Original Article

Influence of Age and Education on Neuropsychological Tests in Zambia

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ABSTRACT

Objective: The purpose of this study is to explore the influence of age, education and reading ability on neuropsychological tests in Zambia.

Methods and Materials: 324 adult participants were recruited from urban and rural areas in Zambia. They had an age range of 19-65 and education range of 5 – 19 years of schooling. The Zambia Neurobehavioural Test battery was administered.

Results and Conclusion: Results showed that all Neurobehavioural test scores had a strong association with education and an inverse relationship with age. Education did not generally offer protection against age-related decline in neuropsychological functioning. Reading level predicted performance on neuropsychological tests better than years of schooling.

INTRODUCTION

Assessment of neurocognitive impairment relies on a judicious synthesis of biological and behavioural evidence. Psychological tests afford a standardised framework for sampling the competencies of an individual, so that deviation of test performance from the norm constitutes one important criterion of impairment. Understanding the interaction between age and education in Zambia is important as both factors may need to be taken into account in the establishment of norms in the fairly new field of neuropsychology in Zambia. Norms of cognitive test performance inevitably reflect the range of opportunities for acquiring the relevant skills afforded by a given society's educational provision. In societies where such opportunities are unevenly distributed across social groups and generations, it is widely agreed among clinicians that some form of adjustment or correction is needed in order to interpret an individual's scores.

Education is clearly an important construct that affects neuropsychological test performance.[1,2] However, it is a great challenge to find an accurate estimate of educational attainment. This is even more problematic in an African country like Zambia with few psychometrically sound and standardised assessment tools to measure this construct. The relationship between self-reported years of education and neuropsychological test performance has received extensive attention in the literature with results suggesting that self-reported years of education correlate positively with test scores on nearly all domains of cognitive functioning.[3] 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[4], suggesting a general consensus as to the importance of considering self-reported years of education when interpreting neuropsychological data.

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It is common knowledge in Zambian society that the quality of public education has dropped over the past three decades, in the context of a severe economic recession, with an increase in pupil to teacher ratios, shortage of instructional materials and dilapidation of facilities.[5] Thus it has become increasingly doubtful that completing a given number of years of schooling guarantees a certain level of knowledge and skills: an individual may have completed 12 years of schooling but perform at the level of a 10th or 11th grader. This then poses a challenge to interpretation of test results based on reported years of schooling. Recent research has found that reading ability as an index of literacy was a stronger predictor of neuropsychological test performance among elderly persons in the USA than self-reported years of schooling.[6-9]

The aim of this study was to establish the influence of age, education and reading ability on neuropsychological tests in Zambia. It was part of a larger study designed to generate comprehensive norms for the Zambia Neurobehavioral Test Battery. It was hypothesised that age would have an inverse effect on neuropsychological test scores. Education would have a positive effect on the test scores but reading ability would prove to be a better predictor of performance on neuropsychological test scores than reported years of schooling. It was also expected that increased education would show a protective effect against age related decline in neurocognitive functioning.

MATERIALS AND METHODS

Participants

A total of 324 Zambian adults were recruited in the study. All participants were recruited though the various Voluntary Counselling and Testing (VCT) centres and Maternal Child Health (MCH) facilities set up in selected clinics. For purposes of the study, VCT and MCH staffs were requested prior to the commencement of the study to check records for all candidates who had tested negative in their second HIV test within three months. However, recruitment continued even when the study had commenced. Study participants consisted of HIV negative Zambian adults from the ages of 20 to 65 years *(M = 38.48, SD = 12.8),* from both rural and urban areas of Zambia. They were about equally distributed in terms of gender and had a range of 5 to 19 years of education (*M =11.02, SD 2.8).* Education in this sense was operationally indexed by the participants self-reported years of schooling. In quantifying the education index, reported years of schooling were categorised according to the Zambian Ministry of Education criteria with grades 1-7 termed Primary education, 8-9 basic education and 10-12 high school education. The participants' present state of depression was assessed using the Beck Depression Inventory (BDI).[14] Personal functioning and Daily living were also assessed using the Patients Assessment of Own Functioning Inventory(PAOFI)[15] and Activities of Daily Living (ADL).[13] These tests were meant to ensure that all participants were 'normal' and qualified to be part of a norming study. It is worth noting that no participant was excluded as a result of failing any of the above screening tests. Zambia as a whole has more than 80dialects of 10 indigenous languages with English as the official language. As a way of standardising test administration, all the tests were administered in English. All participants were screened for ability to read the English language through the Zambia Achievement Test, an individually administered test constructed to quantify academic achievement for the purpose of identifying academic difficulties in Zambian children in grades 1 through 7.[16] Even though the test was made for children it can also be used for adults as the items contain words used in everyday language.

