PERFORMANCE OF RURAL AND URBAN ADULT PARTICIPANTS ON NEUROPSYCHOLOGICAL TESTS IN ZAMBIA

BY

HAPPY ZULU

A dissertation submitted to the University of Zambia in partial fulfillment of the requirements for the award of the Master of Science in Clinical Neuropsychology

The University of Zambia

Lusaka

2011

DECLARATION

I, Happy Zulu, do declare that this dissertation is my own work and that it has never been submitted by anyone at this institution or any other university.

Signature…………………..

Date……………………….

NOTICE OF COPYRIGHT

CERTIFICATION OF APPROVAL

This dissertation by Happy Zulu has been approved as a partial fulfillment of the requirement for the award of the degree of Master of Science in Clinical Neuropsychology of the University of Zambia.

Signed…………………………Date……………………...

Signed…………………………Date……………………...

Signed…………………………Date……………………...

ABSTRACT

Neuropsychological examination is an important way of formally assessing brain function. While there is so much documentation about the influence that some factors such as age and education has on neuropsychological tests (NP), not so much has been done to assess the influence that residency (rural/urban) may have. The specific objectives of this study were to establish if there is a significant difference in mean test scores on NP tests between rural and urban participants, to assess which tests on the Zambia Neurobehavioural Test Battery (ZNTB) are more affected by the participants' residency (rural/urban) and to determine the extent to which education, gender and age predict test performance on NP tests for rural and urban participants. The participants (324) were drawn from both urban and rural areas of Zambia (Rural = 152 and Urban = 172). However, only 234 participants (Rural = 152 and Urban 82) were used for all the analyses in this particular study. The 234 participants were used as the actual proportion of the rural vs urban population in Zambia was 65% : 35%, respectively (CSO, 2003). The rural-urban ratio for the participants that were captured during the data collection process was 152 : 172, respectively. Thus, all the rural participants (152) were included and 90 of the 172 urban participants were randomly excluded so that the rural/urban ratio reached the desired 65% : 35 % which was the required ideal statistic for appropriate representation of the actual population in Zambia. Data on NP tests were analyzed from 234 participants, rural (N=152) reflecting 65% and urban (N=82) reflecting 35%. T-tests indicated that urban participants had superior performances in all the seven NP tests domains and all the mean differences in all these domains were found to be statistically significant. Residency had a large or moderate effect in five domains, while its effect size was small only in two of the domains. A standard multiple regression revealed that education, age and residency as predictor variables made a significant contribution to variance in performance on various domains of the ZNTB. However, gender of participants was not a major factor in determining one's performance on neuropsychological tests. This particular report is part of an ongoing larger cutting-edge study aimed at formulating the normative data for Zambia with regard to performance on neuropsychological tests. This is necessary for appropriate, effective and efficient assessment or diagnosis of various neurocognitive and neurobehavioural deficits that a number of people may currently be suffering from. It has been shown in this study that it is vital to make careful analyses of the variables that may be associated with one's performance on neuropsychological tests.

DEDICATION

I dedicate this dissertation to my parents, Mr. and Mrs. Zulu, for the love, support, guidance and encouragement they have given me throughout my education.

ACKNOWLEDGEMENTS

I would like to extend my heartfelt gratitude to my supervisors, Dr. M. Imasiku and Dr. R. Paul; and indeed, all my lecturers and mentors for the guidance through my master's degree course. I wish to thank the NORAD Master's Programme (NOMA) for the scholarship for me to pursue this degree. I would also like to thank sincerely my course mate and friend, Katongo Owen Kabanda and all my colleagues in the 2008-2010 Neuropsychology class for the support throughout the programme.

CONTENTS

LIST OF TABLES

LIST OF SYMBOLS

μ …………………………………………………………………………..micro sign

dl………………………decilitre – a unit of measuring liquids (there are 10 dl in a litre.

1…………………………………………………………………Residency (Rural)

2………………………………………………………………...Residency (Urban)

M…………………………………………………………………………………Mean

N……………………………………………………………Number of participants

SD………………………………………………………………Standard deviation

LIST OF ABBREVIATIONS /ACRONYMS

- AIDS…………………………………Acquired Immune Deficiency Syndrome
- ASQ……………………………………….Academic Skills Questionnaire
- BDI……………………………………….The Beck Depression Inventory
- CIDI…………………………...Composite International Diagnostic Interview
- CSO………………………………………………Central Statistical Office
- FrSBe………..………………………………Frontal Systems Behaviour Scale
- HIV….……………………………………..Human Immuno-deficiency Virus
- IQ……………………………………………………Intelligence Quotient
- NP……………………………………………………Neuropsychology(…cal)
- SES…………………………………………………….socio-economic status
- Sig………………………………………………………………….Significant
- SPSS…………………………………Statistical Package for Social Sciences
- SIP……………………………………………Speed of information processing
- UNZA………………………………………...The University of Zambia
- WAIS – R…………………………………Wechsler Adult Intelligence Scale
- yrs………………………………………………………………………years
- ZNTB………………………………..Zambia Neurobehavioural Test Battery

OPERATIONAL DEFINITIONS OF CONCEPTS

Urban…………. A geographical area constituting a city or town, peri-urban being places just outside towns and cities.

Rural…………… This is an area outside of cities and towns. Also referred to as "the country" or "the countryside," rural areas are usually large and isolated areas of a country, often with low populations.

Residency……………The state of living in a particular place (in this study, rural or urban).

Adult………….. 18 years and above

Acculturation…………………This is a process which occurs when two or more groups come into continuous first-hand contact with each other for an extended period of time" (Berry, 1989). "Level of acculturation has been defined as the degree to which an individual espouses the cultural values, beliefs and practices of a given ethnic group versus that of the dominant ethnic/cultural group (Landrine & Klonoff, 1995)."

Normative data……………Based on a mathematical principle of the bell-shaped curve; this approach considers the middle range 'normal' and both extremes deviant. Variability is described only within the context of groups, not within the context of the individual, Sadock and Sadock (2007).

Lingua franca………….. A shared language of communication used between people whose main languages are different.

PREFACE

Neuropsychology may be considered as a branch of neurology that overlaps with psychology and psychometric testing. It is mainly concerned with the brain's structure as it relates to, and with behavior that results from brain injury or disease. The importance of the rapidly growing new field known as clinical neuropsychology cannot be overemphasized. As stated by Kaplan and Saccuzzo (2001), the field of clinical neuropsychology is a scientific discipline that focuses on psychological impairments of the central nervous system and their remediation.

Appropriate normative context with regard to interpreting one's performance on neuropsychological tests, is very vital, lest the diagnosis and/or assessment be faulty, inefficient and ineffective. This outcome would even be more disastrous with regard to the necessary subsequent process of developing and carrying out interventions for those who suffer brain injuries/lesions or related problems. The conventional variables such as age, education and gender have usually been at play in formulating normative standards. The influence of residency (rural vs urban) may however not be overlooked because of the underlying variables such as education and acculturation that are usually associated with this single variable, especially in developing countries such as Zambia. This background has been the major rationale of carrying out this study. The study thus, brings out the comparative aspect of performance between rural participants and their urban counterparts on neuropsychological tests, as well as contributing significantly to the appropriate formulation and definition of a normative standard.

A detailed account of the background of the study, literature review and methodology, results and discussion, has been done in this dissertation. The analyses that were carried out have been illustrated by tables. Some symbols, abbreviations, acronyms and operational definitions given have also been provided.

Finally, it is my hope that this piece of work will go beyond just being a mere academic piece of writing. I hope that the finding in this study will contribute to the formulation of appropriate normative standard for this part of the world and therefore, enhance the so much needed application of the field of neuropsychology and become a source of reference for subsequent research in this field.

CHAPTER 1

1.0. INTRODUCTION

Neuropsychological examination is an important way of formally assessing brain-behaviour function. In most objective neuropsychological tests, quantitative results are compared with some normative standard, including data from groups of non brain-injured persons and groups of persons with various kinds of brain injury.

There are a number of factors that may affect how one performs on neuropsychological tests such as the ones adapted for the Zambian setting (the Zambia Neurobehavioral Test Battery). Some of these factors are age, level and quality of education, someone's health history, culture, socio-economic status (SES) and someone's life experience – whether he/she has lived most or all his/her life in a rural area or urban area. To this effect, Ardila (2006) observed that culture (values, beliefs, styles of behavior) can affect neuropsychological testing. This research will concentrate on assessing how the rural and urban participants of Zambia perform on neuropsychological tests. Another focus in this study will be to contribute to the formulation of normative data for Zambia. This allows for a person's performance to be compared to a suitable control group, and thus provide a fair assessment of their current cognitive functioning. This is important for successive researches and clinical work.

Silberberg and Katabira (2006) alluded to the fact that neurological disorders are increasingly prevalent in Sub-Saharan Africa, Zambia inclusive. This situation in Zambia, like many other countries in Africa with regard to these increasing neurological disorders presents the challenge of effective and efficient way of formally assessing, diagnosing and treating them. Employing the use of neuropsychological tests is thus very cardinal. The factors that are producing this increased burden include conditions such as malnutrition, adverse perinatal conditions, malaria and HIV & AIDS. Leading neurological disorders include cerebral palsy, mental retardation and other developmental disorders, epilepsy, peripheral neuropathy, stroke and increasingly, the central nervous system complications of HIV & AIDS, trauma and alcohol abuse. The disabling rather than fatal nature of many neurological disorders, the stigma associated with brain disorders, and the enormous difficulty in gathering epidemiologic data have resulted in their being underreported and neglected in Sub-Saharan Africa. Silberberg and Katabira (2006) further stated that although few epidemiological studies have been carried out in Sub-Saharan Africa, it is clear that some disorders of the nervous system are more prevalent in this region than elsewhere in the world.

1.1. Background

According to the CSO (2003), Zambia is one of the most urbanized countries in Sub-Saharan Africa with an urban population of 35% and the rural population of 65%. The total population is slightly over ten million people. This is according to the 2000 national and housing census. As a result of clear general demographic differences in variables such as SES, cultures, accessibility of education and health care facilities between rural and urban areas, this research is meant to compare these participants on the urban-rural dichotomy and make the normative data collected as representative as possible of the Zambian population.

Education, cultural, religious issues and beliefs are important in Sub-Saharan Africa. They influence the value placed by society on neurological health, the presentation of symptoms, illness behavior, access to services, pathways through care, the way individuals and families manage illness, the way the community responds to illness, the degree of acceptance and support - and stigma and discrimination - experienced by the person with neurological illness (Silberberg and Katabira, 2006). Because of this, it is important to consider differences between rural and urban areas with regard to cultural and other contextual factors in developing locally appropriate health care policies, programmes and services.

While all ethnic groups have the capacity to process information and to think, it has been found that different cultures, having different environmental influence, value particular skills (Ostrosky-Solis et al., 2004, Salvia & Ysseldyke, 1995), and cognitive abilities are shaped by the individual's exposure to and opportunities to play and refine his or her cognitive abilities. This was demonstrated in the comparison between white

English children in the United Kingdom and black Zambian children in Zambia, who were asked to complete clay models, pen-paper tasks and wire modeling tasks. The English and Zambian children achieved equally on the clay modeling task, a material accessible to both groups of children, while the English children performed better on pen-paper tasks and the Zambian children performed better on the wire modeling task (Neisser et al., 1995, Serpell, 1994). Thus, the type of materials available will determine the activities that are engaged in and consequently the types of skills developed (Miller-Jones, 1989). In these ways, the individual's life experiences will influence the type of knowledge that is acquired, and this knowledge, activities and learnt behaviors will solidify into what is known as crystallized knowledge (Kline, 2002).

1.2. Rationale

For effective, efficient and appropriate diagnosis, assessment and rehabilitation of patients with neurobehavioural deficits, a reference framework of what is considered 'normal' functioning or impaired functioning in a particular setting is needed. The use of other norms from other areas (countries) with very different demographic variables may be misleading and not very helpful with regard to assessment and rehabilitation, especially for clinical purposes (Strauss et al., 2006). This research therefore, will contribute to understanding the differences if any in how the rural participants perform on neuropsychological tests as compared to those who reside in urban areas.

Clinical neuropsychology is a new field in Zambia. This research therefore, has both theoretical and practical implications. It is hoped that the findings gathered in this study will contribute significantly to the body of knowledge in this field. The data collected will offer some insight on whether living in an urban area or a rural area in Zambia affects how one performs on neuropsychological tests. The contribution to the formulation of normative data for Zambia on neuropsychological tests performance is another important justification for carrying out this research. The information gathered will thus be of importance. The discrepancy between rural and urban adult participants as was discovered concerning performance on NP tests implies that utmost caution should eventually be taken when considering the evaluation and interpretation of their scores on these tests. This may imply that a score on neuropsychological tests may not necessarily indicate the actual neurocognitive impairment for someone who has lived all or most of his/her life in a rural location if the same standard is used as one who has lived most of his/her life in the urban location. If however, the findings in this research had indicated that there wasn't much discrepancy in performance on neuropsychological tests for rural and urban adult participants, the same standard would be used to evaluate how an individual's neurocognitive or neurobehavioural performance was for both rural and urban adult participants.

As more and more people leave villages and farms to live in cities, urbanization and urban growth results from this process. The rapid growth of cities like Lusaka can be attributed largely to people from rural communities migrating there. This kind of growth is especially commonplace in developing countries in general not only Zambia. With regard to the dynamics in populations and their associated variables in rural and urban areas, it is imperative that this research is carried out. This will reveal the discrepancy in the level of performance of participants between these two locations – rural and urban areas. As documented by Silberberg and Katabira (2006) that neurological disorders are increasingly prevalent in Sub-Saharan Africa, a response from the clinical neuropsychological perspective is important and ideal. Zambia is not spared from these adverse effects of neurobehavioral deficits. Some of these factors that are producing this increased burden include brain injuries, malnutrition, adverse perinatal conditions, malaria and HIV & AIDS. This research will eventually offer a basis for a guide for what could be considered impaired functioning with regard to the data that will be collected in both rural and urban areas of Zambia when the normative dataset is established.

1.3. Aim

This study was mainly aimed at examining the performance of rural and urban adult participants on neuropsychological tests in Zambia. The other aim was to contribute to formulation of the normative data for Zambia.

1.4. Objectives of the Study

1.4.1. General Objective

The overall objective of this study was to examine the test performance of rural and urban adult participants on the Zambia Neurobehavioural Test Battery.

1.4.2. Specific Objectives

The specific objectives were:

i. To establish if there is a significant difference in mean test scores on the neuropsychological tests between the rural and urban participants
ii. To assess which tests on the Zambia Neurobehavioural Test Battery are more affected by the participants' residency (rural/urban)
iii. To determine the extent to which education, gender and age predict test performance on neuropsychological tests for rural and urban participants.

1.5. Research Questions

i. Is there a significant difference in mean test scores on the neuropsychological tests between the rural and urban participants?
ii. Which tests on the Zambia Neurobehavioural Test Battery are more affected by the participants' residence?
iii. Do the participants' education, gender and age contribute to performance on neuropsychological tests for those in rural and urban areas?

1.6. Hypotheses

i. Urban participants will perform better than their rural counterparts on the neuropsychological tests.
ii. Verbal fluency tests in the Zambia Neurobehavioural Test Battery will be more affected by the participant's residence.
iii. The years of education and age will contribute to the participants' performance on the neuropsychological tests for both rural and urban participants, while gender will not.

CHAPTER 2

LITERATURE REVIEW

There is a considerable body of literature that concludes that rural students perform less well than urban students on standardized tests. As stated in (http://www.ncibi.nih.gov.pubmed), educational achievement is one instance as observed in the American Journal of Economic and Sociology (1999) in a research done in South Africa. One hypothesis for the existence of this condition is that expenditures on education do matter, and they are smaller in rural areas than in urban areas; the second involves the relationships between the values in use of particular inputs and the level of such achievement; and the third is that differences by location in attitudes of individuals, parents, and peers about education exist and result in the observed differences in educational achievement by location.

The process of neuropsychological assessment depends to a large extent on the reliability and validity of neuropsychological tests. Regardless of the origins of neuropsychological tests, their competent use in research or clinical practice demands a good working knowledge of tests standards and of the specific psychometric characteristics of each test used. The frequency distribution of many physical, biological and psychological attributes, as they occur across individuals in nature tend to conform, to a greater or lesser degree, to a bell-shaped curve or normal curve. The normal curve is the basis of many commonly used statistical and psychometric models and is the assumed distribution for many psychological variables, (Strauss, et al., 2006).

