ORIGINAL ARTICLE

Effects of HIV status and Linguistic Medium on the Test Performance of Rural Low-Literacy Adults: Implications for Neuropsychological Test Development in Zambia

L. Ndhlovu, R. Serpell, J. Mwanza

[1]*School of Medicine, Department of Psychiatry, University of Zambia*
[2]*School of Humanities and Social Sciences, Department of Psychology, University of Zambia*

ABSTRACT

Purpose of the study: The purpose of the study was to determine whether the familiar language (Chichewa version) could contribute to the early diagnosis of neurocognitive dysfunctions and develop a battery of locally valid tests capable of detecting early changes in the cognitive profile of neurocognitive dysfunctions among HIV positive patients.

Research question one: What is the difference in performance between HIV negative and HIV positive individuals when they are subjected to the four verbal tests of the neuropsychological test battery using the English and Chichewa versionsfi

Research question two What is the interaction effect among the influences of HIV status, linguistic medium and gender on the four verbal tests of the neuropsychological test batteryfi

Design: It was an experimental design that assessed the neuropsychological effects of HIV status and linguistic medium on the test performance. The Hopkins Verbal Learning Test (HVLT-R) for both immediate and delayed recall were used to test the verbal episodic memory from the Verbal Learning and Memory Recall Domain (Brandt and Benedict, 2001). Other tests included Animal and Action Naming. These tests were translated into Chichewa and administered to 28 HIV positive and 22 HIV negative rural low illiterate adults aged between 40 and 65 years.

Results: On all the Neuropsychological tests administered, HIV positive respondents scored significantly lower than HIV negative respondents, and the mean scores on the English medium version were consistently lower than scores on the L1 (Chichewa) version across all tests and all groups.

Conclusion: The study has shown that the primary language is best suited to test neurocognitive performance and especially when one is using test components that do not require reading or writing.

INTRODUCTION

Elders in most societies generally have a lower-educational level than their children and grandchildren (Ardila et al., 2010:690). Illiterates represent a significant proportion of the world's population and are not immune from HIV and neurocognitive complications. Several studies that have been done to test HIV infected adults by using the western standardized test batteries have excluded rural adults with less than five years of education Although psychometric properties of Western tests like the neurocognitive psychological test battery have been well established in the US and other Western countries, they however are not appropriate for respondents who are illiterate (Laboratory of Comparative Human Cognition, 1983; Manly et al., 2002; Ardila et al., 2010). This is because the battery is an agglomeration of tests that require literacy or numeracy in a foreign language and not in a primary or local language. The factor literacy is related to variations in cognitive test performance like changes in visual perception, logical reasoning, and remembering strategies (Laboratory of Comparative Human Cognition, 1983; Ceci and Williams, 1990). Research has

also shown that schooling has an impact on formal operational thinking (Laurendeau-Bendavid, 1977; Matarazzo, 1979). If the Neurocognitive Test Battery is used in a foreign language in totality among literates and illiterates, residual confounding will occur and spurious differences will be interpreted. In addition, if applied on illiterates, the Neurocognitive Test Battery may cause attenuated specificity, such that cognitively normal illiterates as well as those who are HIV positive are more likely to be misdiagnosed as impaired. However, cognitive functioning such as memory as well as verbal fluency could be assessed without reading and writing. Further, equivalent versions of the English version of the HVLT and naming tests could be generated in languages other than English.

One of the challenges encountered in Zambia when establishing the norms for Neuropsychological testing was the exclusion of low-literacy adults especially in rural areas, and yet these people constitute a large proportion of the general population of Zambia (Ministry Of Education, 2008). Tests that depend on client having completed five or more years of schooling are unsuitable for assessment of clients from this segment of the population, hence, the need to explore a complementary measure that is sensitive to detecting cognitive dysfunctions especially to adult illiterates who may or may not have HIV.

