

Chapter One

INTRODUCTION

1.0 Background

Despite the Zambian government's efforts to promote literacy through provision of free basic education in the public education system, there is still a serious lack of reading and writing skills among the Zambian adults. According to the Central Statistics Office report (2000), the adult literacy rate was at 66.0 percent in 1990. The proportion of female adults who were literate was 56.3 percent while that of males was at 76.2 percent. In rural and urban areas, the rates were 54.4 and 83.6 percent respectively. By 2000, less than half (46.4%) of the female adults in rural areas were literate compared to about four fifths (79.3%) of the females in urban areas. There was a little difference observed compared to the rates in 1990. The stagnation of the literacy rates has often been attributed to among other factors; poverty and lack of good quality basic education.

The topic of literacy has been a significant area of research in the field of neuropsychology for many years, because literacy influences neuropsychological test performance. Scholars worldwide continually try to define what literacy is and how it affects a person's cognitive performance. Individual literacy as cited by Serpell and Hatano (1997:341) is the 'the capacity to extract meaning from a particular script', while others describe it as "a complex system of knowledge, skills, beliefs and attitudes that encompass an individual's activities across a wide range of domains" (Illich, 1991:56). More closely related to the operational definition of literacy in the present study, Wagner (2009:8) defines literacy as "using printed and written information to function in society, to achieve one's goals and to develop one's knowledge and potential". Education on the other hand (which is quite distinct from literacy) is often understood as the foundational acquisition of basic literacy skills that are subsequently exercised by the

individual (Serpell and Hatano, 1997).The title of being literate or illiterate may refer to whether one has completed basic education and is able to use literacy skills (Levine,1982).

In the present study, literacy was defined as the ability to read and write and being able to use the literacy skills in everyday life.

The potential of literacy for social progress should not only be reduced to the strength it has on an individual, either as a form of direct cognitive empowerment where an individual is able to use alternative cognitive networks when confronted with a task or as an indirect pathway of widening one's road for social mobility (ability to earn an income that increases one's social status). But its influence should be better understood in terms of it being a resource of socially distributed cognition and bi-cultural mediation (Serpell and Hatano, 1997). In various theoretical frameworks, literacy has been perceived to be a form of direct cognitive and social empowerment.

Neuropsychological measures are very helpful in measuring the functions of the brain and the nervous system. The standard tests of cognition included in the Zambia Neurobehavioral Test Battery assessed cognitive domains such as attention, information processing speed, executive functioning, memory, verbal fluency and recall, visuospatial, and psychomotor abilities. These are used in the assessment of a variety of cognitive deficits including the effects on cognition of head injury, chronic medical illnesses such as HIV and AIDS (Boone, 1999) and dementia. These tests are typically included in most neuropsychological assessment batteries like the Zambia Neurobehavioral Test Battery. The Zambian Achievement Test (ZAT) is an individually administered test developed to quantify academic achievement for the purpose of identifying academic difficulties in Zambian children in grades 1 through 7 (Stemler et al,2009).

The influences of culture on cognition studied by Vygotsky and Luria in the 1930s remain largely unclear for many neuropsychologists in the contemporary world especially in Africa; it is still not known how different cultural contexts relate to the current brain-behavior models. In the recent literature, the relevance of cultural factors such as literacy, time perception (Perez-Arce & Puente, 1997), attitude towards testing, the value and meaning of the test to the participant (Ardila, 2001) have received a great deal of attention.

1.1 Statement of Problem

Although the effect of literacy on cognitive test performance has been well established in a number of publications, the extent to which self-reported years of education corresponds to real acquisition of literacy skills remains largely unclear, especially in Zambia, where the past access of adults to education is very unevenly distributed.

1.2 The Purpose of the study

This study was aimed at exploring the relationship between literacy and neuropsychological test performance among adults in Zambia.

1.3 Research Questions

This study sought to have the following questions answered:

- a) Is there a significant relationship between literacy and neuropsychological test performance?
- b) What is the amount of variance accounted for by literacy over and above self-reported years of education?
- c) Which measures in the Zambia Neurobehavioral Test Battery (ZNTB) are most related to literacy and education status?
- d) Is there a significant difference in neuropsychological test performance among the four educational attainment groups (primary, basic, high and tertiary)?

- e) Is there a significant relationship between literacy and the Zambian Achievement Test (ZAT)?

1.4 Research Objectives

The objectives of this study were to establish:

- a) To examine the relationship between literacy and neuropsychological test performance.
- b) To assess the amount of variance accounted for by literacy over and above self-reported years of education.
- c) To identify the measures in the Zambian Neurobehavioral Test Battery which were most related to literacy and education.
- d) To assess the difference in neuropsychological test performance among the four educational attainment groups (primary, basic, high and tertiary).
- e) To examine the relationship between literacy and the Zambian Achievement Test (ZAT).

1.5 Research Hypotheses

It was hypothesized that:

- a) There would be a positive significant relationship between Literacy and neuropsychological test performance.
- b) Literacy would account for significant variance in neuropsychological performance over and above what can be accounted for by self-reported years of education.
- c) Among the various tests in the ZNTB, the measures of word fluency would be the most related to both literacy and education.
- d) There would be a significant mean difference in neuropsychological test performance among the four educational attainment groups (Primary, Basic, High and tertiary).
- e) There would be a positive significant relationship between Literacy and scores on the Zambian Achievement Test (ZAT).

1.6 Significance of the study

The study will also refine our current understanding of the importance of education and literacy in neuropsychological test interpretation. The findings will also determine how much literacy and education as measures of educational experience uniquely contribute to cognitive test performance. The study will also provide information of what affects cognitive test performance among the Zambian adults. The study encouraged the need to adjust for literacy and education when interpreting cognitive test scores. The study also determined the cognitive test domains that are most related to literacy and education. Finally, the importance of literacy and education skills acquisition and assessment is elucidated in this study.

Chapter Two

LITERATURE REVIEW

2.0 Literacy and neuropsychological test performance

In an investigation to compare neuropsychological test performance among 580 non-demented literate and illiterate elders in the Northern Manhattan community of the USA, Manly et al (1999) found a significant overall effect for literacy status (literate vs. illiterate) on neuropsychological test performance when groups were matched on years of education and that the overall effect of literacy status remained significant after restricting the analyses to elders with no formal education, and even after controlling for the effects of language of test administration.

In another similar study aimed at analyzing the effects of literacy across different age ranges on neuropsychological test performance in a sample of 1,600 adults collected in Colima City, Mexico, Solis et al (1998) also found that there was a significant educational effect on most of the neuropsychological tests. The largest educational effect was noted in constructional abilities (copying of a figure), language (comprehension), phonological verbal fluency, and conceptual functions (similarities, calculation abilities, and sequences).

Finally, Manly and Colleagues (2003) in a sample of 136 English-speaking African American, Caucasian, and Hispanic elders selected from a longitudinal aging study in New York City, revealed that after accounting for age at baseline and years of education, elders with low levels of literacy had a steeper decline in both immediate and delayed recall of a word list over time as compared to highly literate elders. These findings suggest that literacy skills are protective against memory decline among non-demented elders.

2.1 Education and neuropsychological test performance

The relationship between education and neuropsychological test performance has received a lot of attention in the literature with results suggesting that education correlates positively with test scores on nearly all domains of cognitive functioning (Lezak, Howieson, & Loring, 2004).

Additionally, a recent review found that 78% of 1,440 research papers published in neuropsychological journals between 1995 and 2000 presented data on the influence of educational level on neuropsychological test scores (O'Bryant, O'Jile, & McCaffrey, 2004), suggesting a general consensus as to the importance of considering education when interpreting neuropsychological data.

Research literature so far has established that self-reported years of education significantly overestimates reading level of a sizable number of African-Americans. Baker et al. (1996) found that 63% of their 250 middle-aged and elderly participants recruited from a predominantly black community mental health facility, read at a median level of 5 years below their self-reported educational level. Albert and Teresi (1999) found that, in a sample of 144 urban elderly African-Americans who completed the Wide Range Achievement Test-Revised Reading Recognition subtest (WRAT), 47.5% were reading below what was expected of them based on reported years of education. Manly et al. (2002) also found that self-reported years of education was an overestimate of reading level in 33% of their 434 urban elderly African-American sample.

Lastly, O'Bryant et al (2005) conducted a record review from a 195 mixed psychiatry sample and found that of the 62 African-Americans and 133 Caucasians, self-report of educational level over-predicted estimated reading level (WRAT-3 Reading Recognition test) by 3 or more years in 56.5% and 6 or more years in 25.8% of the African-American patients, whereas the same over-predictions were only found for 14.3% (3 or more years) and 4.5% (6 or more

years) of the Caucasian patients. Thus, African-Americans recorded more discrepancies between self-report years of educational and estimated reading level than their Caucasian counterparts.

2.2 Literacy and neuropsychological test domains

In an attempt to know which cognitive tests in the neuropsychological test battery are most related to literacy, Ratcliff and colleagues (1998) found effects of literacy on sound and category fluency measures among 500 adults aged between 34 and 55 drawn from the rural community of Ballabgarh in India. This study proposes that the ability to segment speech into phonemic units (better performance on initial sound fluency task) is dependent on literacy (Ratcliff et al., 1998).

Reis and Castro-Caldas (1997:67) also found that illiterate women from Southern Portugal performed worse than literate women on “repetition of pseudo words, recall of phonologically related word associates, and a fluency task involving generation of words beginning with specific phonemes”. Lecours et al. (1987: 192), also found that “illiterates performed significantly worse than literates on measures of repetition and auditory comprehension”.

Discrepancies in the neuropsychological test performance of literates and illiterates were not only observed in tasks involving verbal skills but also in nonverbal skills. Ardila et al. (1989) and Rosselli et al. (1990:15) compared illiterate individuals to highly literate professionals in Bogota, Colombia and it was found that “illiterates performed significantly worse on measures of memory, visuospatial ability, digit span, naming, calculation, alternating movements, and cancellation tasks”.