Neuropsychological Assessment

All participants completed a comprehensive Neuropsychological test battery developed for the Zambian population (Zambia Neurobehavioural Test Battery). The battery is an adaptation of the HIV Neurobehavioural Test Battery developed by the

San Diego HIV Neurobehavioural Research Centre Group. The battery has been adapted and used in various international settings[17,18] and is known to yield specific as well as sensitive results of diagnosis and assessment on HIV neuropsychological deficits. The table below lists the tests included in the 4hour battery which assesses seven cognitive domains. The domains are: speed of information processing, verbal episodic memory, visual episodic memory, verbal fluency, working memory, executive functioning and motor dexterity. The battery was administered by 9 trained Master of Science in Clinical Neuropsychology students as part of a larger validation study of the test battery. The students were trained by an expert from the San Diego HIV Neurobehavioural Research Centre.

Table 1: Neuropsychological Tests Administered for each cognitive domain

Speed of Information Process
WAIS Digit Symbol and Symbol Search
Trail Making Test, Part A
Colour Trails 1
Stroop Colours Task
Visual Episodic Memory
Brief Visualspatial Memory Test – Learning
Brief Visualspatial Memory Test – Delayed Recall
Verbal Episodic Memory
Hopkins Verbal Learning Test – Learning
Hopkins Verbal Learning Test – Delayed Recall
Verbal Fluency
Controlled Word Association Test – FAS
Category Fluency Test (Animal and Actions)
Stroop Word Task
Executive Functioning
Colour Trails 2
Halstead Category Test – Total Errors
Stroop Colour/Word Task
Wisconsin Card Sorting Test (64 Item)
Working Memory
Paced Serial Addition Test
WMS Spatial Span
Motor Dexterity
Grooved Pegboard (Dominant & Non Dominant Hands)

RESULTS

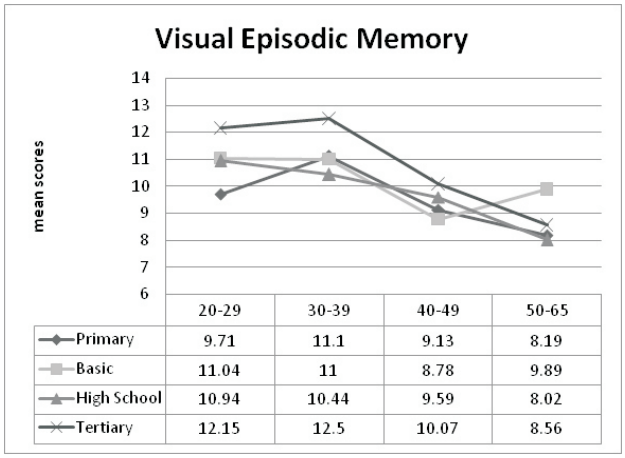
The results showed that both age and years of schooling had a significant effect on performance on neuropsychological tests. Bivariate correlations were computed on each of the cognitive domains on the one hand and age or reported years of schooling on the other. All of these correlations were significant ($p<.01$). All cognitive domains correlated negatively with age with the highest correlation being obtained in the speed of information processing domain $r=-.451$.Years of schooling had the highest positive correlations in the Verbal fluency domain with $r=.535$ as indicated in table two.

Table 2: Bivariate Correlations between age, education and neuropsychological domains

Domain	Age	Education
Visual Episodic Memory	-.404	.283
Verbal Episodic Memory	-.301	.289
Verbal Fluency	-.206	.535
Speed of Information Processing	-.451	.404
Executive Functioning	-.344	.315
Working Memory	-.234	.357
Motor Dexterity	-.338	.324
Global Score	-.443	.485

Figures one, two, three and four present means and standard deviations for four different neuropsychological domains according to age group and education level. In the verbal fluency domain most groups showed a trend of increased scores with higher education and reduced scores with increasing age. In this domain, ANOVA results showed that the effect of schooling was significant at $P<.05$ with the tertiary education group obtaining the highest scores.

