										13
straight	stretch	split	lame	bulk	knowledge										19
abuse	ceiling	diagram	doubt	collapse	gigantic										25
contemporary	contagious	exterior	horizon	triumph											30
alcove	tranquility	efficiency	inquisitive	bibliography											35
municipal	unanimous	discretionary	seismograph	benign											40
itinerary	heresy	usurp	stratagem	pseudonym											45
irascible	heinous	poignant	disingenuous	covetousness											50
omniscient	oligarchy	egregious	assuage	terpsichorean											55

Appendix E - ZAT – READING RECOGNITION TEST

1

Eat	Four
Good	She

2

Old	His
Fly	Round

3

Five	Green
Sing	Around

4

Warm	Fall
Start	Drink

5

Outside	Fishing
Town	Smile

6

Wagon	Houses
Meaning	Families

7

Question	Change
Joined	Brook

8

Instead	Blaze
Signs	Colt

9

Pleasant	Dangerous
Ledge	Escape

10

Northern	Towel
Kneel	Height

11

Exercise	Observe
Ruin	License

12

Uniforms	Pigeon
Moisture	Artificial

13

Issues	Quench
Hustle	Thigh

14

Guardian	Vein
Civilisation	Anchor

15

Composition	Elegant
Sympathy	Authorities

16

Utensil	Geometry
Condemn	Unparalleled

17

Reign	Adjourned
Limousine	Manoeuvres

18

Heroine	Statistics
Phenomenal	Vicinity

19

Judicial	Medieval
Rheumatism	Silhouette

20

Diminutive	Celestial
Navigable	Ecstasy

Appendix G – Zambia Neurobehavioural Test Battery