Reis et al. (1994:143) also established that “illiterate and semiliterate Portuguese adults had difficulties on visual naming tasks when the objects were presented through line drawings and photographs, but not real objects”. Matute et al. (1997:

167) reported that “Spanish-speaking illiterates made more errors of rotation and disarticulation (overlapping, distant, or displaced vertices) when assembling stick constructions than the Spanish-speaking literates”.

Several studies have proved a strong association between educational level and performance on various neuropsychological measures (e.g., Ardila, Rosselli, & Ostrosky, 1992; Ardila, Rosselli, & Puente, 1994; Ardila, Rosselli, & Rosas, 1989; Heaton, Grant, & Mathews, 1986; Lecours et al., 1987a, Ardila, 1985; Ostrosky et al., 1986; Rosselli, Ardila, & Rosas, 1990). In general, some tests have been observed to be much more sensitive to educational variables (e.g. language tests) than others (e.g., the Wisconsin Card Sorting Test; Rosselli, 1993). Cornelious and Caspi (1987:34) found that “educational level has a substantial relationship with performance on verbal meaning tests but was not systematically related to everyday problem-solving”.

The influence of literacy on neuropsychological test performance has been reported for different types of abilities, including, but not limited to, memory, language, problem solving, constructional abilities, motor skills, and calculation abilities (e.g., Ardila, Rosselli, & Rosas, 1989; Rosselli et al., 1990; Lecours et al., 1987a, 1987b, 1988). Bertolucci, Brucki, Campacci, and Julian (1994:14) selected a 530-subject sample of individuals with diverse educational backgrounds and found that “not only does educational level represent a significant predictor in the Mini-Mental State Exam (Folstein, Folstein, & McHugh, 1975) scores, but also the cut-off point for illiteracy”.

2.3 Educational attainment group and neuropsychological test performance

The relationship between education attainment level and neuropsychological test performance is better documented. For example, Finlayson et al. (1977) tested normal individuals with grade school (less than 10 years), high school (grade 12, without college experience) and university level (at least 3 years college

experience) education. They found significant differences between the different educational attainment groups on the Category Test, the Seashore Rhythm Test, Speech-Sounds Perception Test, and Trail Making A and B. No effect of education was evident on the Tactual Performance Test or Finger Tapping. With three similar groups of brain-damaged individuals, education effects were less pronounced, and were significant only on the Seashore Rhythm Test and Speech-Sounds Perception Test.

In an attempt to critically review the studies cited above it is important to note that although they provide information on the influence of literacy on cognitive performance among adults, they have been conducted within the American population (except Mexico City) and so the biasness towards the American culture and society can not be overemphasized such that generalizing their findings to other populations outside America would be inappropriate. Second, the types of neuropsychological batteries used to test cognitive performance are not specified owing to the various types of neuropsychological test batteries available for adults. Third, the description of the studies reviewed confirmed that they are all quantitative study designs. As a result, most studies attempt to accrue local control groups for study specific comparisons; however, these may suffer from small sample sizes with unique characteristics, and often will be inadequate for developing standards for classifying impairment in individuals with cognitive limitations. It can be argued that it is better to combine rather than separate quantitative and qualitative research methods in what is called triangulation in order to have wider and deeper understanding of the research topic. Although the studies have limitations, there is no doubt that their results have provided adequate information on how literacy relates to cognitive test performance.

Having reviewed literature on the relationship between literacy, education and neuropsychological test performance among adults, the next sections look at the theoretical explanations of how literacy's influence on cognition is conceived.

2.4 THEORETICAL PERSPECTIVES/Framework

The degree to which literacy influences cognition has been construed into three conceptions by Serpell and Hatano (1997) namely; Literacy as a torch, as a hinge and as a resource for socially distributed cognition.

2.4.1 Literacy as a Torch

Literacy in the “modern world” of politics and economics is portrayed as a human need, which must be attained through the provision of the same procedure and method of formal education and those who are deprived of the chance to acquire literacy skills are labeled as illiterate or what Serpell and Hatano (1997:345) refer to as “developmentally incomplete”. Literacy according to this ideology is an important, liberating process that unlocks the door for its participants to move from ignorance to enlightenment, empowering them with a unique repertoire of cognitive resources to understand the environment in ways that are not accessed by the illiterates. In short, literacy provides its recipients with a torch that will provide light for them to see the world clearly.

The enlightenment conceptualization of literacy has been criticized mainly for two reasons. First, for underestimating the general cognitive competence of illiterate people, who may have rich and highly developed skills of orality. Secondly, the ideology advances a reductionist view that tends to emphasize technological features of writing as more important than social practices with which they are associated. Following the criticisms targeted at this hypothesis, and based on their findings in Liberia, Scribner and Cole (1981) concluded that the effects of learning to read and write are rather specific and the uses to which these skills are put depend on the wider social context in which they are acquired. Various researchers have refined this theory to suggest that literacy can serve as a torch empowering individuals, but more in specific ways, depending on what people do with their literacy (Griffin & Cole, 1987).

2.4.2 Literacy as a Hinge

According to this formulation, when literacy empowers its recipient, it functions like a hinge rather than a torch. Those who progress socially, economically and politically due to their literate education do so by opening doors that are closed to their illiterate counterparts. Serpell and Hatano (1997:346) argue that “Literacy is seen as a necessary condition for the doors to open but not a sufficient one. It can have positive consequences only when it allows learners to gain access to culturally enriching practices”. The hinge conceptualization of literacy has been criticized for missing the other significant characteristics of literacy. The critics argue that “it underestimates the potential of literate people for the successful imaginative adaptation of technological resources to new ends” (Serpell and Hatano, 1997: 346).

2.4.3 Literacy as a Resource for socially distributed cognition

A third conception of literacy combines some of the insights of the two ideologies of the torch and hinge already examined. Literacy according to this view is understood as a cultural resource at the disposal of the participants in various socially organized activities. Gardner (1991) asserts that the technological significant characteristics of literacy are both constraining and empowering. The sharing of responsibility that involves cognitive work in everyday activities has been termed “socially distributed cognition”. This is in line with what Wagner (1993) presents as a typical literacy transaction in Morocco that shows the reciprocal interdependency of the participants in a literate activity. A gas station attendant prepares a receipt for sale of gas by endorsing a rubber stamp on it and hands it to the driver to fill in the date, price and the amount of the gas paid. In this joint literacy act, the attendant who cannot read or write is the caretaker of the symbol of bureaucratic power, the rubber stamp, which serves as the official backer of official literacy in Morocco (Serpell and Hatano, 1997).

Drawing on the notion of literacy as a resource for socially distributed cognition, the present study operationalised individual literacy as a multi-dimensional characteristic, involving both cognitive skills and engagement in sociocultural practices. A literacy scale was constructed to assess several complementary dimensions of the individual's literacy skills and participation in various recurrent activities in Zambian society that afford opportunities for the deployment of those skills.

2.5 Operational Definitions

Education: self-reported time spent in a formal institution learning how to read and write.

Literacy: ability to read, write and application of the skills in everyday life.

Literate: someone who had an attained education level and has acquired literacy skills

Illiterate: someone who may or may not have attained an education level but has not acquired literacy skills.

Neuropsychological test performance: cognitive performance on the Zambia Neurobehavioral test Battery.

Adult: HIV negatively tested person between the ages 20 and 65.

Primary: attainment of 7 years of education

Neuropsychological test battery: a compilation of different tests that measure the functioning of the brain and nervous system.

Conclusion

In this chapter, we made effort to explain some of the studies that have been conducted on the relationship between literacy, education and neuropsychological test performance among adults and we also explored some of the theories of literacy. This was done with the belief that it is in light of these studies reviewed and their theoretical perspectives that we were able to understand the data that we collected. In the next chapter, we explain the procedure of how data was collected.

Chapter Three

METHODOLOGY

3.1 Design

The larger project in which the present study was embedded was designed to be a normative cross-sectional study of selected rural and urban clinics. It involved administering neuropsychological tests to cognitively intact participants in the study areas. The participants' literacy and demographic details were solicited. It was thus designed to be strictly quantitative.

3.2 Population

The population consisted of all the participants tested in the clinics that were actually visited.

3.3 Sample and Sampling Procedures

The sample consisted of three hundred and twenty-four (324) participants who were recruited through the Voluntary Counseling and Testing process (VCT). The clinics targeted in each district were those that we considered to be rural and urban according to the ministry of Health area classification. In each clinic, six (6) participants were assessed. For assessment, the clinic staff was asked to recruit participants who were HIV negative, able to read and understand English. They were also asked to recruit the participants according to the following stratified sampling frame in accordance with age and education level.

Education	Age			
	20-35	36-45	46-55	56-65
5 or more	16 (8 M+8F) (8 urban+8 rural)	16 (8 M+8F) (8 urban+8 rural)	16 (8 M+8F) (8 urban+8 rural)	16 (8 M+8F) (8 urban+8 rural)
7-9 yrs	16 (8 M+8F) (8 urban+8 rural)	16 (8 M+8F) (8 urban+8 rural)	16 (8 M+8F) (8 urban+8 rural)	16 (8 M+8F) (8 urban+8 rural)
10-11 yrs	16 (8 M+8F) (8 urban+8 rural)	16 (8 M+8F) (8 urban+8 rural)	16 (8 M+8F) (8 urban+8 rural)	16 (8 M+8F) (8 urban+8 rural)
12 yrs (high school)	16 (8 M+8F) (8 urban+8 rural)	16 (8 M+8F) (8 urban+8 rural)	16 (8 M+8F) (8 urban+8 rural)	16 (8 M+8F) (8 urban+8 rural)
13 +	16 (8 M+8F) (8 urban+8 rural)	16 (8 M+8F) (8 urban+8 rural)	16 (8 M+8F) (8 urban+8 rural)	16 (8 M+8F) (8 urban+8 rural)

3.4 Participant Demographics

A total of 324 Zambian adults (157 males and 167 females) between the ages of 20 and 65 years (mean age=38.48, Standard Deviation =12.80), with 5 or more years of education (mean level of education=11.02, Standard Deviation =2.58) comprised the sample. The volunteers of this study were recruited from different health centres located in Lusaka, Kafue, Chibombo and Chongwe. The urban sample ($n = 172$, 53%) was recruited from Lusaka and Kafue while the rural sample ($n = 152$, 47%) came from Chibombo and Chongwe.