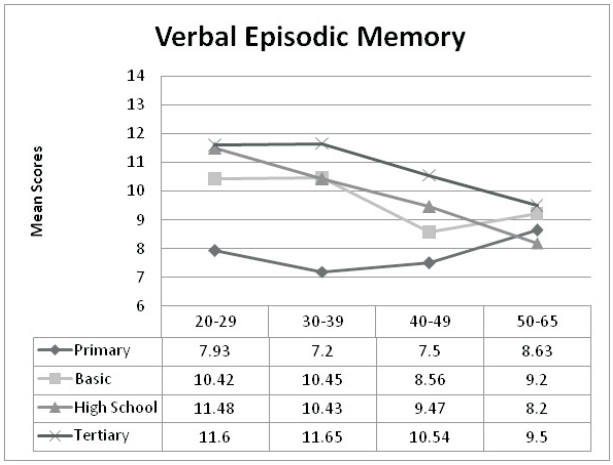
Figure 1: Mean scores by age and education in visual episodic memory



	20-29	30-39	40-49	50-65
Primary	9.71	11.1	9.13	8.19
Basic	11.04	11	8.78	9.89
High School	10.94	10.44	9.59	8.02
Tertiary	12.15	12.5	10.07	8.56

However, there were some deviations from this overall pattern in the visual episodic domain, where results showed that in the 50-65 years age group, those with basic education obtained higher scores than any other educational group.

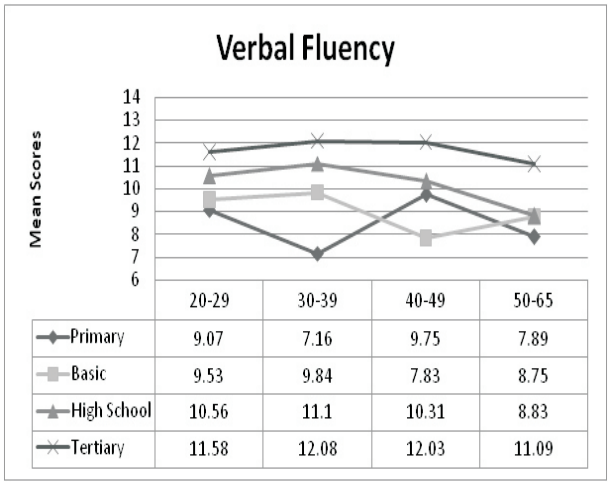
Figure 2: Mean scores by age and education in verbal episodic memory



	20-29	30-39	40-49	50-65
Primary	7.93	7.2	7.5	8.63
Basic	10.42	10.45	8.56	9.2
High School	11.48	10.43	9.47	8.2
Tertiary	11.6	11.65	10.54	9.5

In the verbal episodic domain the primary and basic education groups, the age group 40-49 years recorded lower scores than the 50-65years age group; similarly, the primary and basic education groups in 50-65yrs age group performed better than the high school.

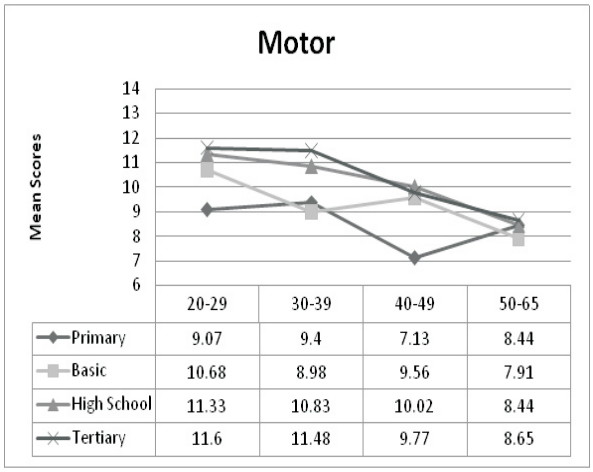
Figure 3: Mean scores by age and education in verbal fluency domain



	20-29	30-39	40-49	50-65
Primary	9.07	7.16	9.75	7.89
Basic	9.53	9.84	7.83	8.75
High School	10.56	11.1	10.31	8.83
Tertiary	11.58	12.08	12.03	11.09

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

Figure 4: Mean scores by age and education in Motor Dexterity



	20-29	30-39	40-49	50-65
Primary	9.07	9.4	7.13	8.44
Basic	10.68	8.98	9.56	7.91
High School	11.33	10.83	10.02	8.44
Tertiary	11.6	11.48	9.77	8.65

Table 3 presents the results of hierarchical multiple regression correlation analysis of global scores on the test battery. Age was entered as the first predictor,

followed by years of schooling in step 2 and scores on the ZAT in step 3. All three predictors were significant with P<.0001 in predicting performance on the neuropsychological test battery. In step three, age yielded the highest beta weight of .40 and accounted for 19 % of the variance, while reading level had a beta weight of .31 and accounted for an additional 7% of the variance over and above age and reported years of schooling.