Several studies have reported differential performance on neuropsychological tests by HIV positive and HIV negative groups in non-Western societies; **(**Cysique et al., 2007b in China; Gupta: 2007 in India; Robertson et al., 2007b in Uganda; Clifford et al., 2007 in Ethiopia; Melrose et al. 2008 in China; Heaton et al., 2009 in Rural China;; Hestad et al., 2012 in Zambia**).** However, the impact of HIV on the cognitive functioning was not being studied among rural low-literacy adults because the only tests available were in a language unfamiliar to them. Furthermore, research has not been reported on the possibility that tests administered to low-literacy, rural adults in a familiar language may be more sensitive to HIV-induced neurocognitive impairments than tests in a less familiar language that is primarily restricted to educational and other formal urban settings.

Although numerous review articles and meta-analyses have been published on the neurocognitive aspects of HIV (e.g., Grant and Atkinson, 1999 ; Reger et al. 2002; Grant et al., 2005), a unique aspect of this study is the focus on the cognitive neuropsychology of HIV Associated Neuropsychological Disorders based on the use of two linguistic mediums. By cognitive neuropsychology, we mean the use of theoretical models from cognitive psychology and the cognitive neurosciences to test hypotheses related to performance.

This study aimed at comparing neuropsychological tests results in two linguistic media among individuals who were HIV positive and HIV negative in order to include respondents who are not fluent speakers of English language but Chichewa language within a rural elderly setting of the Zambian population whose knowledge of English language is minimal.

METHODOLOGY

Study design

An experimental design involving two versions of a set of tests – one in English and the other in Chichewa was conducted on 28 HIV positive and 22 HIV negative individuals who were purposively sampled by age and years of schooling from typical rural clinics of Chipata, in Eastern Province of Zambia where the sample spoke Chichewa as a familiar language. The study was designed to detect differences in performance between HIV positive and HIV negative participants when tested in the two language media and determine which linguistic media would discriminate the neurocognitive deficits more sharply than the other. Participants were tested on four neuropsychological tests which were translated into Chichewa. These included the Hopkins Verbal Learning Test for both immediate and delayed recall, Animal and Action Naming Tests.

Sampling

In order to ensure a representative sample of participants in the rural clinics, a simple random technique was employed. To select those who were HIV positive, the clinic register was used and every second name was selected. Those on ART were excluded from the HIV positive group by the help of the clinic staff as they had reliable records for those on ART and those who were not. This was to avoid other confounding factors like drug therapy.

The recruitment was done as patients came for VCT. Due to other conditions that might have excluded the participants, we enrolled more than 20 at each clinic.

Measures

All participants were subjected to various questionnaires that helped gather information on their demographic variables, neuropsychological performance, daily living functioning, psychiatric history, depression and drug abuse. That information would also provide relevant information to other researchers.

1) Screening instruments

Zambia Achievement test

This was a test that asked the participants to read and understand English words

Psychiatric and Drug Abuse Assessment

This tool uses the Composite International Diagnostic Interview (CIDI) that provides results in the presence or absence of DSM-IV-TR /ICD-10 diagnosis of the past or present history of substance disorders. It takes about 30-60 minutes.

Beck Depression Inventory

This is used to collect information regarding the severity of depressive symptoms. It is a 21-item self-report scale consisting four response options of graded severity. Its time frame is the past 2 weeks. The range of scores between 0 - 13 signify "minimal" depressive symptoms; 14 - 19, mild; 20 - 28, moderate; and 29 - 63, severe symptom severity (Beck et al., 1996).

Assessment for everyday functioning

Measures everyday functioning of the participants and involves three assessment scales which include: 1) The Frontal Systems Behaviour Scale (FrSBe). 2) Independent Activities of Daily Living Scale (ADL) questionnaire. 3). The Patient's Assessment of Own Functioning Inventory (PAOFI).

2). Components of the neuropsychological test battery

The authors did not use the whole battery but only used the Hopkins Verbal Learning Test - immediate recall, Hopkins Verbal Learning Test – Delayed Recall, Animal naming and Action naming Tests.