3.5 Inclusion/Exclusion Criteria

Inclusion:

- HIV negative, based on the biomedical test report from VCT staff.
- Educational level of between 5 and 13+ years based on the demographic questionnaire
- Age range of between 20 and 65 based on demographic questionnaire.
- Ability to speak read and understand English based on WRAT screening test.

Exclusion:

- HIV positive based on self report and informant report from a VCT staff.
- History of neurological illnesses (Parkinson's disease, Epilepsy, Multiple Sclerosis Alzheimer's disease, Huntington's chorea, closed head injury, Stroke, or alcohol disorder) based on the Neurobehavioral Medical Screening test.
- History of drug abuse based on the Chinese substance use history questionnaire.
- History of Psychiatric illness and present state of depression based on Beck Depression Inventory II.

3.6 Data Collection Procedures

The data was collected in two (2) stages as follows:

3.6.1 Self-Administered questionnaires

Participants were recruited from the clinic via the Voluntary Counseling and Testing (VCT) department of the specific clinic after confirmation of Participant's HIV status based on self-report and informant report (included only HIV negatives). The researcher then sought consent from the participant (asked them to complete the informed consent form) and explained the purpose, benefits of the study and then administered the neurobehavioral medical screening and the wide range achievement screening Test (WRAT) as part of the screening procedure, they were then given additional questionnaires which contained more detailed questions regarding their demographics, literacy skills, language usage and educational experience. Instructions of how to complete the self-administered questionnaires were also given. The questionnaires included the Beck depression Inventory-II, Patient's assessment of own functioning, activities of daily living, substance use History, the use of academic skills questionnaire and the functional adult literacy questionnaire, language usage questionnaire as well as the reading subtest of the formal Zambian Achievement Test (ZAT) instrument. After the participants had confirmed that the instructions were understood, adequate time to complete the questionnaires was given and if the instructions were not understood, the instructions would be repeated and clarified. All the participants who were assessed seemed to have understood the rationale of the study and did their best to cooperate.

3.6.2 Test battery Administration

After the participants were screened and had completed the questionnaires, they were given eighteen tests (including three computerized tests) from the Zambian Neurobehavioral Test Battery which was aided by standardized instructions for each test that were read by the examiner to the participant. The participants were

also free to ask any questions, arising from the instructions. The whole evaluation took approximately three to four hours with a number of breaks built into the testing session and this evaluation assessed a broad range of cognitive abilities sensitive to HIV impairment (Woods et al., 2004). All the participants were paid K50, 000 as meal and transport stipend. The tests in the battery were administered either at the local rural or urban clinic which had private rooms suitable for testing or anywhere within the clinic premises where adequate testing conditions such as quiet environment and privacy were guaranteed.

Zambian Neurobehavioral Test Battery used in the current study included the Hiscock Digit Memory Test,(HDMT), Hopkins Verbal Learning Test revised (HVLT-R), Brief Visuospatial Memory Test-Revised (BVMT-R), WAIS-III Digit Symbol,WAIS-III Symbol Search, WMS-III Spatial Span, Trail making Test – Part A only (TMT-A), Grooved Pegboard Test – Dominant and Nondominant Hands (GPDH and GPNH, respectively); Color Trails tests 1 and 2(CTT), Controlled Oral Word Association Test (FAS), Category Fluency Test(CFT), Stroop Color and Word Test (SCWT) and the computerized tests included Paced Auditory Serial Attention Test (PASAT), the Wisconsin Card Sorting Test-64 card version (WCST-64) and the Halstead Category test(HCT). Some of Specific tests and what they measure are listed below under central instruments.

3.7 Central Instruments

The Reading subtest of the Wide Range Achievement Test-3rd Edition (WRAT-3): was administered to all participants as part of a larger neuropsychological test battery given as a screening tool. WRAT-3 Reading Recognition subtest is a sight word-reading test where the participant is asked to read aloud a single word printed on a stimulus card, with the words becoming increasingly difficult as the examinee progresses. The examiner can use the tables presented in the publication manual to convert raw scores to “Absolute Scores,”

“Standard Scores,” or “Grade Scores.” For the current analysis, the grade scores were of primary interest (Wilkinson, 1993).

Hiscock Digit Memory Test (HDMT): was developed by Merrill Hiscock and Cheryl Hiscock in 1989 to clinically identify an individual thought to be purposefully feigning or faking memory impairment (Prigatano et al, 1997: 610). There are three versions of this test. The 72-item, 36-item and 18-item Hiscock Digit Memory Tests. For the current study, the later was used. The 18-item HDMT is usually administered in order to reduce the time demands of the neuropsychological evaluation which is estimated to take three and half hours. Participants are required to view (and are asked to remember) a successive series of 5-digit numbers for 5 seconds each, which are presented individually on a 7.6 X 12.7 cm note cards attached to an easel.

For each stimulus card, there is a response card containing two 5-digit numbers printed side-by-side. One of the numbers (the target) matches that which is shown on the stimulus card and the other number (foil) differs from the target in at least two digits, including either the first or the last digit. There are four sets of response cards. Sets A and B differ in the numbers used as foils. Sets C and D are identical to A and B respectively, except that positions of target and foil are reversed. Thus, each target and each foil appear an equal number of times on the left and right side of the card (Hiscock & Hiscock, 1989:972).

There is a 5 second delay between the initial presentation and response during which there is supposed to be no distractions or intervening cognitive tasks. After the delay participants are shown another note card containing two, 5-digit numbers from which they are to identify the original target number. The delay time is lengthened by 5 seconds after every block of six trials on the 18-item HDMT and every 12 trials on the 36-item HDMT (Hiscock & Hiscock, 1989). With every increase in time delay, participants are informed that the administrator is interested in determining whether they are “still able to remember the numbers

after longer periods of time.” Participants are provided feedback regarding the accuracy of each response by the administrator saying ‘right’, ‘correct’, ‘good’ or some similar positive remark. The administrator is not supposed to respond at all after an incorrect response (HNRC, neurobehavioral testing booklet). Participants were classified as having passed the HDMT on the basis of performance at or above the established cutoff of 90% correct (Ellwanger, Tenhula, Rosenfeld, & Sweet, 1999; Guilmette, Hart, Guiliano, & Leninger, 1994).

Hopkins Verbal Learning Test revised (HVLTR): consists of a list of 12 nouns that belong in equal numbers to three semantic categories. There are six forms of this test, each employing different semantic categories. Although the English language version was administered in the current study. There are three learning trials, delayed free recall, and recognition components. For the HVLTR, the outcome measures presented are as follows:

- 1) *Total recall:* The sum of all valid items generated across learning trials 1–3.
- 2) *Delayed recall:* The number of valid items generated after a delay (trial 4).
- 3) *Percent retained:* Delayed recall score divided by the higher of trial 2 or 3 $\times 100$.
- 4) *Recognition Discrimination Index:* True positive responses minus false positive responses.

Brief Visuospatial Memory Test-Revised (BVMT-R): The BVMT-R requires reproduction of the features and spatial placement of two-dimensional geometric figures. It consists of a page containing six geometric designs that are presented to the participant for three immediate recall trials, a delayed free recall trial, a recognition trial, and a copy trial to rule out visual defects. There are six equivalent forms of the BVMT-R. For this study, Form 1 was used. To ensure scoring consistency, all test scores were re-scored by an independent external examiner using the guidelines in the published manual as well as additional guidelines for each figure that were developed locally in order to standardize scoring. As in the HVLTR, there are three learning trials, delayed free recall, and recognition components. For the BVMT-R, the outcome measures presented are as follows: *Total recall:* The sum of all valid items generated across learning

trials 1–3,*Delayed recall*: The number of valid items generated after a delay (trial 4),*Percent retained*: Delayed recall score divided by the higher of trial 2 or 3 $\times 100$,*Recognition Discrimination Index*: True positive responses minus false positive responses

WAIS-III Digit Symbol and Symbol Search: These tasks make up the speed of information processing index from the Wechsler Adult Intelligence scale-III. While both tests assess speed of information processing, they have been found to measure attention and working memory (Strauss et al, 2006). The psychometric properties of the two tests reveal adequate internal consistency, as well as test-retest reliability and validity studies have shown that individuals performed similarly on the two tests as on other tests of cognitive functioning (Clay et al, 2006).

Trail making test A (TMT): was originally developed by John Partington and was popularized by Reitan (1958) as part of the Army Individual Test. It is now one of the most widely used neuropsychological instruments (Demakis, 2004) having two parts (Parts A and B). Part A consists of the numbers 1 through 15 appearing separately within circles and participants are required to link the numbers using a standard work sheet. The test measures psychomotor speed, visual-spatial scanning, attention, and motor sequencing skills. Trail Making Test B was not included in the present study because it was not part of the ZNTB. Scoring was the time in seconds spent in completing the connecting task.

Color trails 1 and 2 (CTT): Trail making tests are among the most widely used measures in neuropsychological practice (D'Elia, 1994). The most recent of them are the Color Trails Test (D'Elia, Satz, Uchiyama, & White, 1994), which reportedly allows broader application to cross-cultural studies compared to the original Trail Making Test A and B, at the same time being similar to it in terms of neuropsychological sensitivity. CTT was developed as a measure of attention and concentration in individuals 18 years of age and older. The participant must

be able to recognize Arabic numerals and distinguish between pink and yellow colors. It is suggested that even if an individual is colorblind, he or she would still be able to detect the difference between colors on the basis of darkness, and hence to complete the task (D'Elia et al., 1999). The test consists of two parts, and the score represents the time in seconds spent to complete each part.

Spatial Span (SS): the spatial span measures attention, concentration, and short-term memory. Digit forward requires the participant to touch the digit sequences in the same order in which the examiner touched them. In the Digit backward task, participants must touch digit sequences in reversed order. Two scores were collected in this research project: number of digit forward touched correctly and number of digit backward touched correctly.