Table 3 – Hierarchical Regression Analysis of Global Neuropsychological Scores

Variable	B	SEB	,	B	SEB	β	B	SEB	β
	Step 1			Step 2			Step 3		
Age	-0.06	0.01	0.44*	-0.06	0.01	0.84*	-0.06	0.01	0.40*
Years of Schooling				0.31	0.03	0.43*	0.20	0.03	0.28*
Reading Level (ZAT)							0.19	0.03	0.31*
.	0.19			0.38			0.45		
ΔR^2	0.19			0.18			0.07		

DISCUSSION

In considering the influence of age and education on the different neuropsychological tests, it was observed that there was an increase in performance in all the groups as they advanced in their schooling but there was also a reduced performance with an increase in age. This result was consistent with previous research conducted in the US and Italy[2, 10-12, 19-21] which found a reduction in test performance with advancing age. The tests most sensitive to age were in the domains of speed of information processing, executive functioning, working memory and visual episodic memory.

It has been noted that as a person grows older the brain functions less well than when a person is younger. The results are also in line with previous research which found that Speed of Information processing is one of the first functions to decline among individuals.[22] Bivariate correlations obtained have also shown a similar pattern with strongest correlations with age being obtained in the speed of information processing r=-.451. Since a decline in performance with increase in age was observed in a normal sample, it cannot be attributed to other diseases such as dementia but simply age-related decline. Our findings further demonstrate that the process of cognitive decline follows a different course in the different domains with some being affected more than others.

In examining the protective influence that education might offer the aging group, a clear difference among schooling levels in age related decline was not observed in the results. This reveals phenomena which appear different from what has been documented in previous research where low scores are expected in the lower education strata (primary education) and can be attributed to lower cognitive stimulation.[2] Some of this variation among age groups may, in the case of Zambia, reflecta reduction in the quality of education received in different historical eras. Thus in figures 1-3, the differences in performance by respondents with basic education and those with primary education was often greater for the younger cohorts than for those who attended school in the era before large scale decline in quality of education was reported.

Educational effects were observed more in the verbal fluency domain. One of the explanations for this is that the verbal fluency domain contains test items that require the production of English words; therefore it is understandable that a strong educational effect was observed in this domain by individuals who more frequently use English either at work or at school. In this study, all the tests were administered in English, which although it is the official language in Zambia, is not usually used in the home but rather in schools and the workplace.[23]

Research with diverse populations in North America[6-9] has established that although age and

schooling are both important in obtaining test results that are sensitive and specific for diagnosis and treatment, reading ability adds more predictive power. This is because reading ability also reflects other extraneous variables such as pupil teacher ratios, availability of materials such as books and desks to facilitate the learning process that may not be reflected in reported years of schooling. Moreover, the ability to read directly affects how individuals perform on neuropsychological tests, by enhancing respondents' automatic word production and phonological skills required to perform well on tests such as the controlled word association, category fluency and Stroop word tasks used in this study to assess verbal fluency.

Using reading ability as a measure of educational attainment will not only give an indication of levels of performance but is more likely to give better diagnosis in conditions such as HIV related dementia. Other scholars[24, 25] argue that using test results corrected for reading ability will increase the specificity and sensitivity of the tests and reduce levels of reported impairment. In cases where only reported years of schooling was used as a measure of educational attainment, results tended to inflate the levels of impairment resulting in wide variations among individuals of different backgrounds.

When considering the effect of education on the speed of information processing and working memory domains, it may be argued that the emphasis on speed in the tests of these domains is much less consistent with the traditional African cultural norms prevailing in Zambia's rural communities than it is with the urban western culture that permeates the formal educational system prevalent in Zambia, Uganda and other African countries.[26] Therefore, it is not surprising that English reading ability was predictive of performance in these domains. Students in Western educational systems are generally encouraged to "work as quickly and accurately as they can." This philosophy of Western cultures, where assessment of cognition is usually associated with both speed and accuracy is in conflict with the Zambian rural culture, where indigenous conceptions of intelligence such as '*nzelu*' include being cautious and thoughtful, which often results in slower, more deliberate test-taking. In the context of traditional African values, interpreting slow test taking as a symptom of cognitive impairment could lead to misinterpretation of neuropsychological test performance relative to Western norms. Hence the importance of moderating test scores by Zambian adults to take account of the degree to which they have been influenced by Western formal education. A more detailed analysis on the impact of other demographic factors on neuropsychological assessment in Zambia can be found in.[27]

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