While previous studies have focused on the rural versus urban areas issue, this demarcation may be misleading. The fundamental issue explaining student educational achievement is not the rural versus urban areas issue, but the determination of variables within which differences explain the significant variation in student achievement in any area (http://www.ncibi.nih.gov.pubmed). In the same vein, significant discrepancy in performance on neuropsychological tests between rural and urban participants of Zambia are likely to be due to differences in accessibility to education, health care facilities and culture as underlying factors/variables, directly accounting for such discrepancy in performance on NP tests. For instance, participants from both rural and urban areas would be expected to perform similarly, if the associated values of explanatory variables (access to education, culture, etc) are similar, irrespective of location. The implication of this assertion in other words, is that the geographical location *per se*, has nothing to do with how these participants on the rural/urban perform, but rather the factors or variables as stated already, which directly influence how the rural and urban participants perform. If the distributions of values of explanatory variables such as culture, access to quality education and health differ by location, the demarcation therefore, simply substitutes for the difference in the distributions of such variables. Since education in particular has some influence on neuropsychological tests, it would be ideal to assess the effect that education and other variables such as SES and health care facilities has on performance on neuropsychological tests in both rural and urban areas. Difference in rehabilitation services between rural and urban is also observed, (http://www.ncibi.nih.gov.pubmed). The main variable in this case is the residency (rural/urban dichotomy) and the underlying variables or factors that directly affect performance on neuropsychological tests are the ones that have been mentioned such as education, access to health care facilities and culture.

It is well understood in the field of neuropsychology that interpreting an individual's cognitive test performance is problematic without the proper normative context. Beyond traditional considerations of age, education and in many cases, gender (Finlayson, Johnson & Reitan, 1977 in Gupta et al., 2011); (Heaton et al., 1996 in Gupta et al., 2011), as defining a normative standard against which a given neurocognitive performance may be interpreted, the influence of other demographic and personal factors, such as literacy (Dotson et al., 2008 in Gupta et al., 2011); (Manly et al., 1999; Manly et al., 2002 in Gupta et al., 2011) and ethnicity (Heaton, Taylor & Manly, 2003 in Gupta et al., 2011); (Heaton et al., 2004; Heaton et al., 2009 in Gupta et al., 2011), have begun to be appreciated. Although the inclusion of the latter in normative projects has been the subject of some debate (Brandt, 2007; Manly, 2005 in Gupta et al., 2011), the variance in normal NP tests performance accounted for by these factors makes a strong case for inclusion. Gupta et al., (2011) further stated that, the goal ultimately of including appropriate normative corrections for a test is to obtain an optimal estimate of expected performance in the absence of any acquired brain dysfunction, in order to maximize precision in classifying disease-related NP impairment or its absence.

Estimating normal performance of individuals in developing countries / Least Developed Countries (LDCs) on NP tests is further complicated, where a variety of background factors beyond those mentioned above may have substantial influences on test performance (e.g. linguistic background, exceptionally low socioeconomic status [SES] and associated quality of formal and informal educational opportunities, nutrition in the early years of life and after, and access to modern health care). Especially in developing areas of the world, these latter factors tend to be strongly related to whether people were born and grew up in rural versus urban areas (Singh, 2009; Snow et al., 1994; Vegas, 2007; Zeck & McIntyre, 2008) in Gupta et al., (2011). Therefore, it seems likely that, particularly in developing nations, urban versus rural upbringing could bring to bear several factors that differentially influence neurocognitive performance Gupta et al., (2011).

Nguyen et al., (2008) in Gupta et al., (2011) also found that in a multi-site sample from across Latin America and the Caribbean, childhoods spent in rural environments were associated with increased rates of cognitive impairment in later life. They acknowledged though that it is unclear whether these associations are primarily due to the confounds of limited educational opportunities, the vagaries of rural life (e.g. lack of access to optimal nutrition, medical care or health education), or directly due to the lack of cognitive stimulation characterized by farm work, or even the neurocognitive effects of exposure to pesticides and other toxic agricultural chemicals, which are more commonly used in the developing world (Dartigues et al., 1992) in Gupta et al., (2011). SES for instance, which tends to covary with rural and urban backgrounds, has also been shown to be associated with cognitive outcomes. For example, Singh-Manoux et al. (2005) in Gupta et al., (2011) modeled the relations among childhood SES, education, adulthood SES and cognition in middle age, and found that the effects of education and adult SES (including occupation) were the strongest predictors of adult cognition. Clearly, this implies the importance of a number of factors throughout the life course that either directly or indirectly affects adult cognition.

At present, there is no normative data for reference for the Zambian population with regard to how they perform on neuropsychological tests. For example, a recent study done by Mulenga, Ahonen and Aro (2001) entitled ‘Performance of Zambian children on the NEPSY: A pilot study,’ was referenced to the US norms for children and it only included children from urban areas of Zambia. In this study, forty-five literate schoolchildren aged 9 (N = 25) and 11 (N = 20) from urban Zambia were given core and expanded tests on the NEPSY and their performance was scored according to age-equivalent norms for U.S. children. This study indicates that in urban, literate Zambian children, the NEPSY is relatively insensitive to language and cultural influences that often compromise the applicability of Western tests in the developing world. No consistent improvement in the standard scores was found as a function of educational experience. Comparison against the U.S. normative average revealed that both age groups were poorer in the domains of language and attention and executive functions, whereas their performance was better in the visuospatial processing domain. It is concluded that the NEPSY in its present form may be clinically useful, but its results should still be treated with caution, taking into account cultural, language, and personal demographic information. From this study, they acknowledged however that, more studies, with divergent and larger samples of varying age ranges are required. They also stated that it seems that the NEPSY could serve as the initial step in the development of neuropsychological practices in Zambia. This study will thus contribute to providing more insight in the nature of performance on neuropsychological tests for both rural and urban adult populations in Zambia. This will be imperative for other follow up researches and for clinical purposes in fields such as neuropsychology.

One of the main considerations in the process of formulation of normative data is whether a broadly representative sample is selected or whether a more specific subgroup is more appropriate, such as one defined by specific gender, education, ethnicity socioeconomic status (SES), geographic location and other variables. It is imperative therefore that this process of formulation of normative data in Zambia include information on where this data were collected. This is because of regional variations in demographic factors that can affect test scores such as education, SES, education and access of health care facilities. As stated by Strauss, et al, (2006:52), “In most cases, both rural and urban individuals are represented in order to represent regional variations in test performance. However, not all tests include this additional stratification variable.” Strauss, et al, (2006) pointed out that these differences occur on two levels, i.e. content differences due to different exposure or culturally specific responses to individual items and ability responses related to socio-economic or other socio-demographic variables.

The idea that each culture affects what is learnt and consequently performance on cognitive tests was one reason that the Black Intelligence Test of Cultural Homogeneity (BITCH) was developed (Sattler, 1992) as cited in Gaylard (2005). It assesses knowledge of inner city black slang in the USA. Although it is culture-specific, it was found to have limited validity across the USA and could not predict future academic success as well as the Wechsler tests. The author further stated that pragmatically, it would appear that developing such culture specific tests is an unrealistic ideal and not a feasible solution to the need for assessment in a multi-cultural world, where the current milieu of globalization results in rapid integration and convergence between individuals from different ethnic groups. Furthermore, from a neuropsychological perspective, assessment tests such as the WAIS-III can provide useful diagnostic information that can inform intervention and facilitate compensation (Claassen, et al., 2001). When used cautiously, taking into account cultural factors as well as both level and quality of education, such an American-based test can be beneficial when applied to black African first language individuals (Shuttleworth-Jordan, 1996; Shuttleworth-Edwards et al., 2004).

Gaylard (2005) however, cautioned that considerable research in the last 30 to 40 years has demonstrated that it is inappropriate to generalize normative data on standard cognitive tests (including the Wechsler tests) from one ethnic group to another, as this may result in diagnostic and placement errors. As described in detail above, research has found that differences in test performance between ethnic groups have been found to reflect socio-cultural factors. She further stated that, as learning and intelligence is shaped by the culture or environment in which the individual lives and the opportunities and stimuli that are available to him or her, the use of western middle class tests on individuals from different cultural backgrounds is not a true reflection of "intelligence", but rather reflects the discrepancy between the western middle class "norm" and the individual's culture.

In this regard, Mercer (1973) as cited in Gaylard (2005) found that the IQ of black and Chicano testees increased in direct proportion to the number of Anglo socio-cultural features they demonstrated. This suggests that the more an individual acquires the skills and exposure to a western middle class context, a process commonly referred to as "acculturation" the more his or her IQ score will increase (Ogden & McFarlane-Nathan, 1997: 4).

An important factor to be considered in the application of tests across cultures is the testee's test wiseness. Testees who are exposed to western schooling systems and have a higher level of acculturation, develop the ability to respond to the test items by paying attention, concentrating, following directions and have a higher level of confidence, as well as specific skills, such as pencil use and copying (Nell, 1999). Nell further describes how test-taking skills are 'absorbed' instead of being taught, and result in the testee managing to balance the contradiction of speed and accuracy when responding to test items. Individuals from non-westernized cultures may believe that intelligence is reflected in cautious, careful work, which will impact on his or her response to the test items and consequently the test result. Thus, the literature suggests that individual test performance will be affected by the interaction between ethnic group and level of acculturation (Helms, 1992). Urbanization such as that in Zambia comes with cultural heterogeneity and some extent of acculturation.

With regard to acculturation and its impact on neuropsychological tests, it was well demonstrated in the comparison between the test scores of black rural Pedi and black urban Pedi adults (Kendall, 1980) in South Africa. Kendall's battery consisted of non-verbal tasks, as he was attempting to develop a "culture-fair" test of universal application. Many of the tasks were taken from Biesheuvel's General Ability Battery

(GAB), and consisted of construction tasks, pattern and design copying, sorting of objects and symbols (Kendall, 1980). It was found that education, urbanization and age all contributed to the testee's performance, but education had the greatest impact, followed by urbanization. Some possible explanations for the poorer performance of the rural group is that the type of competencies or skills required to complete the tasks may be of little use to rural individuals and / or the type of individual who tends to move to the cities to find work may be more ambitious and more motivated (Kendall, Verster & Von Mollendorf, 1988). This effect of urbanization (or acculturation) on scores such as intelligence tests was also found in the administration of the Griffiths Scales of Mental Development, where urbanized children performed significantly better than rural children (Rosen & Venter, 1988, in Paulsen, 1994) in Gaylard (2005). Accordingly, exposure to a more urban, western environment appears to influence IQ test results positively. Gaylard (2005) asserted that, the field of neuropsychological assessment therefore, is a challenging arena as it is increasingly unusual to find one ethnic group that is separated and unaffected by other cultures and each ethnic group will vary as to the amount of exposure to other cultures.

Manly and her colleagues (1998, 2002, 2004) as cited in Gaylard (2005) have done extensive research into the interaction between acculturation, neuropsychological test performance, and literacy level and quality of education. For example, Manly et al. (1998), cited in Gaylard (2005) investigated the relationship between acculturation through self-report, linguistic behaviour and neuropsychological test performance. Acculturation was measured using the African-American Acculturation Scale – short form (AAAC). This scale measures cultural experiences, including values, beliefs and practices as reflected in 'music, arts, people, religious beliefs and practices, traditional foods, traditional childhood experiences, superstitions, interracial attitudes – cultural mistrust'. Results found that performance of healthy African-Americans on WAIS-R and Boston Naming Test was directly related to acculturation. The more the testee reported acculturation to the white English culture, the more his or her neuropsychological tests conformed to the normative data for white English Americans. Thus, acculturation is directly related to improved neuropsychological test performance and hence the comparative aspect of this research regarding rural and urban population may reveal more information to his regard.

One other aspect that may be responsible for obtaining different results on neuropsychological tests between urban dwellers and their rural counterparts is that of exposure to neurotoxins. It has been shown by research that those that are exposed to certain neurotoxins more than others are prone to having some neurocognitive and neurobehavioural deficits. For example, some agricultural communities in the countryside that are exposed more to pesticides on commercial farms may score less on some neuropsychological tests than those that are not exposed even if the age, education and other variables are corrected for. Similarly, neurotoxins as a result of industrial and mining activities in some towns may contribute to poorer scores for those people that are exposed more (Eckermana et al., 2007).

To this regard, a review of a research that was carried out in Brazil on the effect of exposure to neurotoxins has been done in this paper. Adolescents (10 to 18 years old) from a rural area in the state of Rio de Janeiro, Brazil were tested using the Behavioral Assessment and Research System (BARS) to evaluate their performance. Participants were drawn from two areas - a school serving farm children (rural N = 38) and a school serving children from a city within this area (urban N = 28). These children were drawn from an ongoing study being carried out by Fundação Oswaldo Cruz where rural and urban participants were matched for age, sex, and level in school. For this ongoing study, the participants had been interviewed to determine their occupational history, especially their activities that might involve exposure to pesticides. Interview responses were used to assign an exposure index to each participant. While a few BARS performance measures suggested behavioral impairments for the rural versus the urban participants, a stronger and more consistent association between BARS measures (especially impairment of tapping, digit span, and selective attention) and level of exposure to pesticides was noted when the exposure index was entered into a multiple linear regression analysis. Exposure appeared to be especially strong for the youngest participants (10–11 years old). The relationship between these behaviors and the exposure index was stronger than the relationship between behaviors and either age or sex, Eckermana et al., (2007). Even if this research only included adolescents, it gave some indications on the effect that neurotoxins could have on performance on neuropsychological tests and hence reflecting the effect on cognitive functioning of those exposed and those not exposed to neurotoxins. Even if these neurotoxins may not be a prevalent feature in Zambia's agricultural communities, a similar phenomenon may be prevalent in mining townships where exposure to certain toxins may affect performance of affected individuals on neuropsychological tests. For instance, Kabwe in Central Province has been documented as having some lead poisoning and consequent neurological effects especially on children. In some neighbourhoods in Kabwe, blood concentrations of 200 µg/dl or more have been recorded in children and records show average blood levels of children range between 50 and 100 µg/dl. On average, children's blood lead levels in Kabwe are 5 to 10 times the permissible maximum and in many cases are close to those regarded as potentially fatal, (http://www.worstpolluted.org/projects_reports/display/45). Corrected for age, education and other related variables, those areas that are affected with these neurotoxins in towns may contribute to people living there having lower scores on the neuropsychological tests compared with those not affected. In Zambia particularly, the effect of having less access to health care facilities, education and the culture generally, in rural areas may contribute more than the subtle effect of neurotoxins mostly experienced in urban areas on the performance on neuropsychological tests. Thus, the effect would be more prevalent and pronounced were these neurotoxins emission in rural areas.

Based on this background of the factors responsible for the performance on NP tests, the main hypothesis in this study was that even in the matched groups with regard to education, age and gender, there would be differences on the NP performance across rural and urban groups on individual NP tests domains. Thus, despite sharing other demographic characteristics, the urban group would outperform the rural group on most of the NP tests. This was based on the premise that due to presumed higher quality of education in the urban context, and more culturally-related risk for lower cognitive development and maintenance in the rural area such as less cognitive stimulation and differences in nutrition and healthcare.

CHAPTER 3

3.0. METHODOLOGY

3.1. Study Type

This was a quantitative study which mainly involved administration of the Zambia Neurobehavioural Test Battery and an interview schedule.

3.2. Study Site

This study was conducted in both rural and urban areas of Zambia. Sites in urban areas included UNZA Clinic, Mtendere Clinic and Chilenje Clinic. Rural areas included some health posts/centres within Chongwe , Chibombo and Kafue Districts.

3.3. Study Sample

There were 324 participants drawn from both rural and urban areas of Zambia (rural = 152 and urban = 172) as part of the larger study for collecting norms for the Zambia Neuropsychological Test Battery. For this particular study however, only 234 participants (rural = 152 and urban 82) were included. This was done to keep in keep line with the prevailing total population proportions of 65% of people in rural areas and 35% of people staying in urban areas of Zambia (Central Statistics Office, 2003). Of the 234 participants, 119 of them were males while 115 were females. They were aged between 18 years to 65 years with levels of education ranging from 5 years to over 13 years.

3.4. Inclusion / Exclusion Criteria

3.4.1. <u>Inclusion</u>

For one to be included in the study, they needed to:

i. Be between 18 years to 65 years of age;

ii. Have at least 5 years of education; and

iii. Be literate in English.

3.4.2. <u>Exclusion</u>

i. HIV positive

ii. Any medical, neurological or mental condition that might have negatively affected performance on neuropsychological tests.

iii. With history of drug or alcohol abuse.

3.5. Ethical Considerations

The nature of this study raises some ethical issues such as confidentiality and informed consent. The participants who were willing to participate in the study signed a consent form after reading it and understanding it. This was to make sure that they were willing to participate and understand clearly what was involved in the study. All the information like the participants' HIV status for those included or excluded in the study was treated with utmost confidentiality.

To ensure that the study met the ethical requirements, the protocol was submitted to the University of Zambia Biomedical Ethics Committee. See ethics approval letter in Appendix B. After approval from the Committee, the Zambian Ministry of Health was then contacted for permission to conduct the research in the health centres. See date stamp on Appendix B for one of the District Health Management Teams (Chongwe).