The Hopkins Verbal Learning Test (HVLT-R)

It is a brief verbal learning and memory test which has been shown to be sensitive to HIV in several developing countries (Cysique et al., 2007; Gupta et al., 2007; Robertson, et al. 2007); The test consists of three trials of free-recall of a 12-item, semantically categorized list which is read aloud to the participant at the rate of approximately one word every two seconds followed by yes/no recognition. The Immediate Recall test includes three learning trials. Delayed Recall is assessed 20 to 25 minutes after completion of the Immediate Recall test. Immediately after administration of the Delayed Recall trial, a forced-choice Recognition test is administered. The Recognition test includes the 12 target words, plus 12 distracters which include six semantically-related and six semantically-unrelated words. The Test administration time takes approximately seven minutes for the Immediate Recall test and three minutes for the Delayed Recall and Recognition tests (Benedict et al., 1998; Brandt & Benedict, 2001).

Trial 1: This is where the list of words is read to the participant while he/she listens carefully and asked to produce as many words as he/she can remember in any order at the end of the reading. The read list is at the rate of one word every two seconds. If participant does not spontaneously begin reporting words after the last word is read, he/she is asked to do so. When the participant is through, he/she can be gently prompted by asking if he/she can recall any other words.

Trial 2*:* After participant has indicated that he/she can recall no more words, the list is read to him/her again and asks whether he/she is able to remember the words including those she mentioned earlier in any order. The list is read at the rate of one word every two seconds.

Trial 3: After participant has indicated that he/she can recall no more words, the list is read one more time and asks him/her to produce as many of the words as he/can can remember, in any order, including the words he/she already mentioned.

After participant has indicated that they can recall no more words record the clock time on the Time Trial 3 Completed line. Delay should be done 20-30 minutes after this time.

Delay: After 20 minute delay: The participant is asked to remember the list of words he/she tried to learn before.

Recognition: Immediately following the Delay trial a longer list of words is read to the participant. Some of the words are from the original list while some are not. After reading each word, the participant is asked to say "Yes" if it was on the original list or "No" if it was not."

Animal Naming Test

Animal Naming Test requires the participants to name all the types of animals that they may think of in sixty seconds. The categories of animals may also include reptiles, and insects but not humans. Only one response is aloud and the correct response is recorded as a score. The score is the total number of correct words produced within one minute.

Action Naming Test

Action Naming (AN) is a test of language that taps into frontal neural systems (Woods et al., 2005) and has been shown to be sensitive to the neurocognitive effects of HIV infection in subjects in both developed and resource-limited countries (Cysique et al., 2007). This task requires participants to generate as many action words (verbs) as they can within sixty seconds. The participants are advised not to use the same word with different endings, like eat, eating, eaten. They are also advised to give single words such as eat rather than a sentence. Only one response is aloud and the correct response is recorded as a score. The score is the total number of correct words produced within one minute.

Translation

Translation of the tools from English to Chichewa was done by the first author using Nida's dynamic equivalence theory of translation. Nida bases his theory on some linguistic achievements made by Jackobson and Chomsky. The duo make claims that a dynamic dimension can be added to language structure through the use of transformation. Drawing from them, Nida argues "Anything that can be said in one language can certainly be said in another language…", with reasonable accuracy by establishing equivalent points of reference in the receptor's culture and matching his cognitive framework by restructuring the constitutive elements of the message (Nida, 1984: 13). Using dynamic equivalence, the researcher had to reproduce "in the receptor language (Chichewa) the closest natural equivalence of the source-language message… (English tool), "(See Nida and Taber, 1969: 12).