The Wisconsin Card Sorting Test (WCST): We employed a computerized version of the WCST that was developed by Allen Y. Tien. This software version runs in DOS on a desktop or portable computer with a color screen (Chwen-Yng et al., 2008). During the WCST, participants were required to match response cards to the four stimulus cards along one of three dimensions (color, form, or number) by pressing one of the 1 to 4 number keys on the computer keyboard. Subjects were not informed of the correct sorting principle, nor were they told when the principle would shift during the test, but they were given feedback ("Right" or "Wrong") on the screen after each trial. The test results were scored by the computer software program and saved on Memory sticks. All of the indexes defined in the WCST manual (Heaton et al., 1993) except for Total Correct were used for analysis. The Total Correct index was not included since it is complementary to Total Errors. The indexes used were (1) Total Errors: total number of perseverative and nonperseverative errors; (2) Nonperseverative Errors: number of errors that were not perseverative; (3) Perseverative Errors: number of errors that were perseverative, reflecting tendency towards perseveration; (4) Perseverative Responses: number of responses that were perseverative, regardless of whether they were correct or not; (5) Categories

Achieved: number of times 10 correct responses in a row were made, reflecting overall success; (6) Trials to Complete First Category: number of trials to successfully complete the first category (counted as 129 if no category was completed), reflecting initial conceptual ability; (7) Conceptual Level Response: proportion of consecutive correct responses occurring in runs of 3 or more, reflecting insight into the correct sorting principles; (8) Failure to Maintain Set: number of times subject makes between 5 and 9 correct responses in a row, reflecting efficiency of sorting; and (9) Learning to Learn: average difference in percent errors between successive categories, reflecting the average change in conceptual efficiency during the test (Heaton et al., 1993). The last index can be calculated only for whom the total numbers of Categories Achieved and categories attempted are larger than 3. Percent Total Errors, Percent Nonperseverative Errors, Percent Perservative Errors.

Controlled Oral word association Test (COWAT): phonetic and semantic fluency was measured using the COWAT, the letters used in the phonetic fluency were 'F', 'A' and 'S' where participants were required to mention as many words as they could that begin with the letters: f, a and s .While in semantic fluency participants were asked to name words belonging to the following categories: animals(i.e., animals that the participant could think of),actions(i.e., things that people do).Allowed time for each individual category was 1 minute.

Category fluency test (CFT): Commonly applied in assessment of frontal functioning in the Western world, the test has its analogs in the Lurian scheme of neuropsychological evaluation (see Glozman, 1999; Luria, 1980). Performance on verbal fluency tasks depends on several factors including short-term memory, ability to initiate and maintain response, cognitive flexibility, and response inhibition capacity (Luria, 1980). These functions are usually referred to as "executive" and associated primarily with the left frontal area of the brain (Benton, 1968;Milner, 1964). The most commonly applied version of verbal fluency test in English-speaking countries is FAS and CFL (Spreen & Benton,

1969), where a subject is asked to name as many words as possible that begin with letter “F” or “C” in 60 s, the same procedure is repeated for the other two letters. The animal and action naming test was used, where the participants were to name as many different animals and things people do as they could in 1 min. The test scores were the total number of different animals and actions named in the allocated time.

Stroop Color and Word Test (SCWT): The SCWT was developed by John Ridley Stroop in 1935. In addition to information processing speed, it also assesses executive functioning. For this version of the stroop test, three cards of A4 size with 100 stimuli per card are arranged in a vertical orientation against a white background. The reading condition requires that the participant read color words (*red, blue, green*) printed in black ink and presented in random order as quickly as possible. The color naming condition consists of rectangles of colors (*red, blue, green*) arranged in random order and requires that the participant name color blocks as quickly as possible. For color-reading interference condition (stroop color) the words “red”, “Green” “blue” were printed in different color ink and the participant are required to name the color of the ink in which the word was printed and not read the word. For each condition, time (45 seconds) taken to complete the task was used as the outcome measure.

The test-retest reliability studies done by Levine, et al (2004) have shown that the TRR of Color task was $r=.87$, Word /Color task was $r=.81$ and $r=.88$ for the word task.

Halstead Category Test (HCT): The test was developed by Halstead (1947) to assess the ability to conceptualise qualities such as size, shape, number, position and colour. In its original form it had 336 items with 9 subtests. Reitan in 1948 reduced the subtests to 7 with 208 items. Each subtest has a different principle which may be odd stimulus, number of objects, spatial position, a combination of different principles etc. To complete the test, “the participant must rely on feedback based on correct or incorrect guesses to show what the principle in that

subtest is. The test requires deduction of a classification principle by means of a response based feedback, the use of the principle while it remains effective and to abandon the principle when it is no longer effective (Strauss, Sherman & Spreen, 2006). The test is scored based on the number of errors made.

The category test has for a long time been known to measure several constructs such as counting, perceptual organization, set maintenance, and learning (Simmel & Counts, 1957 as Cited by Allen, Goldstein & Mariano 1999: 237). Allen et al (1999), embarked on a study to evaluate the category test based on three factors with different populations and the relationships of these factors with other cognitive abilities.

In the 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. In the analysis, four models were examined and the three factor model based on the work of Johnston et al (1997) which specified that the Category Test subtests 1 and 2 loaded on the first factor (Counting/Symbol Recognition factor), subtests 3, 4, and 7 loaded on the second factor (Spatial Positional Reasoning factor), and subtests 5 and 6 loaded on the third factor (Proportional Reasoning factor) was assumed to explain the factor structure of the Category Test. However, the results indicated that it is based on a two factor model which is spatial position reasoning for subtest 3, 4, and 7 and proportional reasoning in subtests 5 and 6. Donders (2001) also added that the spatial positioning factor is affected by age and the proportional reasoning factor affected by education and sensitive to head injury (as Cited in Strauss, Sherman & Spreen, 2006). Thus when interpreting results obtained it is important to keep this information as a guide to what is being assessed and the objective of the assessment.

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 test 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, Sherman & Spreen, 2006).

Functional Adult Literacy Scale: This scale was developed by the present author with emphasis on the following aspects of literacy; the participant's opportunity to read, work-related literate activities, the value participants placed on education, everyday uses of literacy, religious practice-related literate activities, reading materials owned by the participant, time spent on reading, study-related literate activities and the participant's observed writing skills. In addition to requesting demographic information, the respondent's current and past occupational activities were requested (see appendix B1 for the full details of literacy scale, including actual items and how they were grouped for scoring under the various sub-headings that have been listed here).

Zambian Achievement Test (ZAT): is an individually administered test constructed to quantify academic achievement for the purpose of identifying academic difficulties in Zambian children in grades 1 through 7. The English version of the test was used in the current study to assess adults who have received primarily English instruction at school. The English version was developed first and reviewed for cultural sensitivity and familiarity of stimuli to Zambian school children. Current national guidelines for Zambian education and Zambian group achievement testing were used to guide estimated item-level difficulty. The ZAT was constructed to evaluate performance in four core academic areas: (i) mathematics, (ii) reading (letter and word) recognition, (iii) pseudo word decoding, and (iv) reading comprehension. However, the current study only utilized the reading recognition sub-test. The construction of the items

in ZAT was guided by Zambian school textbooks, proficiency examinations, and consultations with Zambian educators. The Reading Recognition subtest originally consists of 120 items. However, only 20 word items were used for the current study. For these 20 items, participants were simply asked to point and read aloud single words presented in the test book. These words, theoretically, got progressively more difficult to decode. The first items were letter matching: For example, participants were presented with a page in which a single letter, letter combination, or short 2- or 3-letter word appeared at the top of the page. The items were designed to cover a large range of difficulty levels, appropriate for adults with 0–7 years of formal schooling in Zambia. Stemler and colleagues (2009) report that the ZAT Reading Recognition subscale is a psychometrically sound instrument (test–retest reliability, $\rho = .81$ ($p < .001$) for Pseudo word Decoding). These results indicate that the ZAT Reading Recognition subscale has internal validity.

3.8 Data Analysis

Before the data was analyzed, it was checked and corrected for errors by trained neuropsychology data experts with a minimum qualification of a PhD. Analysis of this data was done with the aid of statistical package for social sciences software (SPSS) which generated the Bivariate correlations (used for determining the correlation coefficient) and the Analysis of Variance (used for determining the mean difference).

3.9 Ethical Considerations

The research induced some very mild psychological exhaustion in the participants, i.e. the administration of the test battery and the literacy scale took approximately three and half hours which was quite a long time of sitting in one place. To ensure sound ethical consideration, firstly, the proposal was submitted for review and approval to the University of Zambia Biomedical Research Ethics Committee which is mandated to govern research on living matter. The

Biomedical Research Ethics Committee determined that the study protocol adhered to ethical principles.

Secondly, 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. The participants were also informed about what their participation in the research entailed. The information that was provided by the participants was kept confidential and only used for academic research purposes. The researcher explained to the participants that their participation was voluntary and free from coercion. Further, the researcher and his assistants from the clinics were granted official approval from the Ministry of Health to collect data from the clinics. If some adults show heightened levels of anxiety during the assessment process the procedure was terminated.

Conclusion

The above chapter explained the methodology of the study, in terms of: the design, the population, samples and sampling procedures, the participant demographics, inclusion/exclusion criteria, data collection procedures, the central instruments used, the ethical considerations and data analysis. In the next chapter, the results of the study are presented.

Chapter Four

RESULTS

In this chapter, we present the findings of the study, organized according to the hypotheses that guided the present study. On ethical consideration, the names of both the clinics and the participants are not disclosed.

4.1 Hypothesis 1: Literacy and Neuropsychological Test Performance

Based on theoretical speculations, it was hypothesized that there would be *a significant positive relationship between literacy and neuropsychological test performance (measured by the global mean score)*. To assess this association, the bivariate correlation analysis was used and it revealed that literacy and neuropsychological test performance were positively correlated ($r=.219, n=324, p<.01$), however, the correlation was moderate.