The researcher also ensured that participants were fully informed about the purpose, methods and intended possible use of the research and consent to participate was sought from them. They were also informed about what their participation in the research would entail, like how long it would take and an allowance to cater for their transport and other costs incurred. The information they provided was kept as confidential as had been stated. The researcher also ensured that the participants were well aware that their participation was voluntary and free from coercion. After clear understanding of the terms and conditions of this study, the possible participant then freely signed an Informed Consent Form. See Appendix A for the Informed Consent Form.

3.6. PROCEDURE

3.6.1. Screening Procedure

Upon consent, the research participant underwent the following screening procedure:

Ability to speak and understand English: Since the neuropsychological assessments were done in English, there was an assessment of the participants' ability to use English by use of the Writing and Read Ability Test (WRAT) to ensure only individuals who were literate in English participated. The Zambia Achievement Test was also administered. Although it was not part of the compulsory screening procedure, this test was administered to assess quality of education the participants have had. It was an index of the quality of education. This test involves an individual reading a list of words, four in each category with progressively getting more difficult. Although designed for children, this test can be administered to adults as an index of the quality of education received. Those who have had low quality of education would read relatively very few of the words on the ZAT and the opposite is true for those who have had higher quality of education.

Psychiatric and Drug Abuse Assessment: The psychiatric and drug abuse assessment included the use of the Composite International Diagnostic Interview (CIDI) which provides results in terms of presence or absence of DSM-IV/ICD-9 diagnosis of present or past depression and substance disorders. The severity of depressive symptomatology was assessed using the Beck Depression Inventory (BDI). The BDI is a 21-item self-report scale with each item having 4 response options of graded severity. The inventory focuses on an individual's life for two weeks prior to the assessment.

Everyday Functioning Assessment: This included the use of the Activities of Daily Living Scale (ADL) questionnaire, and the Patient's Assessment of Own Functioning Inventory (PAOFI). These measured daily functioning level, one's difficulties with memory, language and communication, use of hands, sensory-perception, higher level cognitive and intellectual functions, work, and recreation.

3.6.2. <u>Neurocognitive Measures</u>

The Zambia Neurobehavioural Test Battery (ZNTB) was administered to all the participants who met the inclusion criteria and passed the screening. The neuropsychological tests were administered and scored by the 9 investigators who had been fully trained in test administration and scoring in accordance with the procedures outlined in the Zambia neuropsychological tests manual. The participants' performances were then scored according to the approved HIV Neurobehavioral Research Center (2009) guidelines. The processes of administering this whole test battery took approximately two and half hours. The details regarding the development, reliability, validity, as well as the administration and scoring procedures for these neuropsychological tests used in this study are as given in the paragraphs that follow.

<u>Hiscock Digit Memory Test (HDMT):</u>

This test was designed to measure visual memory and deliberate responding or malingering. It was developed by Merill Hiscock and Cheyl Hiscock from the University of Saskatchewan in 1989. It was named after its developers. Clinically it is used to detect factitious sensory or perceptual impairment and also applied to cases of claimed memory loss. Further, it is used to identify individuals thought to be purposefully feigning or faking memory impairment (Prigatano et al., 1993).

There are three versions of the Hiscock Digit Memory Test also called the forced choice test. The 72-item, 36-item and 18-item Hiscock Digit Memory Test. The 18-item HDMT is the one that is included in the Zambian neurobehavioral battery. The 18-item HDMT is usually administered in order to reduce the time demands of the Neuropsychological evaluation which is estimated to take two and half hours.

Hiscock & Hiscock (1989), recommends that, "the Hiscock Digit Memory Test is better suited for use with a broad spectrum of patients undergoing neuropsychological assessment" (Hiscock & Hiscock,1989:968).

A study to substantiate the validity and reliability of the HDMT was carried out by Hiscock and Hiscock (1989). They administered the HDMT, Weschler adult Scale, Trails A and B, Wisconcin Card Sorting Test and other tests to a 45 year old male patient who claimed to have had a memory loss after a head injury and was referred by the provincial Worker's Compensation Board in Canada. Two control subjects: a severely demented 53 year old woman with dementia of the Alzheimer's type and a normal 5 year old girl were recruited.

On test administration, it was found that the scores of the patient progressively declined across the second and the third blocks leading to an overall score of 21 out of 72 (29%) which was significantly below the chance (50%) level. The severely demented 53 year old woman scored at the 51% chance level (not significantly different from chance) and the normal 5 year old girl score was 82% which is significantly above chance.

Prigatano et al. (1993) undertook a study on 37 subjects (27 with brain dysfunction and 10 normal controls). It was hypothesized that malingerers would be identified on the digit memory test (DMT). The mean level of performance for the patients with brain dysfunction and the normal controls was between 94% to 100% correct on the HDMT. For the suspected malingerers, the level of performance was below the 50% correct which is the cutoff point, indicating that the digit memory test was both valid and reliable for detecting malingering. These and other findings show that Hiscock Digit Memory Test (HDMT) is a reliable and valid neuropsychological tool (Hiscock et al., 1989; Prigatano et al., 1993).

Participants were asked to remember a successive series of 5-digit numbers for 5 seconds each, which were presented one at a time on 7.6 X 12.7cm note cards attached to an easel. For each stimulus card, there was a response card containing two 5-digit numbers printed side-by-side. One of the numbers (the target) matched that which was shown on the stimulus card and the other number (foil) differed from the target in at least two digits, including either the first or the last digit. There was a 5 second delay between the initial presentation and response during which there was no distractions or intervening cognitive tasks.

After the delay, participants were shown another note card containing two, 5-digit numbers from which they were to identify the original target number. The delay time was lengthened by 5 seconds after every block of six trials. With every increase in time delay, participants were informed that the administrator was interested in determining whether they were "still able to remember the numbers after longer periods of time."

Participants were provided with feedback regarding the accuracy of each response by the administrator saying 'right', 'correct, 'good' or some similar positive remark. The administrator did not respond at all after an incorrect response.

Participants were scored and classified as having passed the HDMT on the basis of performance at or above the established cutoff of 90% correct (see also Ellwanger et al., 1999; Guilmette et al., 1994).

Hopkins Verbal Learning Test-Revised (HVLT-R)

The Hopkins Verbal Learning Test-Revised (HVLT-R) is a test of learning ability and immediate recall on verbal information across multiple trials. It also measures an individual's capacity to retain, reproduce, and recognise information after delay (Strauss et al., 2006).

The test was developed by Brandt and Benedict (2001) and it is methodologically similar to the Brief Visuospatial Test Revised (BVMT-R). The test was modeled after other word list learning tests such as the California Verbal Learning Test (CVLT) and the Rey Auditory Verbal Test (RAVLT). Some changes have been made to some words to make the test more adaptive to the Zambian situation. Some original items for instance emerald, sapphire, jade and pearl have been replaced with copper, iron, lead, and zinc respectively.

The original English language HVLT-R normative sample consisted of 1,179 adults (75% women), ranging in age from 15-92 years (M=59.0, S.D = 18.6), and education between 2 and 20 years (M = 13.4 years, S.D = 2.9). Participants were reportedly free from neurologic or psychiatric disorders. In this study, it was found that age had the largest effect accounting for 19% of the variance in test performance with education and gender having no significant effect.

Despite the broad education range, the high mean education level for the normative group suggest that higher levels of education were also overrepresented in the normative sample for HVLT-R. According to Shapiro et al. (1999), the HVLT-R also correlated strongly with other tests of verbal memory and relatively weakly with a test of general intelligence leading to conclusions that the HVLT-R is a valid test of verbal learning and memory. Woods et al. (2005), further supports the reliability, convergent, construct, predictive and discriminant validity of the learning and recall measures on the HVLT.

Administration of the test was such that a list of 12 words (four words from each of the three semantic categories) was presented to the participant over three trials and after that they were required to say back the items on the list in any order. The delayed trial was administered 20 minutes later in which the participants were requested to recall as many words as they could remember from the list read to them earlier.

Finally, the test administrator read out a list of 24 words which were items that were presented originally in the same semantic class as well as ‘new’ unrelated words. This was the recognition task and the participants were required to answer ‘yes’ or ‘no’ depending on whether or not they believed the word read out to them was in the original list of words (Strauss et al., 2006:760).

When scoring, minor errors in pronunciation or pluralization such as lions for lion were corrected and counted as correct. The total score for the HVLT-R was taken to represent the participant’s measures of verbal learning memory.

Brief Visuospatial Memory Test- Revised (BVMT-R):

This test provides a measure of immediate recall, learning rate, as well as delayed recall and recognition for visuospatial information. It is basically a figural learning test developed by Benedict in 1997. "The Brief Visuospatial memory Test-Revised (BVMT-R) measures visual learning and memory using a multiple-trial list learning paradigm" (Strauss et al., 2006:701).

According to Cherner et al. (2002), in (Strauss et al., 2006) the existing BVMT-R was standardized with 588 healthy English-speaking adults ranging in age from 18 to 79 years (M=38.6 S.D = 18.0), with a mean education of 13.4 years (S.D = 1.8). The sample was 64.5% female and predominantly Caucasian (82%), with small portions of African Americans (14.5%) and other ethnic groups (3.6%). Hierarchical Polynomial regression analyses were used to determine the effects of age, gender, and education on test performance.

It was concluded that education and gender did not influence test results and as such, the standard T-score generated for the BVMT-R correct only for age. Although the education range was not described, the high mean education value for the normative sample suggests that the range was limited at the low end. As such the existing norms may over estimate impairment among those with low levels of education.

To this effect, users of the BVMT-R should be cautious of some limitations of scoring and normative data. It has been noted that the combination of accuracy and spatial location score requires further research in order to ascertain whether separating these two dimensions would improve diagnostic accuracy. Literature seems to suggest that IQ is moderately related to most of BVMT-R measures thus poor performance must be interpreted with considerable caution in population with considerably below – average I.Q (Strauss et al., 2006).

Participants were presented with an 8 1/2" by 11" card containing six simple designs in a 2" by 3" matrix. The display was presented for 10 seconds, after which it was taken away and the participant asked to reproduce as many of the designs as possible in their correct location on a blank sheet of paper.

After two more trials and a 25-minute delay, participants were once again asked to reproduce the matrix. This was followed by a recognition trial in which participants were shown 12 designs, one at a time, and asked if the design appeared in the original matrix. The recognition trial consisted of the six original designs and six foils.

A copy trial was administered in order to rule out poor performance due to graphomotor or visuospatial impairment. In the copy trial, participants were given the display along with a blank sheet of paper and asked to copy the designs. There was no time limit for recognition trial or copy trial, and when drawing figures during recall.

Scoring of the BVMT-R was two pronged. In terms of accuracy of the design as well as location on the sheet of paper. A point was given to each of the two dimensions captured correctly. That is, a point was given if the design was correctly reproduced with regard to accuracy but not correctly placed or if the location was correct although not accurately produced was still recognizable as the target design. Designs that neither met the accuracy nor location specifications gained a zero point (see also Strauss et al., 2006:702).

<u>WAIS III – Digit Symbol & WAIS III - Symbol Search</u>**:**

One of the commonest measures used in many neuropsychological batteries is the Weschler Adult Intelligence Scale-III (Strauss et al., 2006). The digit symbol and symbol search tests are tests that make up the processing speed index of the WAIS-III. "WAIS-III is a revision of WAIS-R". Weschler, (1991) postulates that measures such as letter number sequencing, *symbol search* were developed to assess working memory and processing speed. The WAIS-III therefore measures verbal comprehension, perceptual organisation, working memory, and processing speed (Strauss et al., 2006).

Studies on the validity and reliability of these two tests have usually been incorporated in the WAIS-III as a whole measure, however emphasis has been made on the processing speed index. In their study to confirm the four description model of the WAIS-III, Gorsuch et al. (2000) concluded that, the replication of the four – factor structure (verbal comprehension, processing speed, working memory and perceptual organization) demonstrate the psychometric integrity of the WAIS-III and attest to its portability across cultural boundaries.

Not only have studies across cultures confirmed the reliability and validity of the WAIS-III, but the validity has also been confirmed in measuring cognitive decline in old age (Clay et al., 2009). It has been argued that, "those subsets that measure speed of processing show the greatest difference with increasing age" (Strauss et al., 2006:.289).

Another study by Paul and Kreiner (2000), confirmed the reliability of the WAIS-III across cultures and across both the clinical and standardization sample. They specifically made mention of the 11 subsets used and among those were the digit symbol and symbol search tests. They concluded that "none of the reliability estimates differed significantly from those reported for in the WAIS-III. Similar Symbol search and the digit symbol have interesting clinical findings and significance. The processing speed index (PSI) is the most affected in many forms of brain insult (Strauss et al., 2006:300). Therefore with regard to criterion validity, PSI is the most sensitive. This weakness on PSI has been shown to appear more with an increase in the severity of the insult, in particular Digit symbol (Strauss et al., 2006:300). “Symbol search also has demonstrated meaningful relationships with measures of severe traumatic brain injury (TBI) such as length of coma or presence of intracranial lesions” (Donders et al., 2001).

On the WAIS III Digit Symbol, the participants were required to match symbols to numbers as quickly as possible, using a visual reference. On the WAIS III Symbol Search, the participants were asked to scan two groups of symbols visually and determine if either of two target symbols matched any of five symbols appearing to the right of the target symbols. The participant then attempted to complete as many items as possible within a 120-second time limit. The examinee’s score was determined by the number of symbols correctly scanned within the 120 second time limit.

Grooved Pegboard:

This is a test of fine motor coordination and speed. In this test, participants were required to place 25 small metal pegs into holes on a 3" x 3" metal board. All pegs were alike and had a ridge on one side, which corresponded to a notch in each hole on the board. First the dominant hand was tested, and participants were asked to place the pegs in the holes as fast as they could. This was then repeated with the non-dominant hand.

The participant’s performance on this test was the total time they took to fill the pegs in the holes. The time was recorded for each hand was recorded (both dominant and non-dominant hand).

Trail Making Tests, Part A:

Trail Making Test A measures psychomotor speed, attention and cognitive sequencing. The Test consists of 25 numbered circles distributed over a sheet of paper. The participant’s task was to draw lines to connect the numbers in ascending order. The participants were instructed to connect the circles as quickly as possible, without lifting the pen or pencil from the paper. If the participant made an error, it was pointed out immediately and they were allowed to correct it. Errors affected the participant’s score only in that the correction of errors is included in the completion time for the task.

The participant’s test performance was recorded as the total amount of time it took for them to complete the task. It was unnecessary to continue the test if the patient had not completed both parts after five minutes had elapsed.

Color Trail Test (CTT):

The Color Trails Test (CTT) has been described as a culture-fair test of visual attention, graphomotor sequencing, and effortful executive processing abilities relative to the Trail Making Test (TMT). CTT measures attention, sequencing, mental flexibility, visual search and motor function. The adult version is for individuals aged 18 to 89 years and that for children (CCTT) is for ages 8 to 16 years. It is important to note at this point that these versions do not include age 17. The CTT is designed to minimize the influence of language so that it can be used in cross-cultural settings. Part 1 is similar to the trail making test (TMT) part A except that all old-numbered circles are pink and all old-numbered circles, yellow. Part 2 is similar to TMT part B - it shows all numbers from 1 to 25, alternating between pink and yellow circles and disregarding the numbers in the circles of the alternate colour, (Strauss et al., 2006).

“Normative data for the CTT are based on the performance of 1528 health volunteers, including subsamples of 182 African Americans and 292 Hispanic Americans between the age of 18 years and 89 years, 11 months. These norms are presented separately for six education levels” (Strauss et al., 2006:555). A sample of 678 children in Los Angeles provided the normative data for ages 8 to 16.

The Color Trails Test (CTT) was developed as a culturally fair analogue of the Trail Making Test (TMT). In one study to examine the equivalence of these two tests, 180 Chinese people in Hong Kong volunteered. They were classified into four groups according to their age and level of education. Their performance on these two tests was compared. The findings suggested that age and level of education indeed played significant roles in their performance on these two tests.

Strong correlations ($r = 0.72$) were only observed between scores on Part B of the TMT and Part 2 of the CTT when the participants were older and had higher levels of education (Lee et al., 2000). This suggests that the equivalent construct of the TMT and CTT can only be examined and established within specific age and education parameters.

With regard to the test-retest reliability for CTT, two-week reliability is reported as marginal (.64) for Part 1 and acceptable to high (.79) for Part 2. It is also stated that paired t-tests indicate that the interference index is significantly greater on the second test session. It is also reported that there are moderate correlations between CCT Parts 1 and 2 with TMT A and B of .41 and .50 respectively. It has been ascertained that there is a significant slow performance on Parts 1 and 2 in patients with traumatic brain injuries and HIV respectively (Strauss et al., 2006).

The CTT is based on the use of numbered colored circles and universal sign language symbols. The CTT stimuli consisted of circles with numbers printed inside. Each circle had either a vivid pink or yellow background (which are colors perceptible to color-blind individuals).