The author identified key words that were "closest", "natural" and "equivalent". By "closest", Nida indicates that owing to the impossibility of absolute equivalence, the "closest" equivalent is the most ideal one. Drawing on the works by stressing that "a natural rendering must fit the receptor language and culture as a whole; the context of the particular message; and the receptor-language audience," the researcher translated the tool into Chichewa. To put it plainly, either the meaning or form should not sound "foreign". Among all languages, Chichewa was preferred according to Central Statistical Office data, because it was the second most widely used language in Zambia after Bemba. It was also the language that the authors had competence in.

Procedure

The purpose of the study, and research procedures were fully explained to participants and were given a written consent. All participants were to speak Chichewa as their primary language and interviews were conducted in Chichewa. All participants provided demographic information; underwent a thorough neurological assessment and a complete medical history and physical examination. This was done by clinicians before neuropsychological testing was done to detect any focal neurological deficit suggestive of Central Nervous System opportunistic infection. This thorough clinical assessment of each participant combined with review of his or her prior medical history and laboratory data, was to ensure that potential confounding factors such as Central Nervous System opportunistic infections are ruled out.

The HIV status of each participant was determined by the medical practitioners in the rapid immunochromatographic HIV-1/2 test (Abbott Diagnostics, Chicago, IL, USA) and the Murex HIV antigen/antibody Combination ELISA (Abbott Diagnostics). A participant was considered HIV+ if they tested positive for the 2 tests and HIV- if negative for both tests, and discordant if positive for only one test. No discordant cases were included to take part in the study.

Participants were excluded from investigations based on the following criteria: (a) if they were less than 40 years (b) significant histories of neurological, psychiatric, or other diseases affecting the brain; (c) functional employment or daily life problems, (d) illiterate participants who were able to identify the letters in the screening test; (e) if they were able to read a newspaper text fluently, (f) if they were able to answer six simple comprehension questions correctly, (g) or made spelling errors on a simple dictation task. In addition, Reis et al., (2003) exclusion criteria was applied -participants who had started school or an educational program but not finished or who had or were presently engaged in literacy training for adults were excluded. Potential participants were excluded if they had a history of Parkinson's disease, stroke, and head injury with loss of consciousness, alcohol abuse, or serious mental illness such as depression or schizophrenia. This determination was made on the basis of a doctor's clinical examination. The doctor's diagnosis was used as a gold standard for the absence of dementia, since the neurological assessment was made independent of the participant's performance on the neuropsychological battery.

Test administration Procedure

We administered the selected tests from the main battery of tests and in the same order to each participant. The duration of the battery, in total, did not exceed 2 hours. Our battery included tests that are widely used as standardized measures of verbal fluency (Animal and Action Naming Tests), Hopkins Verbal Learning Test both immediate and delayed recall. All test instructions for the English tests were translated into Chichewa for easy administration.

These tests were administered to each participant by the author in the private, quiet and well-lit room that was provided by the clinic in-charge personnel.

Data Analysis

ANOVA and t-tests were performed to determine whether HIV status and linguistic medium had an influence on performance.

As this was an experimental study, alpha was set at 0.05 to determine statistical significance.

Ethical Considerations

This research study was approved by the University of Zambia Biomedical Research Ethics Committee. All participants provided written informed consent. The examiner read the form to all of them as they could not read themselves including those who claimed to have reached grade 4, and were treated according to the ethical guidelines set forth by the University of Zambia Bioethical and Research Committee. Issues of confidentiality were well explained. Participation in this study was purely voluntary and those who decided to withdraw would do so at anytime with no consequences attached. To reduce fatigue that could be experienced by participants, from a longer time of the assessment, they were free to ask for a short break at any time of their request.

Results

The study was designed to assess neurocognitive functioning among rural adults 40-65 years of age and with 0-4 years of education.