4.2 Hypothesis 2: Education and Literacy prediction of Neuropsychological Test scores

It was hypothesized that *Literacy would account for a significant variance in neuropsychological test performance (measured by the global mean score) over and above what could be accounted for by self-reported years of education*. Hierarchical multiple regression was used to assess the ability of literacy and education to predict neuropsychological test scores after controlling for the influence of age and gender. Preliminary analyses were conducted where age and gender were entered at step 1, explaining 21.4% of the variance in neuropsychological test scores as shown below in table 1 (model 1 row under R square column). After entry of literacy and education at step 2, the total variance explained by the model as a whole was 39.2% as shown below in table 1 (model 2 row under R square column). Looking at the R square change column under model 2 in table 1, Literacy and Education explain an additional 18% of the variance in NPS scores, after controlling for age and gender, R square Change = .179 (.18 [2

decimal places]), the statistical significance of F Change (2,319) = 46.87, $p < .001$ is shown in table 2 below. To find out how well each of the variables (literacy and education) contributed to the final equation we will focus on the coefficients table in the model 2 row in table 3. Under the part correlations column, the coefficients of literacy and education are .054 and .372 respectively. If these values are squared (we obtain the delta squared values which are .00 and .14 for literacy and education respectively), these values give an indication of the unique contribution of literacy and education each to the total R square. In other words, these values tell us how much of the total variance in neuropsychological test scores is uniquely explained by literacy and education and how much R square would drop if either of these variables were not included in the model. Looking at the **Sig.** column, there are only two variables (age and education) that made a statistically significant contribution (less than .05). In order of importance, they are: education (beta = .40, delta = .14) and age (beta = -.38, delta = .14). Neither literacy (beta = .058, delta = .00) nor gender (beta = -.104, delta = .01) made a unique contribution as shown in table 3 below. Another way of evaluating each of the independent variable's unique contribution to the dependent variable (NPS Test scores) is by using beta values in accordance with Pallant (2007:163) who argue that "beta values represent the unique contribution of each variable (education and age) when the overlapping effects of all other variables are statistically removed".

Table 1: Total variance in Neuropsychological test scores explained by education, age, gender and literacy

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.462 ^a	.214	.209	1.64	.214	43.576	2	321	.000
2	.626 ^b	.392	.385	1.45	.179	46.872	2	319	.000

Comment [R1]: This is indeed the goal of the analysis. But your account of the meaning of Delta R-squared is not clear in that regard. Gabby done

Comment [R2]: Well done. This is much clearer !

Comment [R3]: The title should specify variance of what dependent variable. gabby, done

Table 2: Analysis of Variance values showing the statistical significance of the literacy, gender, age and education model

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	234.877	2	117.438	43.576	.000 ^a
	Residual	865.101	321	2.695		
	Total	1099.978	323			
2	Regression	431.361	4	107.840	51.451	.000 ^b
	Residual	668.617	319	2.096		
	Total	1099.978	323			

Comment [R4]: This title and that of Table 5 below are not sufficiently precise and explicit.

This table is repeated: one should be deleted.gabby DONE

Table 3: Multiple Regression Correlation Coefficients of education, literacy, age and gender relative to neuropsychological Test scores

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations			Delta squared values	VIF
		B	Std. Error	Beta			Zero-order	Partial	Part		
1	(Constant)	13.282	.394		33.75	.000					
	age	-.063	.007	-.438	-8.851	.000	-.443	-.443	-.438	.14	1.001
	gender	-.483	.183	-.131	-2.643	.009	-.147	-.146	-.131	.01	1.001
2	(Constant)	9.446	.528		17.87	.000					
	age	-.055	.006	-.381	-8.629	.000	-.443	-.435	-.377	.14	1.021
	gender	-.384	.161	-.104	-2.376	.018	-.147	-.132	-.104	.01	1.006
	Literacy	.018	.014	.058	1.246	.214	.219	.070	.054	.00	1.147
	edu	.289	.034	.403	8.532	.000	.485	.431	.372	.14	1.172

Comment [R5]: The titles of the tables need careful revision. Gabby Done

In order to attend to the hypothesis, where it was speculated that literacy would account for a significant variance in neuropsychological test performance over and above what could be accounted for by self-reported years of education, a hierarchical multiple regression also was used. Literacy was entered at step 1, explaining 4.8 %(.048) of the variance in neuropsychological Test scores as shown below in table 4 (model 1 row under R square column). After entry of education at step 2, the total variance explained by the model as a whole was 23.7%(.237) as shown below in table 4 (model 2 row under R square column). Looking at R square Change column under model 2 in table 4, Education explained an additional 19% (.189) of the variance in NPS scores, after controlling for literacy. Thus, education uniquely contributed more to test scores than literacy.

Table 4: Total variance in Neuropsychological test scores explained by education and literacy

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.219	.048	.045	1.80	.048	16.294	1	322	.000
2	.487	.237	.233	1.62	.189	79.611	1	321	.000

4.3 Hypothesis 3: Literacy and word fluency measures in the ZNBT battery

The third hypothesis stated that *the measures of word fluency would be most affected by literacy and education*. As presented below in Table 5, literacy and education demonstrated significant positive associations with fluency measures showing the association with literacy($r=.229, n=324, p<.01$) and education($r=.535, n=324, p<.01$). To corroborate the above hypothesis, among the correlations with literacy and education the highest is with measures of word fluency as shown below in table 5.

Table 5: Coefficients of correlation between Literacy and various Test Domains

Test Domains	Literacy	Edu
Visual episodic memory (BVMT learn and delay)	.177**	.238**
Verbal episodic memory (HVLT learn and delay)	.161**	.289**
Fluency mean scale(FAS, animals, actions, stroop word)	.229**	.535**
Speed of info Processing (Trails A, Color trails 1,digit)	.132*	.404**
Executive function(color trails2, category errors, WCST total errors, stroop color and word)	.139*	.315**
Working memory (PASAT and Spatial Span)	.190**	.357**
Motor skills (Pegs dominant and non-dominant)	.147**	.324**

** . Correlation is significant at the 0.01 level (2-tailed) and * . Correlation is significant at the 0.05 level (2-tailed).

4.4 Hypothesis 4: Difference in test performance according to level of educational attainment.

The fourth hypothesis stated that *there would be a significant mean difference in neuropsychological test performance among the four educational attainment groups (Primary, Basic, High and tertiary)*. A one-way between-group Analysis of Variance (ANOVA) was conducted to explore the impact of educational attainment on test performance, as measured by the global neuropsychological scale. Participants were divided into four groups according to their educational

Comment [R6]: Something is incorrect here. Table 2 has no bearing on this matter and is presented above. Table 4 is relevant, but only for Literacy, not for Education. This is gabby I have taken not and revised this part.

RS: but Table 5 only shows correlations with literacy, whereas the hypothesis you cite mentions education too. Moreover, you have not commented on the fact, confirming part of your hypothesis, that among these correlations with literacy the highest is with measures of word fluency.

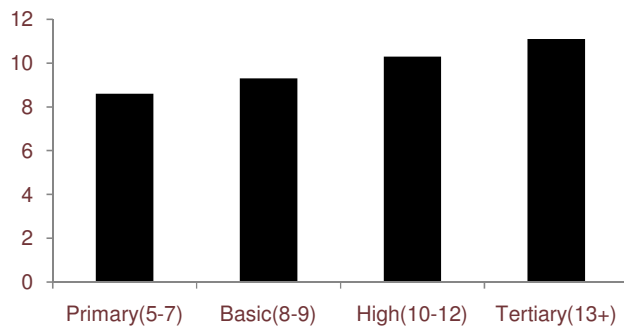
Comment [R7]: Your reference to Table 5 is an improvement, but Table 5 only shows correlations with literacy, whereas the hypothesis you cite mentions education too. Why not also tabulate the correlations with Education in an additional column of this table ?

Moreover, you have not commented on the fact, confirming part of your hypothesis, that among these correlations with literacy the highest is with measures of word fluency. Gabby : it has been done.

attainment level (Primary: 5 to 7 yrs; Basic: 8-9 yrs; High: 10-12yrs; Tertiary: 13 and above).

ANOVA showed that there was a statistically significant difference at the $p < .05$ level in neuropsychological scores (global mean) for the four educational attainment groups: $F(3,320) = 25.6, p = .00$. The actual difference in mean scores among the groups was large hence reaching statistical significance. The effect size, calculated using eta squared, was .19. The Post hoc comparisons using the Tukey HSD test indicated that the mean score for those with high school education ($M=10.3, SD=1.68$) was significantly different from those with basic ($M=9.28, SD=1.65$), primary education ($M=8.62, SD=1.66$) and tertiary education ($M=11.1, SD=1.65$), as illustrated in the bar graph in figure 1 below.

Figure 1: Test performance of Educational attainment groups on the Global Neuropsychological scale



4.5 Hypothesis 5: The relationship between Literacy and the Zambia Achievement Test

Based on theoretical speculations, it was hypothesized that there would be *a significant positive relationship between literacy and the Zambia Achievement Test*. To assess this association the bivariate correlation analysis was used and it

revealed that among the seven subscales of the literacy scale, observed writing skills ($r=.233, n=324, p<.01$) and work related literacy ($r=.152, n=324, p<.01$) were the most highly correlated with the Zambian Achievement Test (ZAT) as shown below in table 6.

Table 6: Coefficients of correlation between the various Literacy subtests and ZAT

Literacy subscale	ZAT
Work related literacy	.152**
Everyday use of literacy	.058
Religious practice related literacy	.014
Texts owned	.011
Time spent reading	.044
Study-related literate activity	.092
Observed writing skill	.233**
Total score on the literacy scale	.274**

** . Correlation is significant at the 0.01 level (2-tailed) and * . Correlation is significant at the 0.05 level (2-tailed).

4.6 Correlations of the literacy sub-scales

Bivariate correlation values were computed to explore the relationships among the different literacy sub-scales. As presented in the table 6, among the sub-scales, the time spent reading ($r=.345, n=324, p<.01$) indicated a significant positive association with observed writing skills.

Table 7: Correlation Matrix of the Literacy subscales

Literacy subscales	1	2	3	4	5	6	7
1. Work related literacy	-						
2. Everyday use of literacy	.178**	-					
3. religious related literacy	.098	.182**	-				
4. Texts owned	.037	.175**	.121*	-			
5. Time spent reading	.132	.132	.173**	.063	-		
6. Study-related literate activity	.014	.056	.168**	.003	.123*	-	
7. Observed writing skill	.304**	.251**	.178**	.090	.345**	.227**	-

** . Correlation is significant at the 0.01 level (2-tailed) and * . Correlation is significant at the 0.05 level (2-tailed).