Color Trails 1 is similar to Trails A with the exception that all odd numbered circles had a pink background and all even-numbered circles had a yellow background. For Color

Trails 2, each number was presented twice, once with a pink background and once with a yellow background.

When administering, 5 to10 minutes were needed and prompts and corrections were given. The time for the completion of parts 1 and 2 was recorded in seconds. The qualitative scoring involved number errors, near-misses and prompts. Score were then transformed to standard scores (M = 100, SD = 15), T scores and percentiles (see also guidelines in Strauss et al., 2006).

<u>WMS - III Spatial Span:</u>

The Wechsler Memory Scale II Spatial span is a component of the Weschler Memory Scale III (3^{rd} ed.) which is a neuropsychological test battery used to assess learning and memory in adolescents and adults of age range 16 to 89 years of age. The WMS-III spatial span has been adopted into various batteries because of its testing properties. It is a visual test of attention and memory and a derivative of the Corsi blocks test which was first developed by Corsi in the 1970s to compliment the verbal memory span task.

The WMS-III Spatial Span task is a test of working memory. The Spatial Span subtest taps an examinee's ability to hold a visual-spatial sequence of locations in working memory and then reproduce the sequence. The spatial span is a recent revision (last 15 years) of the Corsi blocks test (over 35 years) and thus has very little research done on it than the Corsi blocks test (Berch et al., 1998).

The testing of the validity of the spatial span is a more complex measure because it is based on three assumptions of which several studies have questioned. For example, a study was done to assess performance of a clinical population on the WMS spatial span subtest in comparison to the Digit span (Wilde & Strauss, 2008). The sample consisted of 44 participants referred for assessment after injury, seizure disorder, and surgery. The study reviewed records of the clients referred for neuropsychological assessment for medical reasons as mentioned and with a Glasgow coma scale of 14 and no history of unconsciousness greater than 1 hour. The sample was comprised of 26 males and 18 females of average educational level of 12.4 years and mean age of 37.1 years.

Results showed that the raw scores for the forward digit span were higher than those for the forward spatial span while backward digit span results were lower than those of the backward spatial span. There were also generally similar raw scores for both the forward and backward spatial span results. Hence questions have been raised as to whether the spatial span is a valid measure of visual-spatial memory or perhaps its validity would be a more complex measure. Wilde and Strauss (2008) have concluded by cautioning the interpretation of the spatial span backward scores for clinical purposes. It is important to note however that generally those that performed poorly on the forward spatial span test also did poorly on the backward span test.

With regards to reliability, the spatial span is a good test or recurrent assessment of degeneration (dementia) because it has a negligible practice effect (Nuechterlein et al., 2008). It however shows reliable change indices when there is deterioration in cognition. This conclusion is based on studies done in epileptic patients in whom subtests were administered before and after surgery in order to identify tests that can be used to monitor responses to treatment. Spatial span test showed test-retest reliability and little practice effect (Martin et al., 2002).

Similar results were obtained in a study on schizophrenic patients that was done to develop a valid and reliable test battery for diagnostic and prognostic purposes. The spatial span was one of the 10 out of 36 tests that were selected to test for 5 critical areas of cognitive impairment in schizophrenic patients based on the results of the study. The study consisted of a mixed population of Caucasians, Asians, and Africans making a total of 176 (Nuechterlein et al., 2008).

The WMS-III spatial span had two parts (spatial span forward and spatial span backward). In the first part of the subtest, the participant was asked to replicate an increasingly long series of visually presented spatial locations. When giving the test, the administrator pointed to a series of blocks at a rate of approximately one block per second and asks the examinee to point to the same blocks in the same order (Spatial Span Forward).

In the second part of the subtest, the administrator pointed to a series of blocks and asked the participant to point to the same blocks in the reverse order (Spatial Span Backward).

Two trials (trail 1 and 2) for each sequence item were administered. Both trials of an item were administered even if the participant passed the first trial. The administrator discontinued after scores of zero on both trials of an item. 1 point score was given for each correct replication and zero point was given for a wrong replication. The total participant's scores were recorded as per correct number of locations that they were able to replicate (on both the forward and backward span respectively).

Wisconsin Card Sorting Test - 64

The Wisconsin Card Sorting (WCST) 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. These are in red, green, yellow or blue colours. All cards were different and there were no two identical cards. The test taker is supposed to match one of the cards at the bottom to those that are shown among the four (Lezak, 2004). The Wisconsin Card Sorting Test has for a long time been used as a test that measures abstract behaviour or executive functioning.

The validity of WCST has been used tested by several researchers. Paolo et al. (1995), looked at the construct validity of the Wisconsin Card Sorting Test and the relationship between WCST test scores and memory and attention. In their study, they recruited 187 normal elderly and 181 persons with Parkinson's disease who were recruited from the community and retirement homes. An exclusion criterion was used by excluding all 'normals' that scored below 130 on the Dementia Rating Scale as they were not supposed to show any signs of dementia and a score of less than 130 was associated with early dementia.

The results were analysed on both number of categories and the number of preservative errors, these indicated that there was an increased number of preservative errors among the subjects with Parkinson's disease than the normal. The results thus indicated that an increase in preservative errors increase among individuals with frontal lobe dysfunction supporting the validity of the test as a measure of frontal lobe functions.

In trying to understand the reliability of the WCST, Bowden et al. (1998), evaluated the reliability and internal validity of the WCST. In their work they had a sample of 75 university students to assess the reliability of the test and were given two forms of the test one after the other. In the administration process, the first set was given in the standard form while in the second form the administration was changed. The results were significant on the errors and the number of categories completed. There were no practice effects that were observed in this study. The results also showed low retest reliability and alternate form reliability with an average of r=.43 on Pearson's r which showed that almost 80% of the results could be attributed to error variance.

Bowden et al. (1998), have argue that the test cannot be used in a clinical sample until the reliability of the test is clearly tested. However, it is important to take note that the administration of the test was altered in this study and this could have likely affected results as standard rules of test administration were not followed.

Further it can be ascertained that WSCT is a valid test of executive functioning and the studies outlined above give some guidance on what to consider in further research as well as when making clinical decisions. It is also important to take note that the reliability of the test is not optimum and caution should be used especially in the administration of alternate forms of the test. It has also been argued that due to its low reliability the test does not have very good specificity although it reports high sensitivity to frontal brain lesions (Bowden et al., 1998).

This test was administered using a computer. It measured executive functioning and required planning, use of feedback, and shifting cognitive sets. Participants were required to match a card that appeared on the bottom part of the computer screen to one of four stimulus cards that were presented on the upper part of the computer screen.

The stimulus cards had four different designs on them – the first had a red triangle, the second had two green stars, the third had three yellow crosses, and the fourth had four blue circles. The cards that participants were required to match to one of the four stimulus cards varied in color, geometric form, and number. Participants received feedback each time on correct or incorrect performances. There was no time limit for this test.

There are three principles in the way the cards could be matched and these were the colour, the shape or the number of items on the card. The computerized responses given for each test were either "right" or "wrong", to indicate whether the card had been matched correctly.

Scores were given based on the number of categories completed and persevarative errors. The persevarative errors occurred when the client continued to sort the cards according to one principle. Low correct completed categories indicated problems in forming concepts, profiting from correction and conceptual flexibility (see also Lezak, 2004:587).

<u>Controlled Oral Word Association Test (COWAT):</u>

Assessment of verbal fluency has long been an important component of clinical neuropsychological evaluation. Verbal fluency tests are used as a measure of executive functioning and language, and can also be used to evaluate semantic memory. Verbal fluency is typically tested in letter and category domains. The two forms of fluency tasks most commonly employed are semantic and phonemic fluency.

Marshal (1986), in (Strauss et al., 2006) pointed out that the label "word fluency" is misleading since verbal productivity in conversation or in continuous sentences is not measured. Instead, the test measures timed production of the individual word index for example, a given letter of the alphabet. Thus, to avoid confusion with the fluency/ non fluency dimension of speech, Benton et al. (1994), preferred the term "Controlled Oral word Association" (COWA). However the test is often known under the general term of "verbal fluency".

F, A, and S are the most commonly used letters for this popular test, although other letter combinations are also used (Benton et al., 1994). The other letters include C, F and L and P, R and W. Borkowski et al. (1967), postulates that the choice of a letter set may affect the results to some extent because of differences in letter difficulty and word frequency for each letter. For younger children, words beginning with "Sh" have also been used to avoid the reliance on spelling skills. The purpose of the 'F', 'A', 'S' test is to evaluate the spontaneous production of words within a limited amount of time (Straus et al., 2006).

On internal reliability, Tombaugh et al. (1999), in (Strauss et al., 2006) assessed the degree of internal consistency that existed among F, A, and S as well as among C, F and L. Coefficient alpha was computed using the total number of words generated for each letter as individual items and was found to be high (r = 0.83).

In health adults, test retest correlation is typically above 0.70, for both letter and semantic fluency with short as well as long intervals. Basso et al. (1999), noted no gains among 50 healthy males re-tested following a 12 month interval on FAS. Levine et al. (2004) however, reported gains of about three words for 2145 healthy men when they were reassessed with FAS with the interval of 4 to 12 months.

Although test-retest reliabilities are reasonable for phonemic fluency, these findings suggest that relatively large changes in performance are required to conclude that real decline or improvement has occurred as opposed to being due to the effects of practice and random measurement error (Basso et al., 1999).

In this test, the participant was asked to say as many words as possible (within 60 seconds) that begin with the letters “F,” “A,” and “S,” excluding proper names and different forms of the same word. For each letter, the participant was allowed 60 seconds to generate as many words as they could.

The participants were scored and their performance measured by calculating the total number of acceptable words produced for all three letters. Intrusions and perseverations (word repetitions) were not included in the total score. Intrusions included words that begin with the wrong letter, are proper nouns, or words that differ from a previous response by tense, plurality or grammar usage.

Category Fluency Test

Developed together with and in the similar line with COWAT, both tests are said to be sensitive measures of brain dysfunction and the administration of verbal fluency tasks are recognised as an important component in the comprehensive assessment of neuropsychological functioning (Lezak et al., 2004; Straus et al., 2006). Although both tasks are similar in that they impose substantial language requirements, and that they are both indicators of brain dysfunction, there is evidence to suggest that each task is sensitive to different disease processes and distinct neuroanatomical substrates.

A similar picture emerges for category fluency as the one described on the FAS above. Bird et al. (2004), in (Strauss et al., 2006) evaluated semantic (animal) fluency in 99 healthy adults. All in all, what was noticed in most of the tests done was that there was some notable practice effect on the second administration although some studies proved otherwise.

Practice effects can be reduced by changing the letter or category on each test occasion. The findings of Wilmen et al. (1999), in (Strauss et al., 2006) on 81 normal controls are that Category test is reliable with only small practice effect. For this reason, there is great need for the examiner to control for practice effects so that correct recommendations can be made on patients. Correlations among phonemic fluency task for example the FAS and the category fluency test are high.

Troyer et al. (2000), argue that the two sets of letters are roughly comparable across different settings and groups such as the healthy, psychiatric, suspected CNS dysfunction, with correlations between forms ranging from 0.85 to 0.94. Correlations between forms using different semantic categories are also moderately high at 0.66 to 0.71 for such groups as (animals and clothing) and (animals and food).

On the Category Fluency Test which is similar in format to the Controlled Oral Word Association Test (COWAT), the participant was asked to say as many words as possible that belong to a specified category.

In this study, participants were asked by the administrator to say as many "Animal names" as they could within a space of 60 seconds. The participant was then later asked to produce as many Action words as they could of "Things that people do".

The participant's score was the number of items correctly named. Similar to the COWAT, perseverations (i.e., repetitions of a correct word) and intrusions (i.e., words not belonging to the category) were recorded.

The participants were scored and their performance measured by calculating the total number of acceptable words produced for trail 1 (Animals) and trail 2 (Actions). Intrusions and perseverations (word repetitions) were not included in the total score.

Paced Auditory Serial Addition Task (PASAT):

Paced Auditory Serial Attention Test (PASAT) 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 who are 16 years old and more. This is a challenging task that involves working memory, attention and arithmetic capabilities. It is considered to have been devised by Gronwall and others in 1974 to provide an estimate of speed of information processing (Strauss et al., 2006). The PASAT is also an auditory test of attention and memory.

The original norms were based on a sample of 80 individuals from New Zealand. They warn however, that because this sample was predominantly male and not well described demographically, alternate norms are preferred. The demographic characteristics for the Gronwall version collected by Struss et al. (1989), were based on the normative data based on samples of healthy North American adults. There were 90 community volunteers aged 16 to 69 years with approximately 16 years of education and no history of neurological and/or psychiatric disorder.

Regarding the reliability of PASAT, the Cronbach's alpha for the four PASAT trials is very high in adults (r = .90) and that in children, the CHIPASAT's split-half reliability is approximately .90 at different ages. This implies high internal consistency. Test-retest correlations following short retest intervals (7-10 days) are excellent (r < .90). It has also been pointed out that there are significant practice effects on the PASAT (Strauss et al., 2006).

With regards to validity of PASAT, Wingenfield et al. (1999), in (Strauss et al., 2006) acknowledge that although more research is needed, among auditory versions, computerized and audiotape versions appear comparable. Short and long forms are highly correlated in healthy individuals. For example, r = .86 for the PASAT-50 and r = .95 for the PASAT-100. PASAT is also thought to measure a central processing information-processing capacity similar to that seen on divided-attention tasks.

Further, the test is also said to moderately correlate to other measures of attention, such as Digit Span, Trail Making Test (particularly Trails B), and Stroop Test. According to Strauss et al. (2006), even if PASAT may not be strongly correlated with intelligence or mathematical ability, it is sensitive to mild concussion and appears to be a more sensitive indicator of information-processing capacity in head-injured patients than other standard measures of attention.

This test is an effective measurement of speed of information processing. In this test, a set of randomized digits were serially presented via computer recording (Channel 1 to be specific).

Participants were asked to add the current number to the number that preceded it and respond with the total. Thus, after each new digit was presented, a new total was achieved. The number of correct responses was scored. Both the total number of attempted answers and the total number of correct answers were recorded.

Stroop Color and Word Test

Stroop colour and word test was developed by John Ridley Stroop in1935. It measures "the ability to shift cognitive set by requiring the active inhibition of previously learned responses that are highly automatic" (Sacks et al., 1991:220). The focus of the test is on selective attention, habitual response, automatic response suppression ability and goal oriented and is used for executive functioning.

The most reliable studies done on the stroop have been test-retest reliability study. This so because of the importance placed on practice effect and its impact on neuropsychological tests both in research and clinical populations.

Levines et al. (2004), sampled 37 adults between 52 and 80 years. They were tested at three time interval with an inter-assessment interval of 14 days. They found that "only the colour task did not produce decrease in completion time between the 2^{nd} and 3^{rd} sessions" (Levine et al., 2004:292). Completion time was found to be of greater sensitivity than error scores were to practice effect.

The test retest reliability correlation of the Stroop test has been found to be as high as r=0.90 (Cave, 2008).

A study that showed validity of the stroop test is by King et al. (2007). The sample included 22 adults that had a diagnosis of attention deficit hyperactive disorder (ADHD) in childhood and 22 healthy controls. The subjects were administered a block explicitly cued task switching paradigm and a stroop colour word test. The results showed that the ADHD group performed worse, had errors, and had an inability to control interference. The limitation of the study was the small sample size. These studies show a fair reliability and validity of the stroop test.

This is a test of both information processing speed and executive functioning. It consisted of three pages the participant had to read through as quickly as they could (Word Reading, Color Naming and Color-Word Interference).

Each page had 100 items, presented in 5 columns of 20 items. The Word Reading page consisted of the words "RED", "GREEN" and "BLUE" arranged randomly and printed in black ink on a white 8.5" x 11" sheet of paper. No word was allowed to follow itself within a column.

On the Stroop Test (Words), the administrator instructed the participant to read down the columns starting with the first one and continue until they participant was told to STOP after 45 seconds. The administrator then circled the item the participant ended on. This number was recorded as the score for the participant.

On the Stroop Test (Colours), the administrator informed the participant that this was a test of how fast they could name the colours on the page. They were to complete the page just as they did with the previous one. The participant was given 45 seconds before they were told to stop. The administrator then circled the item the participant ended on. This number was recorded as the score for the participant.

On the Stroop Test (Colour-Words), the administrator informed the participant that the test was just like the one they had finished earlier. Now they were required to name the colour of the ink the words were printed in, ignoring the word printed in each item. The participant was given 45 seconds before they were told to stop. The administrator then circled the item the participant ended on. This number was recorded as the score for the participant.

Halstead Category Test (Computerized):

The test was developed by Halsted in 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 had a different principle which may be odd stimulus, number of objects, spatial position, and a combination of different principles among others. 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 test requires deduction of a classification principle by means of response bases feedback, the use of the principle while it remains effective and to abandon the principle when it is no longer effective" (Strauss et al., 2006:425).