To determine to what extent HIV status is a factor on the neuropsychological test performance on the four selected tests of the battery, an analysis of variance (ANOVA) was performed and results indicated that there was a statistically significant effect of HIV status on the performance. The results were: HVLT-Eng *(*$F(1,48) = 55.156$, $p < .001$, *effect size* = .535); HVLTdr-Eng *(*$F(1,48) = 45.441$, $p < .001$, *effect size* =.486); HVLT-Chi ($F(1,48) = 125.02$, $p < .001$, *effect size* = **.843**); HVLTdr-Chi *(*$F(1,48) = 257.252$, $p < .001$, *effect size* = **.723**); Animals Eng ($F(1,48) = 26.545$, $p < .001$, *effect size* = .356); Animals Chi ($F(1,48) = 252.589$, $p < .001$, *effect size* = **.840**); Actions, Eng ($F(1,48) = 21.37$, $p < .001$, *effect size* = .308); Actions Chi ($F(1,48) = 126.970$, $p < .001$, *effect size* = .**726**).

The results show that the proportion of variance accounted for by HIV status was consistently higher on the Chichewa version of the tests than on the English version.

Table 1 presents the mean scores and standard deviations for each of the tests analysed as a function of HIV status.

Table 1 Mean scores on each test according to HIV status and linguistic medium

HIV status	HVLT Eng	HVLT Chi	HVLTdr Eng	HVLTdr Chi	Anim Eng	Anm Chi	Act Eng	Act Chi
HIV-								
M	14.50	21.23	5.64	9.64	6.50	9.50	4.55	13.23
SD	2.82	2.98	1.65	.902	2.20	1.92	2.02	1.85
HIV+								
M	9.18	12.89	2.86	4.93	3.50	10.3	2.07	2.39
SD	2.21	2.30	1.27	1.12	1.92	2.08	1.71	.18

(M = Mean SD = Standard deviation, HVLT = Hopkins Verbal Learning Test, ir = Immediate Recall, dr= Delayed Recall, Anim =Animal, Act= Action, Eng= English, Chi = Chichewa,, Action naming Chichewa