4.7 Correlations between sub scales and demographic factors

To explore the influence of demographic factors such as education, age and gender on neuropsychological test performance, the association of self-reported years of education, age and gender with neuropsychological test performance were examined. Results from the bivariate correlation analysis as presented in Table 8, revealed that of the three demographic factors (education, age and gender), education was significantly associated with performance on most of the sub-scales (work-related literacy, time spent reading, study-related literacy and writing skill) at the .01 significant level. However, age and gender had weak significant associations with some sub-scales, such that age was negatively associated with study-related literacy at the .05 significant level while gender was positively related to work-related literacy at the .01 significant level, with males scoring higher on this sub-scale than females.

Table 8: Correlations between sub scales demographic factors

Literacy subscales	Edu	Age	Gender
work related literacy	.225**	.109*	.112*
everyday use of literacy	.147**	.035	.062
Religious practice related literacy	.048	.025	.034
texts owned	.080	-.101	.045
time spent reading	.170**	-.045	-.045
study-related literate activity	.059	-.149**	-.019
observed writing skill	.357**	-.044	-.006

** . Correlation is significant at the 0.01 level (2-tailed) and * . Correlation is significant at the 0.05 level (2-tailed).

Conclusion

In this chapter, we set out to present the findings of the study according to the hypotheses proposed. In the next chapter, which is the Discussion chapter, we review the questions that we had raised earlier on in Chapter 1 and sift through the data presented in this chapter to decide what answers emerged from the data.

Chapter Five

DISCUSSION

This chapter presents a discussion of findings in the current study according to the research objectives. First, the present study explored the relationship between literacy and cognitive test performance. Second, it examined the amount of variance accounted for by literacy, over and above years of education. Third, the cognitive test domain most related to literacy and education was established. Fourth, the differences in test performance among the four education attainment groups were examined and finally the relationship between literacy and the Zambian Achievement Test (ZAT) was investigated. We take one question at a time and review the data to explain what answers are provided.

5.1 The relationship between literacy and neuropsychological test performance

Consistent with the first research hypothesis and the previous studies conducted, the bivariate correlation analyses revealed that there was a statistically significant positive correlation between literacy and cognitive test performance. However, this relationship was quite moderate. On the other hand, a stronger significant positive association between years of education and cognitive test performance was found. There are four possible explanations for this finding.

First, cognitive reserve, which is the “ability to maximize performance through use of alternate cognitive strategies”. (Stern, 2002:451) is better indexed by years of education than by the literacy scale used in the current study because the years of education one spent at school presents an opportunity for him/her to acquire many other broader skills in addition to the ability to read and write. In essence, an educated individual is capable of calling up alternate cognitive strategies in response to increased task demand and has more cognitive reserve than one who is less educated. To put it in another way, those who are educated are able to use

more efficient processing mechanisms than their uneducated counterparts. The point is simply that a person with more cognitive reserve might be able to identify a larger collection of alternate brain networks for solving the problem at hand. For example, a trained mathematician might be able to solve a mathematics problem in many different ways, while a less trained individual might have only one possible solution strategy available. The mathematician would have more flexibility in solving the problem if any particular solution strategy was not allowed. The idea of cognitive reserve has also been described to be a more efficient use or recruitment of brain networks.

Secondly, the current results may have been due to not comprehensively representing the Zambian population hence having a limited statistical power and thus, may deserve further study with a larger representative sample.

Thirdly, it can also be speculated that the scale used to measure literacy in the current study may not have provided good psychometric properties because the functional adult literacy scale was not pilot tested before it was used in the present study and it was also not certain to effectively measure adult literacy in order for it to provide evidence for reliability. Moreover, different literacy experts like Daniel Wagner (2009) who has extensively studied adult literacy in Africa and South Africa in particular, have admitted that “adult literacy is not easy to measure, thus needs more research” (Wagner,2009:7)

Finally, this finding can be attributed to the design of the present study. The range of selection for inclusion to participate in the study was restricted to only individuals with at least five years of education whereby all the participants were literate in the current study. Thus, if a wider range of literacy levels had been sampled in the present study a stronger correlation might have been found between scores on the literacy scale and scores on the various Neuropsychological tests.

The focus of the next section is now on how much variance in neuropsychological test scores can be explained by literacy over and above education.

5.2 Variance accounted for by literacy and education

Inconsistent with other studies done by Baker et al. (1996) who found that 63% of their 250 middle-aged and elderly participants recruited from a predominantly black community mental health facility, read at a median level of 5 years below their self-reported educational level, the findings of the present revealed that self-reported education predicted neuropsychological test scores better than literacy. There are two reasons that can be suggested for this finding. Firstly, the experience of going through the process of education may not only be limited to acquisition of writing and reading skills but also other skills such as test-taking, scanning, processing speed, concentration and task switching skills which have an influence on neuropsychological test performance. To put it in another way, years of education represent broader skills than literacy.

Secondly, performance on the neuropsychological tests is largely predicted by years of education than literacy is hardly a surprising finding given that the nature of neuropsychological tests in the Zambia neurobehavioral tests battery appeal to the participant's application of their school experience while they actively participated in the educational system. For instance, the tasks of coming up with words that start with letters of the alphabet like 'F', 'A', 'S' and recall of actions and animals as observed in the controlled oral word association test and the category fluency test, are purely classroom exercises.

In the next section, attention is focused on the neuropsychological tests that are more closely related with literacy and years of education.

5.3 Neuropsychological Measures affected by literacy and education

Consistent with our hypothesis, on one hand, as compared to other cognitive measures such as visual episodic memory, verbal episodic memory, speed of information processing, executive function, working memory and motor skills, the English word fluency measures were more closely correlated with literacy and years of education. On the other hand, the English word fluency measures were found to be more correlated with education than literacy as already shown by the correlation coefficients presented earlier in chapter four. This finding is corroborated by the results of Ratcliff and colleagues (1998) who found effects of education on sound and category fluency measures among Indian adults from the rural community of Ballabgarh. These authors suggests that the ability to segment speech into phonemic units (better performance on initial sound fluency task) is dependent on education and perhaps education and literacy helps one to successfully use linguistic skills to mediate verbal tasks (Ratcliff et al., 1998). There is abundant evidence of a link between phonological awareness and reading ability (literacy), most of it documenting the importance of phonological ability as a precursor and predictor of reading ability (Bentin, 1992; Bradley, 1989).

English word fluency measures were also found to be more correlated with education than literacy in a study by Reis and her colleagues (1997) who found that illiterates performed worse on a fluency task that used a “formal,” phonological criterion as compared to a category fluency task (Reis et al., 1997).

The next section draws attention on the test performance differences according to the educational attainment group.

5.4 Test Performance differences according to educational level

Consistent with other studies done by Finlayson et al. (1977) who tested normal individuals with grade school (less than 10 years), high school (grade 12, without college experience) and university level (at least 3 years college experience) education. They found significant differences between the different educational attainment groups on the Category Test, the Seashore Rhythm Test, Speech-Sounds Perception Test, and Trail Making A and B. No effect of education was evident on the Tactual Performance Test or Finger Tapping. The current study has found that there are statistically significant differences in cognitive test performance among individuals with primary, basic, high and tertiary education. Those who were more educated performed better than their less educated counterparts. The simple reason for these findings is that individuals with higher educational attainment will have more cognitive strategies and mastery of skills at their disposal than those with lower educational attainment. The higher an individual's education, the better their test performance. The relationship between education attainment level and neuropsychological test performance is well documented.

5.5 The relationship between literacy and The Zambia Achievement Test (ZAT)

This study found that among the seven domains of literacy, observed writing skills and work related literacy activities were the most significantly correlated with the Zambia Achievement Test (ZAT). This was because individuals who work in formal placements have a greater opportunity to use their acquired literacy skills than those who operate in non-formal settings. This finding is in agreement with what Ardila, Rosselli, & Rosas (1998) concluded that processing speed and professional writing as a work-related activities as well as other cognitive traits are now being emphasized as in non-Western educational systems and in many non-Western jobs, as important human characteristics in the modern corporate world.

Chapter Six

CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

Throughout this dissertation, we have demonstrated how literacy relates to neuropsychological test performance among Zambian adults, how years of education rather than literacy predict neuropsychological test scores, the test domains that are more closely related with literacy and education, the significant test performance differences observed among the four different educational attainment groups and finally how literacy relates with the Zambian Achievement Test. This chapter has been divided into three parts. Firstly, the summary of the main findings will be offered. Secondly, a set of recommendations arising from the findings will be presented. Finally, a check on the limitations that could have constrained this study will be provided.

6.2 Summary of main findings

The main aim in the present study was to find out how literacy relates to neuropsychological test performance among the Zambian adults. Based on the results, the overall conclusion arrived at in this study is that, on one hand, there is a relationship between literacy and neuropsychological test performance among the Zambian adults, however, the correlation was not as strong as the relationship between years of education and neuropsychological test performance. On the other hand, years of education rather than literacy better predicted neuropsychological test scores. The possible explanations for these findings included the following. First, the experience of going through the process of education may not only be limited to acquisition of writing and reading skills but also other broader skills such as test-taking, scanning, processing speed, concentration and task switching skills which may influence optimal neuropsychological performance. Second, being educated makes an individual to have more cognitive reserve such that an educated or literate individual is capable

of calling up alternate cognitive strategies in response to increased task demand than one who is less educated and/or less literate. Put in another way, those who are educated and literate use more efficient processing mechanisms than their illiterate and/or uneducated counterparts. Third, the functional adult literacy scale used to measure adult literacy in the current study may not have provided good psychometric properties because the instrument was not pilot tested before it was used in the present study. Finally, we can also speculate that these findings can be attributed to the design of the present study. The range of selection for inclusion to participate in the study was restricted to only individuals with at least five years of education whereby all the participants were literate in the current study.