In a study to look at test-retest reliability, Dikmen et al. (1999), in (Strauss et al., 2006) undertook a study with 354 normals or neurologically stable participants. The participants were all of at least 15 years of age. Of the total number, 138 had no recent head trauma but were friends of those with head injuries and were tested after 11 months. Of these, 121 had recent head injury and had their baseline testing a month after the trauma and 11 months after the baseline testing. A variety of tests were used and these included the Halsted Reitan Test Battery, Wechsler's Adult Intelligence Scale (WAIS) and other memory test. The results obtained found reliability coefficient of between Pearson's r = .40 to r = .85 over a median interval of 11 months. In this study it is argued that there are two types of reliability these are the concept of clinical reliability versus psychometric reliability which is cited in this study.

It is argued that "clinical reliability is used to consistently classify individuals' performances as normal *versus* impaired on the basis of cut-off scores" (Dikmen et al., 1999:353) in (Strauss et al., 2006). Further, the results obtained on the neuropsychological measures used including the category test had better clinical than psychometric reliability. However, the clinical reliability is easily affected by practice effects especially if the testing interval is very short. Others have also pointed out that with severely impaired neurological patients, the reliability coefficients tend to be as high as .90 even two years after the baseline testing (Goldstein et al., 1989; Matarazzo et al., 1974) in (Strauss et al., 2006).

Considering that reliability is concerned with getting consistent results and a reduction of measurement error, it can be argued based on these results that the current test retest results may not be very high but they do seem to show some consistency in the way they are reported at different times. It is however important to keep in mind that the when psychometric reliability is low and clinical reliability is somewhat higher, there should be ways of ensuring the reliability of the retest of the test.

The category test has for a long time been known to measure more than one construct. It has been reported to measure diverse skills such as counting, perceptual organization, set maintenance, and learning facilitated performance (Simmel et al., 1957).

Allen et al. (1999), embarked on study to evaluate the category test based on three factors with different populations and the relationships of these factors with other cognitive abilities. In this study, a total of 601 male participants were assessed and these consisted of 195 patients with schizophrenia, 177 had different forms of structural brain damage, and a patient comparison group of 229 participants. The standard version of the Category Test was used in the assessment process as well as Wechsler's Adult Intelligence Scale (WAIS) and all the other tests contained in Halstead-Reitan Neuropsychological Test Battery.

The category test has reported a fairly acceptable level of its reliability and validity and although like the WCST it is a measure of executive functioning. The Category Tested has been cited to have a better sensitivity to brain damage than the WCST. It is said that the Category Test should be a preferred measure if the clinician would like to measure a more difficult and sensitive measure of abstraction ability (Strauss et al., 2006).

The Halstead Category Test was administered and completed on the computer. The participant was shown a series of geometrical figures and designs that represented a number between 1 and 4. The participant was tasked with figuring out which number the current design they were looking at represented, and then pushing the computer key (the keys numbered 1-4) on the computer keyboard.

The test consisted of 7 subtests. Between each subtest the examiner had to read more instructions to the participant, indicating to them that the current subtest had ended and they were about to begin a new one. Within each subtest, the idea, or principle used to find the correct answer never changed.

The strategy only changed between subtests, never within them. The participant was told between each subtest that the idea used to identify the correct number could be the same as in the last subtest, or it could be different. It was the participant's job to figure out if it changed or not, and then figure out the new correct idea or principle in the new subtest to get the right answers. The test was scored based on the number of errors made.

3.7. Statistical Analyses

Performance of the research participants on the fifteen neuropsychological tests was recorded. The raw scores were then converted to scaled scores. The main reason for this was that the distributions of raw neuropsychological test scores often deviate from normality, making them less appropriate for parametric tests of between-group differences. The scaled scores range from 1-19 with a mean score of 10 and standard deviation of 3. The scaled scores, therefore, also provided a uniform scale on which to place the absolute performance of groups and individuals, and a general normative context in which to understand their NP tests performances.

The participants' performance on the neuropsychological tests was grouped according to domains of the brain that the tests were assessing to give a mean score that was used for statistical analysis. The means for each of the domain areas were used to indicate test performance by the study participants on the dependent variables while residence was the independent variable for analysis purposes in the statistical package for social sciences (SPSS) version 15.0.

Only the 7 means of groups of test scores were analysed as analysing all the neuropsychological tests separately was outside the scope of this study. The domains of the brain assessed and the neuropsychological tests used are as shown in table 1.

Table 1: NP Tests Domains Assessed and Actual Tests Used in the Study

Domain	Tests Used
Visual Episodic Memory	Brief Visuospatial Memory Test - Learn, Delay
Verbal Episodic Memory	Hopkins Verbal Learning Test - Learn, Delay
Attention/Working Memory	Paced Auditory Serial Addition Test, & WMS-III Spatial Span
Fluency	Word Sound Fluency Test- FAS, Animals, Actions, Stroop Word Test.
Speed of Information Processing	Trails, Color Trails1, Digit Symbol, Symbol Search, & Stroop Color.
Executive Function	Color Trails2, Category Test Errors, Wisconsin Card Sorting Test - Total Errors, & Stroop Colour Word Test.
Motor Function	Grooved Pegboard - Pegs Dominant hand & Pegs Nondominant hand.
Global	All of the above

The first objective of the study was to establish if there is a significant difference in mean test scores on the neuropsychological tests between the rural and urban participants. The independent sample T-test was used to compare the mean scores on the continuous variable (test performance) for two different and independent groups of people (rural and urban participants).

The second objective of the study was to assess which tests in the Zambia Neurobehavioural Test Battery are more affected by the participant's residence. To assess effect size of residence on all the tests, the Eta Squared values were generated using SPSS Version 15.0.

The third, fourth and fifth objectives were to determine the extent to which education (both years of and quality of), gender and age respectively, predict test performance on neuropsychological tests for both rural and urban participants. To find out the predictive ability of education, gender and age as well as the statistical significance of their predictive power, multiple regression analysis was carried out. Multiple regression is a statistical technique that allows for prediction of the participants' scores on one variable on the basis of their scores on several other variables (Pallant, 2007). In this case, the main purpose was to determine how the participants' education, gender and age could predict performance on the neuropsychological tests and how these stated independent variables would together with the independent variable of residency, individually and/or collectively predict outcomes of the NP tests domain of the ZNTB. This analysis helped in providing information about the model as a whole (dependent variables: education – years of and quality of, gender, age and including residency itself) and relative contribution of each of the variables that made up the model. Multiple regression in this analysis was also used to statistically control for the additional variables when exploring the predictive ability of the model. The other important justification for running this analysis was to provide necessary information as to whether residency (as a particular predictor variable), would still be able to predict an outcome when the effects of other variables (education, gender and age) were controlled for.

The Enter method of multiple regression in SPSS version 15.0 was used. Education (both years of, and ZAT scaled scores as an index of quality of education), gender, age and residency (rural/urban) were used as predictor/independent variables while the mean scores for the respective test domains including visual episodic memory, verbal episodic memory, attention/working memory, language fluency, speed of information processing, executive function, and motor speed tests were used as dependent variables.

CHAPTER 4

4.0. RESULTS

4.1. Comparison of Rural and Urban Participants on NP Tests

Based on available literature, the first hypothesis in this study was that urban participants will perform better than their rural counterparts on all the neuropsychological tests in the Zambia Neurobehavioural Test Battery (ZNTB). An independent samples t-test was run on SPSS Version 15.0 to determine if there were any significant differences on the scaled mean scores on all the seven neuropsychological tests domains of the ZNTB. The results of the study revealed that the difference in performance between the rural and the urban participants was statistically significant (i.e. not likely to have occurred by chance) on all the seven domains with the latter being superior. See Table 2.

On the visual episodic memory domain, the urban participants performed significantly better than the rural participants. Rural (M = 9.64, SD = 2.88) and urban, (M = 11.47, SD = 3.00) t (232) = -4.58, $p < .005$ (two tailed).

On the verbal episodic memory domain, the urban participants performed significantly better than the rural participants. Rural (M = 9.63, SD = 2.74) and urban, (M = 11.72, SD = 2.73) t (232) = -5.57 $p < .005$ (two tailed).

On the verbal fluency domain, the urban participants performed significantly better than the rural participants. Rural (M = 9.75, SD = 2.18) and urban, (M = 12.10, SD = 1.67) t (232) = -8.50, $p < .005$ (two tailed).

On the speed of information processing domain, the urban participants performed significantly better than the rural participants. Rural (M = 9.62, SD = 2.13) and urban, (M = 11.63, SD = 2.02) t (232) = -7.02, $p < .005$ (two tailed).

On the executive functioning domain, the urban participants performed significantly better than the rural participants. Rural (M = 9.93, SD = 1.99) and urban, (M = 10.97, SD = 2.28) t (232) = -3.59, $p < .005$ (two tailed).

On the attention/working memory domain, the urban participants performed significantly better than the rural participants. Rural (M = 9.80, SD = 2.19) and urban, (M = 11.20, SD = 2.49) t (232) = -4.45, $p < .005$ (two tailed).

On the motor/dexterity domain, the urban participants performed significantly better than the rural participants. Rural (M = 9.72, SD = 2.19) and urban, (M = 11.04, SD = 2.82) t (232) = -3.63, $p < .005$ (two tailed).

Table 2: Mean Differences between Rural and Urban Participants on NP Tests

NP Tests Domains	Residency	N	Mean	Std. Deviation	***P***
Visual episodic memory	Rural	152	9.64	2.88	<.005*
	Urban	82	11.47	3.00	
Verbal episodic memory	Rural	152	9.63	2.74	<.005*
	Urban	82	11.72	2.73	
Verbal fluency	Rural	152	9.75	2.18	<.005*
	Urban	82	12.10	1.67	
Speed of information processing	Rural	152	9.62	2.13	<.005*
	Urban	82	11.63	2.02	
Executive functioning	Rural	152	9.93	1.99	<.005*
	Urban	82	10.97	2.28	
Attention/Working memory	Rural	152	9.80	2.19	<.005*
	Urban	82	11.20	2.49	
Motor/dexterity	Rural	152	9.72	2.56	<.005*
	Urban	82	11.04	2.82	

* Results significant at $p < .05$ with 95% confidence

As evident from Table 2 from an independent samples t-test to compare the means of scores on the seven domains of the ZNTB, the urban participants performed significantly better on all the domains than their rural counterparts.

4.2. Effect size of residency (rural/urban) on the neuropsychological tests

The second objective of this study was to assess which tests on the Zambia Neurobehavioural Test Battery are more affected by the participant's residence. In this regard it was hypothesized that tests of verbal fluency would be more affected by the participants' residence (rural/urban). This objective was achieved by generating eta squared values using SPSS. These values may as well be obtained using the following formula:

$$\text{Eta squared} = \frac{t^2}{t^2 + N - 1}$$

Although the differences were statistically significance on all the domains of the ZNTB with probability values (*p values)* less than .005, and hence unlikely to occur by chance, they do not indicate much about the magnitude of the intervention's effect (residency – rural/urban). This was the justification for running this effect size statistic. Thus, finding the effect size of residence helped in identifying which tests had residency (rural/urban) as a variable influencing participants' performance on the ZNTB over and above any confounding factors. "One way that you can assess the importance of your findings is to calculate the 'effect size' (also known as 'strength of association'). This is a set of statistics that indicate the relative magnitude of the difference between means, or the amount of the total variance in the dependent variable that is predictable from knowledge of the levels of the independent variable (Tabachnick & Fidell 2007:54) in Pallant (2007). In interpreting the strength of the different effect size statistics, see Table C_1 in Appendix C.

On the visual episodic memory, the magnitude of the difference in the means (mean difference = -1.83, 95% CI: -2.62 to -1.04) was moderate (eta squared = .083). This indicates that residency (rural/urban) had the effect of 8.3% in explaining the difference in the performance of the participants on visual episodic memory. This influence was neither large nor small but rather moderate.

On the verbal episodic memory, the magnitude of the difference in the means (mean difference = -2.09, 95% CI: -2.83 to -1.35) was also moderate (eta squared = .118). Residency therefore, had the effect of 11.8% in explaining the difference in the performance of the participants on the verbal episodic memory which was moderate.

With regard to the verbal fluency domain, the magnitude of the difference in the means (mean difference = -2.35, 95% CI: -2.89 to -1.80) was large (eta squared = .238). The implication here was that residency (rural/urban) had contributed 23.8% in explaining the difference of participants on the verbal fluency domain.

On the speed of information processing domain, the magnitude of the difference in the means (mean difference = -2.01, 95% CI: -2.58 to -1.45) was also large (eta squared = .175), indicating the effect size of residency (rural/urban) of 17.5%.

On the executive functioning domain, the magnitude of the difference in the means (mean difference = -1.03, 95% CI: -1.60 to -.47) was small (eta squared = .053) indicating only 5.3% influence of residency (rural/urban).

On the attention/working memory domain, the magnitude of the difference in the means (mean difference = -1.40, 95% CI: -2.02 to -.78) was moderate (eta squared = .079), indicating 7.9% influence of residency (rural/urban).

On the motor/dexterity domain, the magnitude of the difference in the means (mean difference = -1.32, 95% CI: -2.04 to -.61) was small (eta squared = .054) indicating 5.4% influence of residency (rural/urban).

Table 3 below shows the relative effect sizes of residence on the seven domains of the ZNTB. It should be noted here that the order in which they have been appearing has been deliberately rearranged so as to follow the descending order of the effect sizes (eta squared values) on all the domains.

Table 3: Effect sizes of Residency on the NP Tests Domains of the ZNTB

NP Tests Domains	Residency	N	Mean	Std. Deviation	*P*	Eta squared value
Verbal fluency	Rural Urban	152 82	9.75 12.10	2.18 1.67	<.005*	.238
Speed of information processing	Rural Urban	152 82	9.62 11.63	2.13 2.02	<.005*	.175
Verbal episodic memory	Rural Urban	152 82	9.63 11.72	2.74 2.73	<.005*	.118
Visual episodic memory	Rural Urban	152 82	9.64 11.47	2.88 3.00	<.005*	.083
Attention/Working memory	Rural Urban	152 82	9.80 11.20	2.19 2.49	<.005*	.079
Motor/dexterity	Rural Urban	152 82	9.72 11.04	2.56 2.82	<.005*	.054
Executive functioning	Rural Urban	152 82	152 82	1.99 2.28	<.005*	.053

* Results significant at $p < .05$ with 95% confidence

As can be seen from Table 3, residency (rural/urban) had a large effect size with regard to performance on the domains of verbal fluency and speed of information processing. The effect of residency was moderate/medium on the domains of verbal episodic memory, visual episodic memory and attention/working memory. The effect size of residency was however, small in the domains of motor/dexterity and executive functioning. The influence of residency on the performance of the seven domains of the ZNTB was therefore, either large or moderate in five and was small only in two.

4.3. Predictive power of education, gender and age on test performance for rural and urban participants

Standard multiple regression was used to assess the ability of four independent/predictor variables (education – years/level of and quality of, gender, age, and residency – rural/urban) to predict NP tests performance on the seven domains of the Zambia Neurobehavioural Test Battery (ZNTB). This was done to find out how each of the stated independent variable would perform in predicting tests performance on each of the seven domains as a model as well as the contribution that each of them would have when the influence of the other variables in the model were controlled for. This analysis would thus help in identifying which specific domains residency would still predict performance of participants on NP tests over and above the stated variables.

It was hypothesized that the years of education and age would contribute to the participants' performance on the neuropsychological tests for both rural and urban participants, while gender would not. Thus, education and age would be a better predictor of NP tests performance than gender for both rural and urban participants.

On the visual episodic memory tests, the *R Square* value was .252 with the model as a whole, $p < .005$. The *Beta* values (ignoring the negative signs) under standardized coefficient were as follows: the largest beta value was -.372 for age with a $p < .005$; the next was ZAT_SS, .160 with $p = .028$; and lastly residency, .127 with $p = .05$. Thus, quality of education indexed by the ZAT scaled scores, age and residency contributed to the model, while the contribution by the years/level of education and gender of the participants was statistically insignificant. On the visual episodic memory domain, residency and education are relatively strongly correlated ($r = .41$); residency and ZAT_SS are relatively moderately correlated ($r = .38$); residency and gender are weakly correlated ($r = -.12$); and residency and age are weakly correlated ($r = -.10$). The sig.

values for education and ZAT_SS, $p < .005$, indicating that both level of and quality of education made significant unique contributions to the model. The sig. values for gender ($p = .038$) and age ($p = .071$), indicating that gender and age did not make significant unique contributions to the prediction of performance on visual episodic memory domain.