Figure 1 - 8: Effects of HIV status and Linguistic medium on Test Performance

Fig. 1 - HIV status and HVLTir-Eng

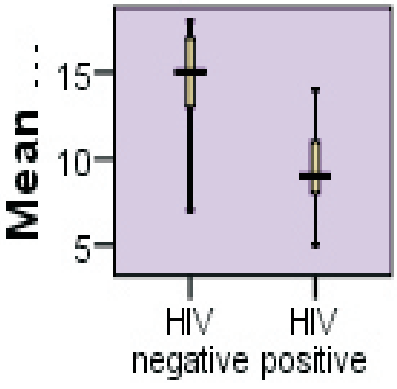


Fig. 2 - HIV status and HVLTir-Chi

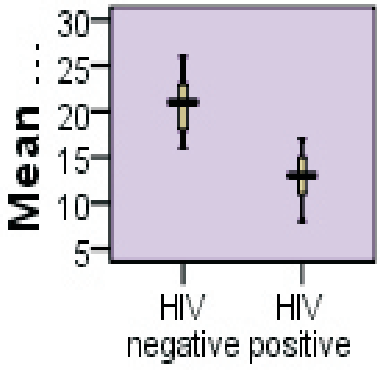


Fig. 3 - HIV status and HVLTdr-Eng

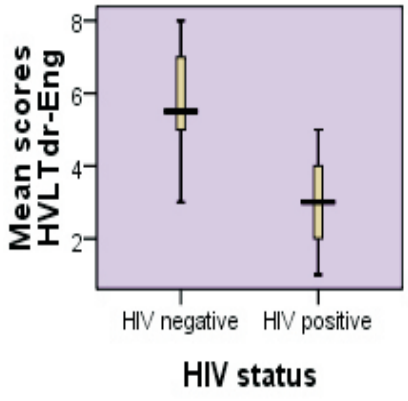


Fig. 4- HIV status and HVLTdr-Chi

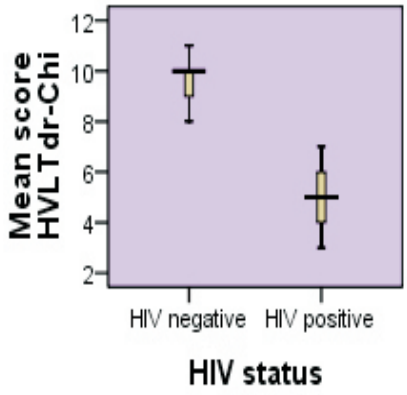


Fig. 5-HIV status and Animal Naming-Eng

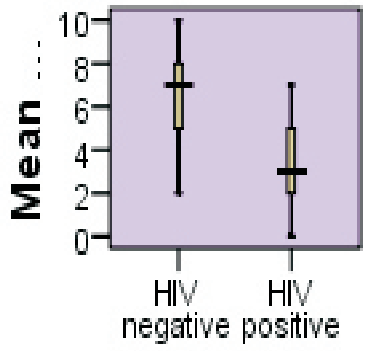


Fig. 6- HIV status and Animal Naming- Chi

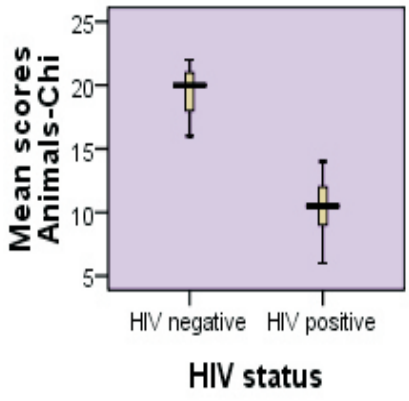


Fig. 7- HIV status and Action Naming-Eng

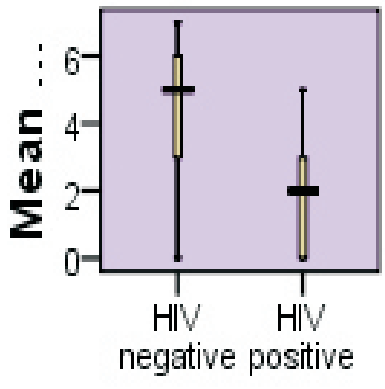
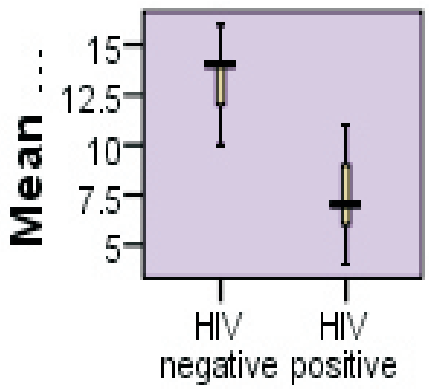


Fig. 8-HIV status and Action Naming- Chi



The results shown in the figures above indicate that HIV status has an effect on all the verbal tests of the Battery with HIV positive group performing poorer.

Interaction effects between HIV status and linguistic medium

In order to determine the interaction effects, a 2x2x2 Factorial design (Repeated Measures Variables ANOVA) was conducted of scores on each of the tests, with HIV status, gender and medium of testing as three orthogonal independent variables.

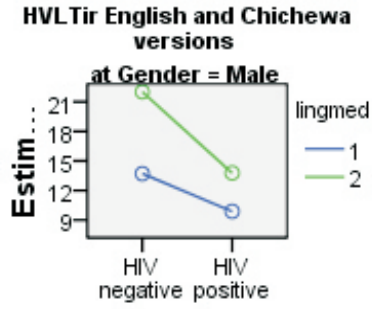
Results indicated that there were highly significant main effects for linguistic medium and HIV status on all the tests. Hopkins Verbal Learning Test Immediate Recall Linguistic medium * HIV status interaction was found to be statistically significant (F (1, 46) = 16.750, p < .001). Partial Eta-squared for the interaction effect size was computed and was found to be .267, meaning that the linguistic medium * HIV status interaction explained approximately 27% of the variance in the dependent variable.