A larger scale study which comprise of both educated and uneducated respondents is needed to determine whether or not what was observed can be said to apply in the whole Zambian population. Such a study would provide a platform on which efforts to establish adult literacy programmes would be intensified. It would also clarify whether the norms for the test battery generated in the present study are relevant for the assessment of respondents who completed less than 5 years of education.

Our findings suggest the need for research into consideration of years of education as a substitute for literacy, or other alternative neuropsychological interpretative methods. The current results support the significant influence of education (schooling) on neuropsychological test performance.

Fluency measures in our battery were closely related with both literacy and education. Thus, confirming the hypothesis that literacy and education had an effect on initial fluency measures than on other cognitive measures. This means that for some tests, acquisition of literacy skills and being educated may result in a significant difference in test performance. This was true of the controlled oral word association test (verbal fluency test) where the participant is expected to master the letters of the alphabet. On a more practical level, these results

emphasize the need to be careful when designing test batteries for use in different settings or interpreting results obtained with different participant groups. This is particularly important given the recent increase of interest in cross-cultural neuropsychology studies. Not all tasks which purport to measure a given cognitive function (e.g., “verbal fluency,” “attention”) are equivalent. The factors limiting performance on a given task may be quite different due to the distinct cultural and ecological contexts in different populations.

Generally speaking, given the documented impact of education on cognitive test performance, the use of reported years of education (schooling) as an estimate of the quality or experience of education will serve as a more meaningful alternative among Zambian adults in the study sample. Therefore, one of the possible conclusions based on these results is that it is necessary to adjust for both literacy and education when interpreting neuropsychological test results among the Zambian adults. Literacy is not a predictor of neuropsychological test results but self-reported years of education is, in the current population.

In conclusion, the unique contribution of this study to the field of neuropsychology lies in its investigation of how literacy and education uniquely contribute to cognitive test results. The present study has shown that years of education rather than literacy better predicted cognitive test scores.

Arising from the findings, the following sections highlight some recommendations which would be beneficial for future research and clinical practice. The first recommendation emphasizes the need to adjust for literacy during interpretation of normative data. The second recommendation explains the importance of years of education in neuropsychological test interpretation. In line with the third objective, the third recommendation highlights the need to be aware of tests that disadvantage illiterate patients when carrying out clinical neuropsychological assessments. Finally, the fourth recommendation calls for the need to increase access to higher educational opportunities.

6.3 Recommendations

- Literacy in the present study has been found to correlate with neuropsychological test performance. Thus, there is need to adjust for literacy status in neuropsychological test interpretation.
- Use of years of education rather than literacy, as an estimate of the quality or experience of education will serve as a more meaningful alternative in neuropsychological test administration.
- Fluency measures that have been found to be more related to literacy and education such as the controlled word association test, stroop test, category fluency and the Hopkins verbal learning test should not be used in the neuropsychological assessment of either illiterate or uneducated participants.
- Higher Educational attainment significantly correlated with the neuropsychological measures, indicating better cognitive performance with higher educational attainment level. Hence, the need to increase higher educational opportunities for the Zambian adult population.

Each study, no matter how well it is planned, is bound to encounter minor or even major challenges, which may limit the study's attainment of its objectives in some way. While the study has generated useful findings which may lead to the above recommendations, the research process was not a smooth sailing one. Thus, in the next section, a few limitations to the current study are highlighted.

6.4 Limitations

1. The reliability of the functional adult literacy scale was not adequate to estimate the literacy level of the participants. Therefore, it appears that replicating the present study using more a reliable instrument would be in order and could yield different results.
2. The sample size in the present study was small and thus was not comprehensively representative of the whole Zambian population. Therefore there is need for the results to be tested in a larger and more representative sample.
3. When developing this project, we aspired to conduct the neuropsychological assessments in convenient facilities such as private rooms suitable for testing or other facilities within the clinic premises where adequate testing conditions such as quiet environment and privacy existed. However, due to lack of infrastructure and other logistical issues, the assessments were conducted outside where accuracy and quality of the results may have been compromised. The rules for standard test battery administration were also perhaps not consistently followed due to environmental interference such as noise and other visual distractions.
4. In the light of the limited literature on the subject of literacy and neuropsychological assessment in Zambia and Africa, there was reliance on literature from Europe, America and other parts of the world to situate the findings of the present study. Hence the need to cautiously apply these foreign literature to the Zambian situation because of inevitable cultural and ecological diversities.

REFERENCES

- Abwender, D. A. et al (2001). Qualitative Analysis of Verbal Fluency Output: Review and Comparison of Several Scoring Methods. *Assessment*, 8, 323 – 336.
- Albert, M.S., & Teresi, J.A. (1999). Reading ability, education, and cognitive status assessing among older adults in Harlem, New York City. *American Journal of Public Health*, 89, 95–97.
- Albert, M.S., Jones, K., Savage, C.R., Berkman, L., Seeman, T., Blazer, D., & Rowe, J.W. (1995). Predictors of cognitive change in older persons: MacArthur studies of successful aging. *Psychology and Aging*, 10, 578–589.
- Allen, D.N., Goldstein, G and Mariano, E. (1999) Is the Halstead Category Test a Multidimensional Instrument? *Journal of Clinical and Experimental Neuropsychology*, 21, 237- 244.
- Anderson, J.R. (1976). *Language, Memory, and Thought*. Erlbaum: Hillsdale
- Ardila, A.(2001). The impact of culture on Neuropsychological test performance. Course 13. In paper presented at 21st annual conference of National Academy of Neuropsychology.
- Ardila, A., Rosselli, M., & Ostrosky, F. (1992). Sociocultural factors in neuropsychological assessment. In A. E. Puente & R. J. McCaffrey (Ed.), *Handbook of neuropsychological assessment: A biopsychosocial perspective* (pp. 181–192). New York: Academic Press.
- Ardila, A., Rosselli, M., & Puente, P. (1994). *Neuropsychological evaluation of the Spanish speaker*. New York: Plenum Press.
- Ardila, A., Rosselli, M., & Rosas, P. (1989). Neuropsychological assessment in illiterates: Visuospatial and memory abilities. *Brain and Cognition*, 11, 147–166.
- Baker, F.M., Johnson, J.T., Velli, S.A. & Wiley, C. (1996) Congruence between education and reading levels of older persons, *Psychiatric Services*, 47, 194–196.
- Barr, A. & Brandt, J. (1996). Word-list generation deficits in dementia. *Journal of Clinical and Experimental Neuropsychology*, 44, 798-800.
- Basso M.R., et al., (1999). Practice Effects on Commonly Used Measures of Executive Tests. *British Journal of Clinical Psychology*, 43, 623 – 628.
- Bentin, S. (1992). Phonological awareness, reading and reading acquisition: A survey and appraisal of current knowledge. *Journal of Orthography and phonology*, 99, 119-130.

Benton, A. L., et al (1994) *Multilingual Aphasia Examination*. Antonio: IX Psychological Corporation.

Bertolucci, P. H. F., Brucki, S. M. D., Campacci, S. R., & Juliano, Y. (1994). Mini-Mental Exam in the General population I. *Neuropsychologia*, 52, 1–7.

Bird, C.M, et al (2004) Monitoring Cognitive Changes: Psychometric Property of Six in Cognitive Brucki S.M.D & Rocha, M.S.G 2004. *Brazilian Journal of Medical and Biological Research*, 12,200-204.

Bonaiuto, S., Rocca, W.A., Lippi, A., Luciani, P., Turtù, F., Cavarzeran, F., & Amaducci, L. (1990). Impact of education and occupation on prevalence of Alzheimer's disease (AD) and multi-infarct dementia (MID) in Appignano, Macerata Province, Italy. *Neurology*, 40, 346 – 351 [Abstract].

Bonne, K.B. (1999) *Neuropsychological assessment of executive functions: Visuospatial impact of age, education, gender, intellectual level and Vascular status on executive test scores*. New York: Guilford Press.

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

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

Bradley, L. (1989). Predicting learning disabilities. In J. J. Dumont & H. Nakken (Eds.), *Learning Disabilities: Cognitive, Social and Remedial Aspects* (pp. 1–17). Amsterdam: Swets & Zeitlinger.

Britain, J.L., La Marche, J.A., Reeder, K.P., Roth, D.L., & Boll, T.J. (1991). Effects of age and IQ on Paced Auditory Serial Addition Task (PASAT) performance. *The Neuropsychologist*, 5, 163-175.

Butler, S.M., Ashford, J.W., & Snowdon, D.A. (1996). Age, education, and changes in the Mini-Mental State Exam scores of older women: Findings from the Nun Study. *Journal of the American Geriatrics Society*, 44, 675– 681.

Chwen-Yng S., Yueh-Hsieh L., Aij-Lie K., and Nai-Wen G., (2008). Construct Validity of the Wisconsin Card Sorting Test-64 in Patients with Stroke, *The Clinical Neuropsychologist*, 22, 273 - 287.

Clay, J., Edwards, J., Ross, L., Okonkwo, W., Wadley, G., Roth, D. (2006). Function and cognitive speed of information processing mediated by age related memory decline and fluid intelligence, *Journal of Aging and Health*, 21, 547-568.

Cornelious, S. W., & Caspi, A. (1987). Everyday problem solving in adulthood and old age. *Psychology of Aging*, 55, 233-268.

Cronbach, L.J. (1984). *Essentials of Psychological testing*. 4th Edition. New York: Harper & company.

CSO (2000) *Central Statistics Office Report: Education Characteristics*. CSO, Lusaka Zambia. Retrived April, 2011 from <http://www.zamstats.gov.zm>

D'Elia, L.F., Satz, P., Uchiyama C.L. & White, T. (1994) Color Trails Test: Professional manual, *Psychological Assessment Resources*.

Delis D. L. (2000) *Verbal Learning Test 2nd ed Manual*. Psychological Corporation: San Antonio.

Dikmen S. S. et al (1999) Test-retest Reliability and practice effects of expanded Halstead Reitan Neuropsychological Test Battery. *Journal of the International Neuropsychological Society*, 5, 346 – 356.

Evans, D.A., Beckett, L.A., Albert, M.S., Hebert, L.E., Scherr, P.A., Funkenstein, H.H., & Taylor, J.O. (1993). Level of education and change in cognitive function in a community population of older persons. *Annals of Epidemiology*, 3, 71-77.