On the verbal episodic memory tests, the *R Square* value was .188 with the model as a whole, $p < .005$. The *Beta* values (ignoring the negative signs) under standardized coefficient were as follows: the largest beta value was -.198 for age with a $p = .001$; the next was years of education, .180 with $p = .019$; and lastly residency, .155 with $p = .022$. Thus, years of education, age and residency contributed to the model, while the contribution by quality of education and gender of the participants was statistically insignificant. On the verbal episodic memory domain, residency and education are relatively strongly correlated (r = .41); residency and ZAT_SS are relatively moderately correlated (r = .38); residency and gender are weakly correlated (r = -.12); and residency and age are weakly correlated (r = -.10). The sig. values for education and ZAT_SS, $p < .005$, indicating that both level of and quality of education made significant unique contributions to the model. The sig. values for gender ($p = .038$) and age ($p = .071$), indicating that gender and age did not make significant unique contributions to the prediction of performance on verbal episodic memory domain.

On the verbal fluency tests, the *R Square* value was .447 with the model as a whole, $p < .005$. The *Beta* values (ignoring the negative signs) under standardized coefficient were as follows: the largest beta value was .322 for years of education with a $p < .005$; the next was ZAT_SS, .265 with $p < .005$; next was residency, .218 with $p < .005$; and lastly age, -.115 with $p = .025$. Thus, years of education, ZAT_SS, residency and age contributed to the model, while the contribution by gender of participants was statistically insignificant. On the verbal fluency domain, residency and education are relatively strongly correlated (r = .41); residency and ZAT_SS are relatively moderately correlated (r = .38); residency and gender are weakly correlated (r = -.12); and residency and age are weakly correlated (r = -.10). The sig. values for education and ZAT_SS, $p < .005$, indicating that both level of and quality of education made significant unique contributions to the model. The sig. values for gender (p = .038) and age (p = .071), indicating that gender and age did not make significant unique contributions to the prediction of performance on verbal fluency domain.

On the speed of information processing, the *R Square* value was .402 with the model as a whole, $p < .005$. The *Beta* values (ignoring the negative signs) under standardized coefficient were as follows: the largest beta value was -.375 for age $p < .005$; the next was years of education, .226 with $p = .001$; next was residency, .195 with $p = .001$; and lastly ZAT_SS, .163 with $p = .012$. Thus, years of education, ZAT_SS, residency and age contributed to the model, while the contribution by gender of participants was statistically insignificant. On the speed of information processing, residency and education are relatively strongly correlated (r = .41); residency and ZAT_SS are relatively moderately correlated (r = .38); residency and gender are weakly correlated (r = -.12); and residency and age are weakly correlated (r = -.10). The sig. values for education and ZAT_SS, $p < .005$, indicating that both level of and quality of education made significant unique contributions to the model. The sig. values for gender (p = .038) and age (p = .071), indicating that gender and age did not make significant unique contributions to the prediction of performance on speed of information processing domain.

On the executive functioning domain, the *R Square* value was .230 with the model as a whole, $p < .005$. The *Beta* values (ignoring the negative signs) under standardized coefficient were as follows: the larger beta value was -.302 age with $p < .005$; the next was years of education, .153 with $p = .041$. Thus, only years of education and age contributed to the model, while the contribution by ZAT_SS, gender and residence of participants was statistically insignificant. On the executive functioning domain, residency and education are relatively strongly correlated (r = .41); residency and ZAT_SS are relatively moderately correlated (r = .38); residency and gender are weakly correlated (r = -.12); and residency and age are weakly correlated (r = -.10). The sig. values for education and ZAT_SS, $p < .005$, indicating that both level of and quality of education made significant unique contributions to the model. The sig. values for gender (p = .038) and age (p = .071), indicating that gender and age did not make significant unique contributions to the prediction of performance on executive functioning domain.

On the attention/working memory domain, the *R Square* value was .228 with the model as a whole, p < .005. The *Beta* values (ignoring the negative signs) under standardized coefficient were as follows: the largest beta value was .202 for ZAT_SS with p < .005; next was -.177 for age with a p = .003; and lastly was gender, -.166 with p < .005. Thus, only ZAT_SS, age and gender of participants contributed to the model, while the contribution by years of education, and residency of participants was statistically insignificant. On the attention/working memory domain, residency and education are relatively strongly correlated (r = .41); residency and ZAT_SS are relatively moderately correlated (r = .38); residency and gender are weakly correlated (r = -.12); and residency and age are weakly correlated (r = -.10). The sig. values for education and ZAT_SS, p < .005, indicating that both level of and quality of education made significant unique contributions to the model. The sig. values for gender (p = .038) and age (p = .071), indicating that gender and age did not make significant unique contributions to the prediction of performance on attention/working memory domain.

On the motor/dexterity domain, the *R Square* value was .221 with the model as a whole, p < .005. The *Beta* values (ignoring the negative signs) under standardized coefficient were as follows: the largest beta value was .278 for years of education with a p < .005; the next was age, .260 with p < .005; and lastly was residency, .168 with p = .011. Thus, years of education, age and residency contributed to the model, while the contribution by ZAT_SS and gender of participants was statistically insignificant. On the motor/dexterity domain, residency and education are relatively strongly correlated (r = .41); residency and ZAT_SS are relatively moderately correlated (r = .38); residency and gender are weakly correlated (r = -.12); and residency and age are weakly correlated (r = -.10). The sig. values for education and ZAT_SS, p < .005, indicating that both level of and quality of education made significant unique contributions to the model. The sig. values for gender (p = .038) and age (p = .071), indicating that gender and age did not make significant unique contributions to the prediction of performance on motor/dexterity domain.

Table 4: Contribution of predictor variables in explaining test performance on NP Tests

Independent/predictor variables	Dependent variable	R Square	Standardized Coefficients Beta	Model *p*	***P***
Years of education ZAT_SS Gender Age Residency (rural/urban)	Visual episodic memory	.252	.081 .160 -.083 -.372 .127	<.005*	.265 .028* .157 <.005* .050*
Years of education ZAT_SS Gender Age Residency (rural/urban	Verbal episodic memory	.188	.180 .105 -.063 -.198 .155	<.005*	.019* .165 .299 .001* .022*
Years of education ZAT_SS Gender Age Residency (rural/urban	Fluency	.447	.322 .265 -.019 -.115 .218	<.005*	<.005* <.005* .698 .025* <.005*
Years of education ZAT_SS Gender Age Residency (rural/urban	Speed of information processing	.402	.226 .163 -.060 -.375 .195	<.005*	.001* .012* .248 <.005* .001*
Years of education ZAT_SS Gender Age Residency (rural/urban	Executive functioning	.230	.153 .114 -.114 -.302 .122	<.005*	.041* .120 .055 <.005* .064
Years of education ZAT_SS Gender Age Residency (rural/urban	Working memory	.228	.145 .202 -.166 -.177 .118	<.005*	.052 .006* <.005* .003* .073
Years of education ZAT_SS Gender Age Residency (rural/urban	Motor	.221	.278 -.057 .033 -.260 .168	<.005*	.005* .438 .584 <.005* .011*

* Results significant at $p < .05$ with 95% confidence

From the results, it was discovered that age of participants had a statistically significant contribution to all the seven NP tests domains of ZNTB. The years of education as an independent variable contributed to the model in five of the seven domains of the ZNTB, while ZAT_SS contributed to the model in four of the domains. Residency had a statistically significant contribution to the model in five of the domains. Gender however, had a statistically significant contribution to only one of the domains of the ZNTB. For details, see Table 4.

CHAPTER 5

5.0. DISCUSSION

5.1. Comparison of Rural and Urban Participants on Neuropsychological Tests

This study was mainly designed to compare the performance of rural and urban adult population on the performance of neuropsychological tests in Zambia. The results generated were also to be part of the data to contribute to the formulation of normative data for neuropsychological tests in Zambia.

Of all the neurocognitive domains of the ZNTB, as hypothesized, the urban participants performed better than their rural counterparts. Thus, in all the NP test domains, the performance as assessed by mean scaled scores suggests that generally, the urban group demonstrates NP tests performances superior to their rural counterparts. T-tests that were carried out to compare the means of the scaled scores of the ZNTB domains actually indicated that the differences in performance between the rural and urban participants were in actual fact, statistically significant all the seven domains.

As was observed from the literature reviewed, the influence of residency on NP tests was elucidated. For example, there was the assertion that beyond traditional considerations of age, education and in many cases, gender (Finlayson, Johnson & Reitan, 1977; Heaton et al., 1996) in Gupta et al., (2011), as defining a normative standard against which a given neurocognitive performance may be interpreted, the influence of other demographic and personal factors, such as literacy (Dotson et al., 2008; Manly et al., 1999; Manly et al., 2002) in Gupta et al., (2011) and ethnicity (Heaton, Taylor & Manly, 2003; Heaton et al., 2004; Heaton et al., 2009) in Gupta et al., (2011), have begun to be appreciated. With an exception of gender, the above stated factors such as age, education and literacy may have contributed in explaining the results that were eventually found. This is so in that formal education, which is a factor that is experienced differentially between the rural and the urban and in most cases favouring the latter, would be a clear and plausible justification to account for the urban participants performing better.

This is so in that the urban participants may have understood the instructions better and easily than their rural counterparts, they may have had more experience with the tests administered to them than their rural counterparts and they may have been freer with the testing environment and test administrators. This may not have been the case with the rural participants.

Some tests were administered on computers. This may have been an issue with the rural participants as computers to most rural participants was viewed as something ‘alien’ in their lives and were actually using them for the very first time. This may also have had an effect. These tests were all administered in English. The use of English is very common in urban areas, a feature which is rare in rural areas. This was particularly so for tests of verbal fluency.

As hypothesized in this study, the urban participants indeed performed better than their rural counterparts, in fact not only on most, but rather on all the NP tests on the ZNT.

5.2. Effect size of residency (rural/urban) on the neuropsychological tests

It was found in this study that the urban participants clearly performed better than their rural counterparts on all the neuropsychological tests domains, all recording significant statistical differences. These were shown by the *eta squared* values that were generated for all the independent t-test analyses. The effect size of residency was large in two domains namely, *verbal fluency* and *speed of information processing*. This research finding addressed the second specific objective in this study which sought to assess which tests on the Zambia Neurobehavioural Test Battery were more affected by the participants’ residency (rural/urban). Verbal fluency and speed of information processing as NP tests domains are therefore clearly sensitive to the variable of residence (rural/urban) as the effect size of this independent variable is large.

This research finding to a large extent reflects what was expected in the study. One justification is that the urban population in Zambia is generally more comfortable and conversant with English, which is the language in which all the tests were administered. English is the official language in Zambia and the main language of instruction in all educational institutions in Zambia – schools, colleges and universities. However, there are about seventy-two tribes in Zambia. Given the diversity in the local languages in different parts of the country, it is practically easier for people to use and communicate in English. Thus, with regard to rural areas, the populations there are more homogeneous, many people still communicate in their local languages, despite having attained some higher levels of education. Most of the rural dwellers also generally have lower levels of education and generally lower quality of education as compared to their urban counterparts. The populations in urban areas of Zambia however, are more heterogeneous, especially with regard to the use of language. English is to a lager extent, a *lingua franca* in Zambian urban areas. Therefore, these factors plausibly account for the large effect size that residency (rural vs urban) has on how someone performs on verbal fluency tests. General lifestyle could be another factor as to why residency (rural vs urban) had a large influence on participants' performance on speed of information processing. It was generally observed that rural participants were apparently more 'concerned' with performing tasks 'as accurately as possible' as opposed to 'as quickly as possible' even on tests that required them to be quick and even if they were reminded to do the tasks as quick as they could.

There was moderate/medium effect of residency (rural vs urban) on the domains of *visual episodic memory; verbal episodic memory;* and *attention/working memory.* The eta squared values explaining the effect of residency in these stated domains were all in-between .01 to .138, which according to Cohen (1988) represent a medium/moderate effect size. For more information on how the effect sizes are categorized, see Table C_1 in Appendix C. The influence of the factors such as education and acculturation differentially associated with the mere geographical location of rural and urban may be plausibly the justification accounting for these disparities in performances. The other factors influencing this outcome could have been general lifestyles favoring most urban populations with regard to their performance on NP tests as compared to most of their rural counterparts: access to IT and other electronic facilities – computers, TVs and cell phones; working environments which require them to perform many different tasks simultaneously; and the complexity of environmental cues such as buildings.

With regard to the domains of *executive functioning* and *motor speed/dexterity*, even if there was a statistically significant mean difference between rural and urban participants, the urban participants performing better, the effect size of residency was small (eta values, 0.53 and 0.54 respectively).

It was expected however, that with regard to the domain of executive functioning, there would be a large or moderate effect of residency (rural vs. urban) mainly because this domain included two tests to be done on computers – Halsted Category Test and WCST. The use of computers is something novel to most of the people in rural areas of Zambia, but the phenomenon very familiar with many of the urban populations of Zambia. Most of the participants were actually using a computer for the first time. Despite this factor as well as other factors such as general lifestyle in rural and urban areas, the effect size of residency was small, with the eta squared value of .053, very close to the score for moderate effect though which is between 0.06-0.138. Thus, even if the urban populations performed significantly better than their rural counterparts, the fact that one lived most or all of his/her life in a rural or urban area did not alter much his/her score on tests of executive functioning and motor/dexterity functioning. The justification for this finding may be plausibly attributed to the fact that influence of education, acculturation or general way of life may not really have a major effect on an individual performs on motor functioning for instance as it has very little to do with the stated variable but rather has so much to do with the physiological condition of an individual. Even if cognitive abilities are certainly important with regard to the domain of executive functioning, there is some form of planning such as farming, trading and so forth even in rural areas. These two domains may thus understandably not have so much difference on participants' performances with regard to the rural/urban dichotomy. The statistically significant disparity in the means of independent t-test scores in the findings however may be to a larger extent, attributed to the understanding of instruction and comfortability of the participants during the administration process of the NP tests which as has been stated already, favoured the urban participants.

Generally, it may be stated that residency had either a large or moderate effect size as an independent variable on five of the seven NP tests domains of the ZNTB. This clearly is a considerable contribution that residency as a variable may play with regard to NP tests.

5.3. Predictive power of education, gender and age on test performance for rural and urban participants

The third objective was to determine the extent to which education (both years of and quality of), gender and age respectively, predict test performance on neuropsychological tests for both rural and urban participants. This was done mainly to substantiate the assertion that the influence of residency on neuropsychological tests is in the context of other associated variables especially that of education which is mostly different between rural and urban areas. While gender as a variable is not supported very much by literature with regard to the influence it has on a number of NP tests, education and age have substantial literature supporting them as is evidenced from a number of studies that have been done (Strauss et al., 2006). Thus, with regard to the background of the literature reviewed that indicated that among the underlying factors of residency (rural/urban) in influencing one's performance on NP tests, education would have a unique substantial contribution. Therefore, to determine the predictive ability as well as the statistical significance of its predictive power of education, gender, age and residency, a standard multiple regression was used.

The *Beta* values generated on the NP tests domain (as dependent variables) in the ZNTB concerning the above stated independent/predictor variables, provided information so as to know which of the variables in the model contributed to the prediction of the dependent variables. This analysis was done on all the seven domains of the ZNTB.

From the results, it was discovered that age of participants had a statistically significant contribution to all the seven NP tests domains of ZNTB. The years of education as an independent variable contributed to the model in five of the seven domains of the ZNTB, while ZAT_SS contributed to the model in four of the domains. Residency had a statistically significant contribution to the model in five of the domains. Gender however, had a statistically significant contribution to only one of the domains of the ZNTB.

From the results, it can be seen that age of participants had a statistically significant contribution to all the seven NP tests domains of ZNTB. In fact, age had the largest contribution in the model for three domains, namely, visual episodic memory, verbal episodic memory, speed of information processing and executive functioning. The negative sign is important here in explaining the implication of the findings of this study. The negative sign indicates that the age was inversely proportional to the performance on the respective dependent variables. The implication of this is that as much as age had a statistically significant contribution to the model on all the domains, the older the participants were, the poorer their performance on NP tests. The influence of age on NP tests is well documented by a number of studies (Strauss et al., 2006). As can be seen from Appendix C, there was not so much correlation between age and residency and hence the contribution by age may not have accounted so much to the urban participants performing superiorly on the premise that urban sample was substantially represented more by younger participants as compared to rural ones.

The years of education as an independent variable contributed to the model in five of the seven domains of the ZNTB, namely, verbal episodic memory, verbal fluency, speed of information processing, executive functioning and motor/dexterity. ZAT_SS contributed to the model in four of the domains, namely, visual episodic memory, verbal fluency, speed of information processing and attention/working memory. Years of education had the most contribution in verbal fluency and motor/dexterity, while

ZAT_SS had the most contribution in working memory. The contribution thus, by the years of education and quality of education may not be overlooked. This is more so regarding the fact that there was relatively substantial correlation between residency and years of education on one hand and residency and ZAT_SS on the other. There is relatively less correlation between residency and age on one hand and residence and gender on the other. See appendix C, Tables $C_{1.1.}$ – $C_{7.3.}$ to see the various correlations of the predictor variables in the model. The implication of this finding could plausibly explain further why the urban participants had performed better from the findings of the earlier analyses of independent samples t-tests. The urban participants therefore were more likely to be represented by participants with higher levels and quality of education that their rural counterparts.