Hopkins Verbal Learning Test Delayed Recall: the linguistic medium * HIV status was found to be statistically significant (F (1, 46) = 28.896, p < .001) and when the *Partial Eta squared* was computed for the effect size, it was found to be .386.

The interaction effect between linguistic medium * HIV status for Animal naming Test**,** was found to be statistically significant (F (1, 46) = 85.788, p < .001). Its *Partial Eta Squared* for the *effect size* was found to be large (.651) and highly significant.

Interaction effects between linguistic medium * HIV status on the Action naming test was equally found to be statistically significant (F (1, 46) = 30.615, p < .001). The computed *Partial Eta Squared* for the *effect size* was found to be .400 (40%).

1



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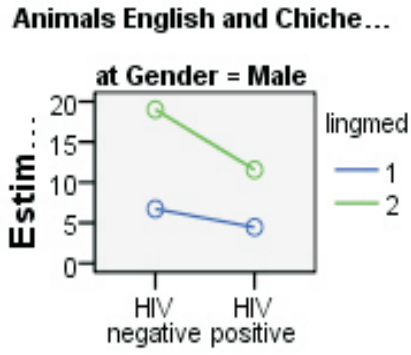

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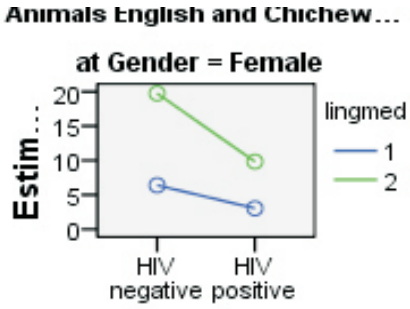

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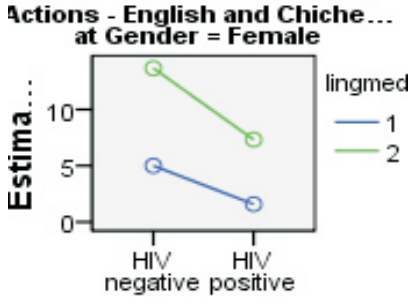

Legend
Lingmed = Linguistic medium
1= English 2 = Chichewa

DISCUSSION OF FINDINGS

The proportion of variance accounted for by HIV status was consistently higher on the Chichewa versions of the tests than on the English versions. These effect sizes were quite large and highly significant. The largest effect sizes were observed, on the Hopkins Verbal Learning Test Chichewa version followed by Animal Naming Chichewa version, Action Naming Chichewa version and Hopkins Verbal Learning Test Chichewa version delayed recall. The results in our present study revealed that when we use the English and Chichewa versions irrespective of the HIV status, the mean scores for HIV negative respondents were consistently higher (See figures 1-8).

The effects of HIV status and linguistic medium effect on neuropsychological test performance showed a significant interaction, with the difference between HIV positive and HIV negative groups being larger with the Chichewa version, indicating that this version can discriminate more sharply between HIV positive and negative individuals than the English version. There was no statistically significant interaction between the effects of linguistic medium and gender, or between the effects of HIV status and gender in performance on any of the tests.

When we examined the two-way interactions revealed in these factorial analyses of variance, we found that the effects of gender were for the most part orthogonal to those of HIV status and of linguistic medium (with no significant interaction between the pairs of independent variables), and the effects of linguistic medium were for the most part not orthogonal to those of HIV status. In all cases a significant two-way interaction was found between the effect of HIV status on test score and the effect of linguistic medium, with the gap between the scores of HIV positive and HIV negative participants being larger when the test was administered in Chichewa than when it was administered in English with Animal Naming recording a large effect size. The absence of significant interactions between gender and linguistic medium supports the interpretation that, in this sample of participants, HIV status affected neurocognitive performance negatively to a comparable degree for males and females, and that the beneficial effect of testing in the

familiar language Chichewa was equally powerful for males and for females.