Farmer, M.E., Kittner, S.J., Rae, D.S., Bartko, J.J., & Regier, D.A. (1995). Education and change in cognitive function: The epidemiologic catchment area study. *Annals of Epidemiology*, 5, 1-7.

Finlayson, M. A., Johnson, K. A., and Reitan, R. M. (1977). Relationship of level of education to neuropsychological measures in brain-damaged and non-brain-damaged adults. *Journal of Consulting and Clinical Psychology*, 45, 536-542.

Folstein, M. F., Folstein, S. E., & McHugh, P. R. (1975). Mini-mental state. A practical method for grading the cognitive state of patients for the clinician. *Journal of Psychiatric Research*, 12, 189-198.

Gardner, H. (1991). *The unschooled mind: How children think and how schools should teach*. New York: Basic Books.

Gibson, E.J. & Levin, H. (1975). *The Psychology of Reading*. Cambridge, MA: MIT press.

Glozman, G.M (1999). Quantitative and qualitative integration of Lurian Procedures. *Neuropsychology Review*, 9, 23-32.

Griffin, P. & Cole, M. (1987) New technologies, basic skills and the underside of education: What's to be done? In J. W. Berry, P. R. Dasen, & T. M. Saraswathi (Eds.), *Handbook of cross-cultural psychology*, Vol. 2. (2nd ed., pp. 345-382), Boston, MA: Allyn & Bacon.

Heaton, R.K., Grant, I., & Matthews, C.G. (1993). Differences in neuropsychological test performance associated with age, education, and sex. In I. Grant & K.M. Adams (Eds.), *Neuropsychological assessment of neuropsychiatric disorders* New York: Oxford University Press.

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.

Horton, A & Wedding, D. (2007). *The Neuropsychology Handbook*. USA: Springer Publishing Company.

Illich, I. (1991). A plea for Research on lay literacy. In D.R. Olson, & N. Torrance. (Eds.) *Literacy and Orality* (pp. 28–46). Cambridge: Cambridge University press.

Laboratory of Comparative Human Cognition. (1983). Culture and cognitive development. In P. Mussen (Ed.), *Handbook of child psychology. Vol 1: History, theories and methods* (pp. 342–397). New York: John Wiley & Sons.

Langeluddecke, P.M. and Lucas, S.K (2002) quantitative Measures of Memory Malingering on the Wechsler Memory Scale – Third Edition in Mild Head Injury Litigants. *National Academy of Neuropsychology*, 22, 550–569.

Laurendeau-Bendavid, M. (1977). Culture, Schooling and cognitive development: A comparative study of children in French Canada and Rwanda. In P. R. Dasen (Ed.), *Piagetian psychology: Cross cultural contributions* (pp. 175–200). New York: Gardner.

Lecours, A.R., Mehler, J., & Parente, M.A. (1988). illiteracy and brain damage: A contribution to the study of speech and language disorders in illiterates with unilateral brain damage (initial testing). *Neuropsychologia*, 26, 575–589.

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), 529–534

Levine, A., Miller, E., Becker, J., Selnes, O., & Cohen, B. (2004). Normative data for determining significance of the test-retest differences on eight common neuropsychological instruments, *The Clinical Neuropsychologist*, 18 (3), 373–384.

Levine, K. (1982). Functional Literacy: Fond illusions and false economies. *Harvard Educational Review*, 52, 249–266.

Lezak M.D. Howieson D.B. & Loring D.W. (1999). *Neuropsychological assessment* (4th ed) New York: Oxford University Press.

Lezak, M. D. (1995). *Neuropsychological Assessment third edition*. New York: Oxford University Press.

Lezak, M.D., Howieson, D.B., and Loring, D.W. (2004). *Neuropsychological Assessment fourth edition*. New York: Oxford University Press.

Luria, A.R. (1980). *Cognitive development, its cultural and social foundations*. Cambridge, MA: Harvard University Press.

Manly, J.J., Byrd, D.A., & Pegah,T.(2004) Acculturation, reading level and neuropsychological test performance among African American elders. *Applied Neuropsychology*, 11, 37– 46.

Manly, J.J., Jacobs, D.M., Touradji, P., Small S.A., and Stern, J. (2002) Reading level attenuates differences in neuropsychological test performance between African American and White elders. *Journal of the International Neuropsychological Society*, 8, 341–348.

Manly, J.J., Jacobs, D.M., Sano, M., Bell,K.,Merchant,C.A.,Small,S.,& Stern,J.(1999) Effect of literacy on neuropsychological test performance in nondemented, education-matched elders. *Journal of the International Neuropsychological Society*, 5, 191– 202.

Manly, J.J., Touradji, P., Tang, M.X. & Stern, Y. (2003) Literacy and Memory Decline among Ethnically Diverse Elders. *Journal of Clinical and Experimental Neuropsychology*, 25, 680–690.

Matarazzo, J. D. (1979). *Wechsler's measurement and appraisal of adult intelligence (5th Ed.)*. New York: Oxford University Press.

Matute, E., Leal, F., Zaraboso, A., Robles, A., & Cedillo, C. (1997).Influence of literacy level on stick constructions in non-brain damaged subjects. *Journal of the International Neuropsychological Society*, 3, 32 [Abstract].

Milner,B.(1964).some effects of frontal lobectomy In Man.In J.M.Warren & Alkert(Eds),*The frontal granular cortex and behavior*(pp.331-334).NY:McGraw-Hill.morphology, and meaning (pp. 67–84). Amsterdam: Elsevier, North Holland.

O'Bryant, S.E Schrimsher, G.W. and O'Jile, J.R.(2005) Discrepancies between self-reported years of education and estimated reading level: Potential implications for neuropsychologists, *Applied Neuropsychology*, 12, 5–11.

O'Bryant, S.E., O'Jile, J.R., & McCaffrey, R.J. (2004) Reporting of demographic variables in neuropsychological research: Trends in the current literature, *The Clinical Neuropsychologist* ,18,229–233.

O'Bryant,S.E.,Lucas,J.A.,Willis,F.B.,Smith,G.E.,Radford,G.R.N.&Ivnik,J.R(2007) Discrepancies between self-reported years of education and estimated reading level

among elderly community-dwelling African-Americans: Analysis of the MOAANS data. *Archives of Clinical Neuropsychology*, 22,327-332.

Pallant,J.(2007) *SPSS Survival Manual: A step by step Guide to Data Analysis using SPSS for Windows third edition*.Berkshire:Open University Press.

Perez-Arce,P.,& Puente,A.E.(1997) *neuropsychological assessment of ethnic minorities.The case of assessing Hispanics living in North America*. Delray Beach,FL:St.Lucie Press.

Ratcliff,G.,Ganguli,M.,Chandra,V.,Sharma,S.,Belle,S.,Seaberg,E.,& Pandav,R.(1998)Effects of Literacy and Education on measures of Word Fluency. *Brain and Language Journal*, 61,115-122.

Razani,J.,Burciaga,J.,Madore,M., & Wong,J.(2007). Effects of acculturation on tests of attention and information processing in an ethnically diverse group. *Archives of Clinical Neuropsychology* ,22,333-341.

Reis, A. & Castro-Caldas, A. (1997). illiteracy: A cause for biased cognitive development. *Journal of the International Neuropsychological Society*, 3, 444– 450.

Reis, A., Guerreiro, M., & Castro-Caldas, A. (1994). Influence of educational level of non brain-damaged subjects on visual naming capacities. *Journal of Clinical and Experimental Neuropsychology*. 6, 448– 460.

Rosselli, M., Ardila, A., & Rosas, P. (1990). Neuropsychological Assessment in illiterates. II. Language and Apraxic abilities. *Brain and Cognition*, 12, 281–296.

Scribner, S. & Cole, M. (1981). *The psychology of literacy*. Cambridge,UK: Harvard University Press.

Serpell, R. (1993). *The significance of schooling: Life journeys in an African society*. Cambridge, UK: Cambridge University Press.

Serpell, R., & Hatano, G. (1997). Education, Literacy and Schooling. In J. W. Berry, P. R. Dasen, & T. M.Saraswathi (Eds.), *Handbook of cross-cultural psychology*, (2nd ed.), Vol. 2. (pp. 345–382), Boston, MA: Allyn & Bacon.

Snowdon, D.A., Ostwald, S.K., & Kane, R.L. (1989). Education, survival and independence in elderly Catholic sisters, 1936–1988. *American Journal of Epidemiology*, 130, 999–1012.

Solis, F., Ardila, A., Rosselli, M., Arango, G.L., Mendoza, V.U. (1998). Neuropsychological Test Performance in Illiterate Subjects. *Archives of Clinical Neuropsychology*,13,7, 645–660.

Stemler, S., Chamvu, F., Chart, H., Jarvin, L., Jere, J., Hart, L., Kaani, B., Kalima, K., Kwiatkowski I, J., Mambwe, A., Kasonde-Ng'andu, S., Newman, T., Serpell, R., Sparrow, S., Sternberg, R.J. & Grigorenko, E.L. (2009). Assessing competencies in reading and mathematics in Zambian children. In E.L. Grigorenko (Ed), *Multicultural psycho educational assessment* (pp. 157-186). New York, NY: Springer.

Stern, Y. (2002). What is cognitive reserve? Theory and research application of the reserve concept. *Journal of the International Neuropsychological Society*, 8, 448–460.

Strauss, E., Sherron, E., & Spreen, O. (2006). *A Compendium of Neuropsychological tests: Administration, norms and commentary, 3rd Edition*. New York: Oxford University press.

Vygotsky, L.S. (1962). *Thought and Language*. Cambridge, MA: MIT Press. Translated.

Wagner, D. (2009, January). Challenges of Adult literacy. Paper presented at the Conference on Adult Literacy. Brussels, Germany.

Wilkinson, G.S. (1993) *The Wide Range Achievement Test-3rd Edition: Administration manual*, Wide Range, Inc, Wilmington.

Zillmer, R. (2009) *Principles of Neuropsychology*. New York: Oxford University Press.