Gender was not really a factor with regard to the influence it had on NP tests performance. This can be seen from the statistically insignificant contribution that it had on all except one NP tests domain (working memory) to the model generated from the multiple regression that was conducted. Gender representations therefore, on both urban and rural participants respectively were not at all a factor in contributing in explaining the findings in the model, except in the domain of working memory. The fact that the Beta value is negative, the implication on this particular domain (working memory) is that the males performed better than their female participants considering the coding that had been used was 1 for the males and 2 for the females.

Residency had a statistically significant contribution to the model in five of the domains, namely, visual episodic memory, verbal episodic memory, verbal fluency, speed of information processing motor/dexterity. Especially with regards to verbal fluency and speed of information processing, the findings are consistent with the large effect sizes that were found in this study when the eta squared values were generated to assess the influence of residence on all the seven domains of the ZNTB. For more details on the results of this multiple regression, see Appendix C. According to the model of predictor/independent variables that was used in this analysis, residency never had statistically significant contribution to the domains of executive functioning and working memory. Especially for the domain of executive function on which the effect size was found to be small considering the eta squared value, this finding is consistent considering that in this particular, there was a similar finding. It should be noted here however, that residency as a predictor variable is an ‘umbrella’ that has within it a number of factors such as education and acculturation that makes it a better predictor of performance on NP tests in developing countries as compared to a single independent/predictor variable of education, age, gender, etc., assessed individually.

The findings of this study are to a larger extent, consistent with those of a similar study that was conducted in China among the rural and urban adults. This study conducted by Gupta et al., (2011) revealed some interesting information with regard to the influence that residency (rural/urban) would have on one’s performance on NP tests. In this particular study, analysis of matched samples from urban and rural locales in China afforded these researchers the opportunity to evaluate the extent to which long-term rural versus urban residence, and myriad associated factors may influence NP tests performance while controlling for basic demographic factors such as age, educational attainment and gender. For instance, it was discovered that particularly in the developing world, urban versus rural residency may differentially affect numerous factors that could influence cognitive tests performances, including quality of both formal and informal educational experiences and access to optimal nutrition and health care. Such disparities thus, may necessitate corrections for urban/rural demographic factors in NP norms.

The main limitation or challenge in this study with regard to elucidating underlying or associated factors accounting for the differences between rural and urban participants on NP tests performance is that there appears to be a complex interplay of several factors. Further, while some of these factors such as education, age, gender and occupation may easily be quantitatively analyzed, other factors such as culture would not. For instance, culture would embody several other subdivisions such as beliefs, language and attitudes.

The other limitation was that a number of research sites that were considered ‘rural’ were those that are not really distant or remote from towns and cities. These areas though called ‘rural areas,’ they were selected mostly for convenience mostly due to limited resources and time. Thus, it is felt that the difference between the rural areas and urban areas with regard to performance on NP tests might have been more pronounced had typical or remote rural areas been selected.

The testing rooms in a number of sites were not very convenient for conducting NP tests as the test administrations were in a number of times confounded by noise and poorly lit rooms. Some research participants would not want to reveal their real age or their highest level of education attained.

Even if there was a possibility of setting out to exhaust all the factors that were responsible for the rural-urban differences in this study as way of analyzing the influence of each factor, such an undertaking would obviously be an intrusion or rather tautology as most of these factors (level and quality of education, literacy, SES, health and culture) mentioned in several places in this study are topics that have presumably been dealt with in detail as this study is just part of a larger study that has one other objective of formulating normative standard for Zambia.

What may clearly be stated however as far as this particular study is concerned, from the analyses that have been carried out especially the t-tests on the separate NP tests domains comparing the means of rural and urban participants, there is actually a statistically significant difference between rural and urban participants with the latter outperforming the former. Therefore, despite the limitations of this study, the findings in this study reveal some important information with regard to the differences that exist between the rural and urban participants.

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

It has been observed from this study that residency (rural/urban) is indeed a major factor with regard to the influence that it has on the performance of an individual on neuropsychological tests. This was very clear as supported by the evidence from the independent samples t-tests that were done to compare the mean scores of the rural versus urban participants across the seven cognitive domains in the ZNTB. The mean differences on the scaled scores actually indicated statistical differences in all the seven domains, the urban participants being superior in their performance on neuropsychological tests, across various age groups and levels of education.

The effect size as indexed by the eta values indicated that residency particularly had large effect sizes on two neurocognitive domains: verbal fluency and speed of information processing. On three of the domains: visual episodic memory; verbal episodic memory and attention/working memory, the effect size of residency was moderate. However, for only two of the domains, even if there was also a statistical significance with regard to the mean differences between rural and urban participants, the effect size was small.

A standard multiple regression that was conducted also revealed that age, education and residence all were predictive of performance on NP tests domains of the ZNTB. Gender did not have a statistical contribution to the influence on performance on NP tests.

Residency therefore, of an individual having stayed most or all of his/her life either in a rural or urban area, in a country such as Zambia, may have some salient influence on how he/she performs on neuropsychological tests and it is imperative that this variable is taken into consideration in the subsequent researches and interpretations of the data collected on NP tests.

This research is part of an ongoing larger study aimed at formulating the normative standard for Zambia with regard to neuropsychological tests. It would thus be ideal and plausible to have the inclusion of the factor of residency in the normative data for Zambia and whenever neuropsychological tests are done on the populations concerned, either for subsequent research, for diagnosis or intervention. This factor of residency should thus, not just be overlooked, especially in developing countries such as Zambia, where the differences between urban and rural areas may be very pronounced not only in neuropsychological tests, but in psychological and educational tests as well. For appropriate, effective and efficient assessment and diagnosis of various neurocognitive and neurobehavioural deficits, it is thus necessary to carefully assess such factors as residency and other salient factors that may have profound influence on someone's performance on neuropsychological tests. The influence of other demographic factors has begun to be appreciated though. In the developing world, urban versus rural residence may differentially affect numerous factors that could influence cognitive test performances, including quality of both formal and informal educational experiences, and access to optimal nutrition and health care. Such disparities may necessitate corrections for urban/rural demographic factors in NP norms. The implication of this is also that when interpreting the tests scores on a NP tests, it is imperative to bear in mind of many variables that may explain the particulars score that an individual gets. This would help greatly in effectively and efficiently assessing, diagnosing and treating individuals with neuropsychological and neurocognitive deficits.

It would be prudent to recommend that further studies be conducted in this field. This would be important to among other reasons, to explore other associated variable to residency that would influence participants' on NP tests. It would also be ideal to adapt, standardize and possibly develop some tests in the field of NP so as be culturally fair and appropriate for assessment, diagnosis and treatment of patients with neurocognitive and neurobehavioral disorders in Zambia.

REFERENCES

Alcock, K.J.; Holding, P.A.; Mung'ala-Odera, V.; and Newton, C.R. Journal of Cross Cultural Psychology Vol XX, Number X, retrieved August 10, 2009 from http://www.ncibi.nih.gov.pubmed

Ardila, A (2005). Cultural Values Underlying Psychometric Cognitive Testing. Neuropsychology Review, Volume 15, Number 4 / December, 2005, pp. 185-195

Armengol, C., G. (2002). Stroop Test in Spanish: Children's Norms. The Clinical Neuropsychologist, 16(1) 67 —80

Basso, M.R. (1999). Practice Effects on Commonly Used Measures of Executive Tests British. Journal of Clinical Psychology, 43, 623 – 628.

Benton, A.L. (1994). Multilingual Aphasia Examination, (3rd ed.). San Antonio, IX: Psychological Corporation.

Berch, D.B., Krikorian, R. and Huha, E. H. (1998). The Corsi Block Tapping Test: Methodological and Theoretical Considerations. Brian and Cognition. 38 (3) 317-338.

Berry (1989) Retrieved on October 2, 2009 from http://www.braininjurylawblog.com/brain-injury-news-new-study-examines-cultural-bias-in-neuropsychological-testing.html

Borkowski J., Benton, A., Spreen, O. (1967). Word Fluency and Brain Damage *Neuro-pyschologia*, 5, 135 – 140.

Borland, M.V. and Howsen, R.M. (1999). American Journal of Economics and Sociology, " A Note on Student Academic Performance: In Rural Versus Urban Areas" July, 1999.

Bowden, S.C., Fowler, K.S., Bell, R.C., Whelan, G., Clifford, C.C., et al (1998). The Reliability and Internal Validity of the Wisconsin Card Sorting Test, Neuropsychological Rehabilitation, 8 (3), 243–254.

Central Statistical Office (2003) "Zambia 2000 Census of Population and Housing: Zambia Analytical Report, Vol. 10" Lusaka: November, 2003.

Claassen, N. C. W., Krynauw, A. H., Hotzhauzen, H., & Mathe, M. (2001). A standardization of the WAIS-III for English-speaking South Africans. Modified Report. Pretoria: Human Sciences Research Council.

Clay, J.O., Edwards, J.D., Ross, L.A., Okonkwo, O., Wadley, G.V., Roth, D.L., et al. (2009). Visual Function and Cognitive Speed of Processing mediate Age-related Decline in Memory Span and Fluid Intelligence. Journal of Aging and Health, 21.547.

Cohen, J.W. (1988). Statistical Power Analysis for Behavioural Sciences (2nd edn). Hillsdale. NJ: Lawrence Erlbaum Associate Eckermana, D.A.; Lincoln, S.; Gimenesa, R.C.; Galvãoa, P.R.; Sarcinellib, P.N.; and Chrismanb, J.R. (2007). Age related effects of pesticide exposure on neurobehavioral performance of adolescent farm workers in Brazil. Neurotoxicology and Teratology Volume 29, 1, January-February 2007, 164-175

Donders, and Tulsky. (2001). In Strauss, E., Sherman, M.S.E., & Spreen, O. (2006). A Compendium of Neuropsychological Tests: Administration, Norms, and Commentary (3rd Ed.) (pp.300). Oxford: Oxford University Press.

Eckermana, D.A.; Lincoln, S.; Gimenesa, R.C.; Galvãoa, P.R.; Sarcinellib, P.N.; and Chrismanb, J.R. (2007). Age related effects of pesticide exposure on neurobehavioral performance of adolescent farm workers in Brazil. Neurotoxicology and Teratology Volume 29, Issue 1, January-February 2007, Pages 164-175

Ellwanger, J., Tenhula, W.N., Rosenfeld, P., & Sweet, J.J. (1999). Identifying simulators of cognitive deficit through combined use of neuropsychological test performance and event-related potentials. Journal of Clinical and Experimental Neuropsychology.

Gaylard, E.K. (2005). Cross-cultural differences in IQ test performance: Extension of an existing normative database on WAIS-III test performance. Unpublished master's thesis. Rhodes University, Grahamstown, South Africa.

Gorsuch, R.L., Saklofske, D.H., & Hildebrand, D.K. (2000). Replication of the Factor Structure. The Weschler Adult Intelligence scale, Third Edition with a Canadian Sample. Psychological Assessment, 12 (4) :436-439.

Guilmette, T.J., Hart, K.J., Guiliano, A.J., & Leninger, B.E. (1994). Detecting simulated memory impairment: Comparison of the Rey Fifteen-Item Test and the Hiscock Forced Choice Procedure. *The Clinical Neuropsychologist, 8, 283–294.*

Gupta, S; Jin, H; Riggs, K; Grant, I; Cysique, L; Shi, C; Yu, X; Wu, Z; and Heaton, R.K. (2011). Neuropsychological Performance in Mainland China: An Urban/Rural Effect. Unpublished Research Study.

Helms, J. E. (1992). Why is there no study of cultural equivalence in standardized cognitive ability testing? American Psychologist, 47, 1083–1101.

Hiscock, M., & Hiscock, C.K. (1989). Refining the forced-choice method for the detection of malingering. Journal of Clinical and Experimental Neuropsychology, 11, 967–974.

HIV Neurobehavioral Research Center. (2009). Zambia Neurobehavioral Test Battery. San Diego, CA: University of California, Department of Psychiatry.

http://www.worstpolluted.org/projects_reports/display/45. Retrieved November 4, 2009.

Kaplan, R.M. and Saccuzzo, D.P. (2001). Psychological Testing: Principles, Applications, and Issues. (5th edn). Belmont: Wadsworth.

Kendall, I. M., (1980). A comparative study of the structure of the intellect of rural and urban adult Pedi. Unpublished Master's Thesis. Rand Afrikaans University, Johannesburg.

Kendall, I. M., Verster, M. A., & Von Mollendorf, J. W. (1988). Test performance of blacks in Southern Africa. In S. H. Irvine & J. W. Berry (Eds), Human abilities in cultural context (pp. 299-341). USA: Cambridge University Press.

King, J.A, Colla, M., Brass, M., Heuser, I. & Cramon, D.Y. (2007). Inefficient cognitive control in adult ADHD: evidence from trial-by-trial Stroop test and cued task switching performance. Behavioral and Brain Functions, 3(42).

Kline, P. (2002). The handbook of psychological testing. London: Routledge.

Landrine & Klonoff (1995) Retrieved on October 2, 2009 from http://www.braininjurylawblog.com/brain-injury-news-new-study-examines-cultural-bias-in-neuropsychological-testing.html

Lee, T.M.C. and Chan, C.C.H. (2000). Are Trail Making and Color Trails Tests of Equivalent Constructs? Journal of Clinical and Experimental Neuropsychology, 22(4), August 2000, 529-534.

Levine, A.J., Miller, E.N., Becker, J.T., Selnes, O.A. & Cohen, B.A. (2004). Normative Data for Determining Significance of Test-Retest Differences on Eight Common Neuropsychological Instruments. The Clinical Neuropsychologist, 18(3) 373-384.

Lezak, M.D., Howieson, D.B., & Loring, D.W. (2004). Neuropsychological Assessment (4th Ed.). New York: Oxford Press.

Martin, R., Sawrie, S., Gilliam, F., Mackey, M., Faught, E., Knowlton, R. et al (2002). Determining Reliable Cognitive Change after Epilepsy Surgery Development of Reliable Change Indices and Standardised Regression-based Change Norms for the WMS III and WAIS III. Epilepsia. 43 (12) 1551-1558

Mulenga, K.; Ahonen, T.; and Aro, M. (2001). Performance of Zambian children on the NEPSY: A pilot study. Developmental neuropsychology 2001, Vol. 20, No. 1 pp. 375-383

Neisser, U., Boodoo, G., Bouchard, T. J., Boykin, A. W., Brody, N., Ceci, S. J., Halpern, D. F., Loehlin, J. C., Perloff, R., Sternberg, R. J., Urbina, S. (1995). Intelligence: Knowns and Unknowns. Report of a Task Force established by the Board of Scientific Affairs. American Psychological Association.

Nell, V. (1999). Standardizing the WAIS-III and the WMS-III for South Africa: Legislative, psychometric, and policy issues. South African Journal of Psychology, 29, 128-138.

Nuechterlein, K.H., Green, F.M., Kern, R.S., Baade, L.E., Barch, D.M. Cohen, J.H., et al (2008) The MATRICES Consensus Cognitive Battery, Part 1: Test Selection, Reliability, and Validity. American Journal of Psychiatry 165(2) 203-213.

Ogden, J. A., & McFarlane-Nathan, G. (1997). Cultural bias in the neuropsychological assessment of young Maori men. New Zealand Journal of Psychology, *26*, 2-12.

Ostrosky-Solis, F., Ramirez, M., & Ardila, A. (2004). Effects of culture and education on neuropsychological testing: A preliminary study with indigenous and nonindigenous population. Applied Neuropsychology, *11*, 186-193.

Pallant, J. (2007). SPPS Survival Manual: A Step-by-step Guide to Analysing using SPSS Version 15. Berkshire: McGraw-Hill Education.

Paul, A.C., Kreiner, D.S., Ray, J.J., Arb, D.J. (2000). Reliability of the WAIS-III Subtests, Indexes and IQs in individuals with Substance abuse Disorders, Assessment, 7 (2):151-156.

Prigatano, G.P., and Amin, K. (1993). Digit memory: unequivocal cerebral dysfunction and suspected malingering. Journal of Clinical and Experimental Neuropsychology, 15, 537–546.

Sacks, T.L., Clark, C.R., Pols, R.G. & Geffen, L.B. (1991). Comparability and stability of performance of six alternate forms of the dodrill-stroop colour-word test. The Clinical Neuropsychologist, 5 (3) 220-225.

Sadock, M.D. and Sadock, V.A. (2007). Synopsis of Psychiatry (10^{th} ed.) Philadelphia: Lippincott Williams and Wilkins.

Salvia, J., & Ysseldyke, J. E. (1995). Assessment. (6^{th} ed.). Boston: Houghton-Mifflin Co.