The means for the Chichewa version for the HIV negative group were much higher than at the HIV positive level. When the respondents were tested in the English version, still the HIV negative group obtained higher mean scores than the HIV positive participants. Averaging the means for Chichewa version at HIV negative and HIV positive levels, results revealed that the mean score for the Chichewa version was higher than when we averaged the mean scores for English version at the HIV negative and HIV positive conditions The difference in means between the Chichewa version and the English version within the HIV negative level was greater than the difference between the two versions at the HIV positive level (See figures 9, 10, 11, and13).

This means that the HIV status has varying interactions with linguistic medium with HIV negative groups recording a wider gap in marginal means than their HIV positive counterparts on these tests resulting into a, narrow gap with a steeper gradient for the Chichewa version, indicating an effect of linguistic medium. These results revealed that the Chichewa version can discriminate more sharply between HIV positive and negative groups than the English medium of testing.

Significance of the study

This study provides methodologically stringent evidence for translating the non-literate components of the neurocognitive battery and an update in Africa other than the Kanmogne Cameroonian study (2010) on the translation from an original language of the tool to a primary language of the respondents. This study other than the Kanmogne study is the first to the author's knowledge to have compared neurocognitive performance in two languages by describing the nature, extent, and analysis of performance of cognitive neuropsychology of HIV Associated Neurocognitive Disorders and proposes what could be considered as a culturally appropriate Zambia neuropsychological test battery in an indigenous language.

This study has dispelled the notion that the neurocognitive tool can only be used on literate respondents.. The study has revealed that a familiar language usable among participants who are considered to be 'illiterate' in a second language as long as there is translation of the tool with equivalence. This finding is important, since it shows that, in this low-education, rural sample of elderly respondents, and the underlying condition of HIV status could be more reliably detected using the Chichewa version of the test than using the English version.

Limitations of the study

The limitations of this study are that the Chichewa version however has no measures of reliability and therefore the results could be considered with scepticism. While this may be the case, the tool has validity in the sense that it used a qualitative counterpart - dynamic equivalence in ensuring reliability. Dynamic equivalence reproduced "in the receptor language the closest natural equivalence of the source-language message…"(Nida and Taber, 1969: 12).

In addition, the results should be considered to be valid not all relevant domains of functioning are characterized and could be used on the selected study sample since they did not require one to be literate (able to read and write). The sample was restricted to respondents fluent in the Chichewa medium and as such the study cannot be generalisable to non Chichewa speakers, this is because the study design was limited to one geographical region.

Recommendations

Given these findings, this study recommends the use of the Hopkins Verbal Learning Test, Animal and Action Naming Tests from the Verbal Fluency Test as selected parts of the main Neuropsychological Test Battery to be used as a tool with the intention of generating an extra-brief tool to assist HIV practitioners in referring HIV-positive persons at risk for impairment. The researcher believes that this study provides a preliminary but robust solution to screening for neurocognitive disorders among low-literacy people who may be living with HIV.

The study recommends that future studies involve the development of tools in other Zambian languages and further a qualitative study to bring out lived experiences in the language and speech problems that people living with HIV have. The authors are suggesting future longitudinal

studies that could extend these results using the same battery.

The research design was limited to one geographical region and on a small sample. The researcher is recommending a national wide study. This will increase the validity and reliability of further study outcomes. It will also provide room for validating the Chichewa version.

CONCLUSIONS

A potentially important finding in the present study is after translation into Chichewa from English, this translated set of the Neuropsychological Test Battery detected cognitive dysfunctions in HIV-infected respondents in the Eastern Province of Zambia. The Chichewa version has established similar outcomes as the English version but has shown greater sensitivity than the English version. It calls, beyond the findings, for consideration by the project to treat people who are HIV positive and have HIV-associated neurocognitive disorders. This is because advances in the treatment of the human immunodeficiency virus (HIV) have dramatically improved survival rates over the past 13 years (Woods et al., 2009).

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