Sattler, J. M. (1992). Assessment of Children. Revised and updated. (3^{rd} ed.). USA: Jerome M. Sattler, Publisher Inc.

Serpell, R. (1994). The cultural construction of intelligence. In W. J., Lonner & R. Malpass (Eds), Psychology and culture. (pp. 157-163). Boston: Allyn & Bacon.

Shuttleworth-Jordan, A. B. (1996). On not reinventing the wheel: a clinical perspective on culturally relevant test usage in South Africa. South African Journal of Psychology, *26*, 96-102.

Shuttleworth-Edwards, A. B., Kemp, R. D., Rust, A. L., Muirhead, J. G. L., Hartman, N. P., & Radloff, S. E. (2004). Cross-cultural effects on IQ test performance: A review and preliminary indications on WAIS-III test performance in South Africa. Journal of Clinical and Experimental Neuropsychology, *26*, 903–920.

Silberberg, D. and Katabira, E. (2006). Neurological Disorders. In Disease and Mortality in Sub-Saharan Africa, edited by D. Jamison et al., The World Bank Press, 2006.

Strauss, E., Sherman, E.M.S. and Spreen, O. (2006) A Compendium of Neuropsychological Tests: Administration, Norms and Commentary (3ed). Oxford: Oxford University Press.

Stuss, D.T., Stethem, L.L., Hegenhoiltz, H., & Richard, M.T. (1989). Traumatic brain injury: A comparison of three clinical tests and analysis of recovery. The Clinical Neuropsychologist, 3, 145-156

Tabachnick, B.G. and Fidell, L.S. (2007). Using Multivariate Statistics (5th edn). Boston: Pearson Education.

Troyer, A.K. (2000). Normative data for Clustering and Switching on Verbal Fluency Task. Journal of Clinical and Experimental Psychology, 22, 370 – 378.

Weschler, D. (1991). *Wechsler Memory Scale*. In Strauss, E., Sherman, M.S.E., & Spreen, O. (2006). A Compendium of Neuropsychological Tests: Administration, Norms, and Commentary (3rd Ed.) (pp.283). Oxford: Oxford University Press

Wilde, N. and Strauss, E. (2002). Functional equivalence of WAIS-III/WMS-III digit and spatial span under forward and backward recall conditions. The Clinical Neuropsychologist, 16(3), 322-330

Woods, SP., Childers, M., Ellis, R.J., Guaman, S., Grant, I., Heaton, R.K., & The HIV Neurobehavioral Research Center (HNRC) Group. (2006). A battery approach for measuring neuropsychological change. Archives of Clinical Neuropsychology, 21, 83-89.

APPENDICES

APPENDIX A

Informed Consent for Participants

University of Zambia

Department of Psychology

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 IT WILL BE PROVIDED.

Description and purpose of study:

You are being invited to take part in this study of standardization of the 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 such as pointing at figures or objects, drawing and remembering words.

This particular research basically aims at *examining the performance of urban and rural adult populations on neuropsychological tests in Zambia*. It is part of a larger study which is aimed at establishing the normative data for neuropsychological tests in Zambia. By focusing on comparative aspect of the performance between adults who have lived most of their life in either urban or rural areas, this study will bring to light extent of the differences that exist if any, between these types of populations.

Adults who are 20 years and above, have at least 5 years of education, HIV negative, without a history of any serious medical or mental condition in both urban and rural areas will be eligible for inclusion in this study. It is anticipated that the results from this study in the area of neuropsychology will eventually be used as a framework or source of reference with regard to diagnosis, assessment and rehabilitation of neurobehavioural deficits especially those associated with HIV/AIDS in Zambia. Currently, this standardized data for Zambia in the area of neuropsychological tests is not available. This particular study is thus part of the larger cutting edge study in the area of neuropsychology in Zambia.

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. You are free to ask for a short break whenever you require it though.
- It is not guaranteed that you will receive any direct benefits from this study although you will have an opportunity to contribute to development of the field neuropsychology 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, your identity will still be kept private.
- The data collected will be used for academic purposes and none of the participants will be identified by name.

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 Participant:……………………………..Date………………...

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

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

Contacts

If you have any further questions about this research please contact:

Dr. A. Menon Project Coordinator
University of Zambia
Psychology Department
P. O. Box 32379
Lusaka.. Cell no.: 0977 846116

Happy Zulu O.M. Principal Investigator
University of Zambia, Sc of Med
Dept. of Physiological sciences
P. O. Box 50110
Lusaka… Cell no.: 0977108965

The University of Zambia Biomedical Research Ethics Committee P.O. Box 50110, Lusaka Tel: 256067

APPENDIX B

THE UNIVERSITY OF ZAMBIA BIOMEDICAL RESEARCH ETHICS COMMITTEE APPROVAL LETTER

APPENDIX C

FURTHER REFERENCE TABLES FOR CHAPTERS 4 AND 5 (RESULTS AND DISCUSSION)

Table C: Categories of effect size

Size	Eta squared (% of variance explained)	Cohen's d (Standard deviation units)
Small	.01 or 1%	.2
Medium	.06 or 6%	.5
Large	.138 or 13.8%	.8

Cohen (1988) in Pallant (2007)

Table $C_{1.1.}$: Model Summary (Visual episodic memory)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.502(a)	.252	.236	2.694

- Predictors: years of education, ZAT_SS, gender, age, residency

- Dependent Variable: visual episodic memory

Table $C_{1.2.}$: ANOVA

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	555.593	5	111.119	15.315	.000(a)
	Residual	1646.967	227	7.255		
	Total	2202.560	232			

- Predictors: years of education, ZAT_SS, gender, age, residency

- Dependent Variable: visual episodic memory

Table $C_{1.3.}$: Correlations

		VEMS	edu	ZAT_SS	gender	age	urbanrural
Pearson Correlation	VEMS	1.000	.288	.245	-.134	-.389	.267
	Edu	.288	1.000	.555	-.095	-.154	.412
	ZAT_SS	.245	.555	1.000	-.160	.056	.378
	Gender	-.134	-.095	-.160	1.000	.010	-.116
	Age	-.389	-.154	.056	.010	1.000	-.096
	Urbanrural	.267	.412	.378	-.116	-.096	1.000
Sig. (1-tailed)	VEMS	.	.000	.000	.020	.000	.000
	Edu	.000	.	.000	.075	.009	.000
	ZAT_SS	.000	.000	.	.007	.196	.000
	Gender	.020	.075	.007	.	.443	.038
	Age	.000	.009	.196	.443	.	.071
	Urbanrural	.000	.000	.000	.038	.071	.
N	VEMS	233	233	233	233	233	233
	Edu	233	233	233	233	233	233
	ZAT_SS	233	233	233	233	233	233
	Gender	233	233	233	233	233	233
	Age	233	233	233	233	233	233
	Urbanrural	233	233	233	233	233	233

*VEMS – Visual episodic memory Scale

Table $C_{2.1.}$: Model Summary (Verbal episodic memory)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.434(a)	.188	.170	2.637

- Predictors: years of education, ZAT_SS, gender, age, residency

- Dependent Variable: verbal episodic memory

Table $C_{2.2.}$: ANOVA

Model	Sum of Squares	Df	Mean Square	F	Sig.
Regression	366.062	5	73.212	10.528	.000(a)
Residual	1578.550	227	6.954		
Total	1944.612	232			

- Predictors: years of education, ZAT_SS, gender, age, residency

- Dependent Variable: verbal episodic memory

Table $C_{2.3.}$: Correlations

		VEEMS	Edu	ZAT_SS	gender	age	Urbanrural
Pearson Correlation	VEEMS	1.000	.338	.262	-.117	-.236	.295
	Edu	.338	1.000	.555	-.095	-.154	.412
	ZAT_SS	.262	.555	1.000	-.160	.056	.378
	Gender	-.117	-.095	-.160	1.000	.010	-.116
	Age	-.236	-.154	.056	.010	1.000	-.096
	Urbanrural	.295	.412	.378	-.116	-.096	1.000
Sig. (1-tailed)	VEEMS	.	.000	.000	.038	.000	.000
	Edu	.000	.	.000	.075	.009	.000
	ZAT_SS	.000	.000	.	.007	.196	.000
	Gender	.038	.075	.007	.	.443	.038
	Age	.000	.009	.196	.443	.	.071
	Urbanrural	.000	.000	.000	.038	.071	.
N	VEEMS	233	233	233	233	233	233
	Edu	233	233	233	233	233	233
	ZAT_SS	233	233	233	233	233	233
	Gender	233	233	233	233	233	233
	Age	233	233	233	233	233	233
	Urbanrural	233	233	233	233	233	233

*VEEMS – Verbal episodic memory Scale

Table $C_{3.1.}$: Model Summary (Verbal fluency)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.669(a)	.447	.435	1.726

- Predictors: years of education, ZAT_SS, gender, age, residency

- Dependent Variable: verbal fluency

Table $C_{3.2.}$: ANOVA

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	547.466	5	109.493	36.769	.000(a)
	Residual	675.980	227	2.978		
	Total	1223.446	232			

- Predictors: years of education, ZAT_SS, gender, age, residency

- Dependent Variable: verbal fluency

Table $C_{3.3.}$: Correlations

		VF	Edu	ZAT_SS	gender	age	urbanrural
Pearson Correlation	VF	1.000	.578	.523	-.119	-.171	.464
	Edu	.578	1.000	.555	-.095	-.154	.412
	ZAT_SS	.523	.555	1.000	-.160	.056	.378
	Gender	-.119	-.095	-.160	1.000	.010	-.116
	Age	-.171	-.154	.056	.010	1.000	-.096
	Urbanrural	.464	.412	.378	-.116	-.096	1.000
Sig. (1-tailed)	VF	.	.000	.000	.035	.005	.000
	Edu	.000	.	.000	.075	.009	.000
	ZAT_SS	.000	.000	.	.007	.196	.000
	Gender	.035	.075	.007	.	.443	.038
	Age	.005	.009	.196	.443	.	.071
	Urbanrural	.000	.000	.000	.038	.071	.
N	VF	233	233	233	233	233	233
	Edu	233	233	233	233	233	233
	ZAT_SS	233	233	233	233	233	233
	Gender	233	233	233	233	233	233
	Age	233	233	233	233	233	233
	Urbanrural	233	233	233	233	233	233

*VF – Verbal Fluency

Table $C_{4.1.}$: Model Summary (Speed of information processing)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.634(a)	.402	.389	1.792

- Predictors: years of education, ZAT_SS, gender, age, residency

- Dependent Variable: Speed of information processing

Table $C_{4.2.}$: ANOVA

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	490.337	5	98.067	30.554	.000(a)
	Residual	728.592	227	3.210		
	Total	1218.929	232			

- Predictors: years of education, ZAT_SS, gender, age, residency

- Dependent Variable: Speed of information processing

Table $C_{4.3.}$: Correlations

		SIP	edu	ZAT_SS	Gender	age	urbanrural
Pearson Correlation	SIP	1.000	.459	.350	-.134	-.419	.392
	Edu	.459	1.000	.555	-.095	-.154	.412
	ZAT_SS	.350	.555	1.000	-.160	.056	.378
	Gender	-.134	-.095	-.160	1.000	.010	-.116
	Age	-.419	-.154	.056	.010	1.000	-.096
	Urbanrural	.392	.412	.378	-.116	-.096	1.000
Sig. (1-tailed)	SIP	.	.000	.000	.021	.000	.000
	Edu	.000	.	.000	.075	.009	.000
	ZAT_SS	.000	.000	.	.007	.196	.000
	Gender	.021	.075	.007	.	.443	.038
	Age	.000	.009	.196	.443	.	.071
	Urbanrural	.000	.000	.000	.038	.071	.
N	SIP	233	233	233	233	233	233
	Edu	233	233	233	233	233	233
	ZAT_SS	233	233	233	233	233	233
	Gender	233	233	233	233	233	233
	Age	233	233	233	233	233	233
	Urbanrural	233	233	233	233	233	233

*SIP – Speed of information processing

Table $C_{5.1.}$: Model Summary (Executive functioning)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.479(a)	.230	.213	1.881

- Predictors: years of education, ZAT_SS, gender, age, residency

- Dependent Variable: Executive functioning

Table $C_{5.2.}$: ANOVA

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	490.337	5	98.067	30.554	.000(a)
	Residual	728.592	227	3.210		
	Total	1218.929	232			

- Predictors: years of education, ZAT_SS, gender, age, residency

- Dependent Variable: Executive functioning

Table $C_{5.3.}$: Correlations

		EF	Edu	ZAT_SS	gender	age	urbanrural
Pearson Correlation	EF	1.000	.323	.246	-.164	-.332	.270
	Edu	.323	1.000	.555	-.095	-.154	.412
	ZAT_SS	.246	.555	1.000	-.160	.056	.378
	Gender	-.164	-.095	-.160	1.000	.010	-.116
	Age	-.332	-.154	.056	.010	1.000	-.096
	Urbanrural	.270	.412	.378	-.116	-.096	1.000
Sig. (1-tailed)	EF	.	.000	.000	.006	.000	.000
	Edu	.000	.	.000	.075	.009	.000
	ZAT_SS	.000	.000	.	.007	.196	.000
	Gender	.006	.075	.007	.	.443	.038
	Age	.000	.009	.196	.443	.	.071
	Urbanrural	.000	.000	.000	.038	.071	.
N	EF	233	233	233	233	233	233
	Edu	233	233	233	233	233	233
	ZAT_SS	233	233	233	233	233	233
	Gender	233	233	233	233	233	233
	Age	233	233	233	233	233	233
	Urbanrural	233	233	233	233	233	233

*Executive Functioning

Table $C_{6.1.}$: Model Summary (Working memory)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.478(a)	.228	.211	2.083

- Predictors: years of education, ZAT_SS, gender, age, residency

- Dependent Variable: Working memory

Table $C_{6.2.}$: ANOVA

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	291.116	5	58.223	13.419	.000(a)
	Residual	984.950	227	4.339		
	Total	1276.067	232			

- Predictors: years of education, ZAT_SS, gender, age, residency

- Dependent Variable: Working memory

Table $C_{6.3.}$: Correlations

		WM	edu	ZAT_SS	gender	age	urbanrural
Pearson Correlation	WM	1.000	.349	.344	-.228	-.201	.291
	Edu	.349	1.000	.555	-.095	-.154	.412
	ZAT_SS	.344	.555	1.000	-.160	.056	.378
	Gender	-.228	-.095	-.160	1.000	.010	-.116
	Age	-.201	-.154	.056	.010	1.000	-.096
	urbanrural	.291	.412	.378	-.116	-.096	1.000
Sig. (1-tailed)	WM	.	.000	.000	.000	.001	.000
	Edu	.000	.	.000	.075	.009	.000
	ZAT_SS	.000	.000	.	.007	.196	.000
	Gender	.000	.075	.007	.	.443	.038
	Age	.001	.009	.196	.443	.	.071
	urbanrural	.000	.000	.000	.038	.071	.
N	WM	233	233	233	233	233	233
	Edu	233	233	233	233	233	233
	ZAT_SS	233	233	233	233	233	233
	Gender	233	233	233	233	233	233
	Age	233	233	233	233	233	233
	urbanrural	233	233	233	233	233	233

*WM – Working memory

Table $C_{7.1.}$: Model Summary (Motor scale)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.470(a)	.221	.204	2.396

- Predictors: years of education, ZAT_SS, gender, age, residency

- Dependent Variable: Motor scale

Table $C_{7.2.}$: ANOVA

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	370.224	5	74.045	12.894	.000(a)
	Residual	1303.581	227	5.743		
	Total	1673.805	232			

- Predictors: years of education, ZAT_SS, gender, age, residency

- Dependent Variable: Motor scale

Table $C_{7.3.}$: Correlations

		MS	Edu	ZAT_SS	gender	age	urbanrural
Pearson Correlation	MS	1.000	.353	.141	-.007	-.322	.283
	Edu	.353	1.000	.555	-.095	-.154	.412
	ZAT_SS	.141	.555	1.000	-.160	.056	.378
	Gender	-.007	-.095	-.160	1.000	.010	-.116
	Age	-.322	-.154	.056	.010	1.000	-.096
	Urbanrural	.283	.412	.378	-.116	-.096	1.000
Sig. (1-tailed)	MS	.	.000	.016	.460	.000	.000
	Edu	.000	.	.000	.075	.009	.000
	ZAT_SS	.016	.000	.	.007	.196	.000
	Gender	.460	.075	.007	.	.443	.038
	Age	.000	.009	.196	.443	.	.071
	Urbanrural	.000	.000	.000	.038	.071	.
N	MS	233	233	233	233	233	233
	Edu	233	233	233	233	233	233
	ZAT_SS	233	233	233	233	233	233
	Gender	233	233	233	233	233	233
	Age	233	233	233	233	233	233
	Urbanrural	233	233	233	233	233	233

*MS – Motor scales