

The copyright of this thesis vests in the author. No quotation from it or information derived from it is to be published without full acknowledgement of the source. The thesis is to be used for private study or non-commercial research purposes only.

Published by the University of Cape Town (UCT) in terms of the non-exclusive license granted to UCT by the author.

**VALIDITY AND RELIABILITY OF THE EXECUTIVE AND
MEMORY SECTIONS OF THE GROOTE SCHUUR
NEUROCOGNITIVE ASSESSMENT BATTERY**

Dylan Lopich

LPCDYL002

A minor dissertation submitted in *partial fulfilment* of the requirements for the award of
the degree of Master in Clinical Psychology in the Faculty of the Humanities

UNIVERSITY OF CAPE TOWN

2008

Supervisor: Mark Solms

COMPULSORY DECLARATION

This work has not been previously submitted in whole, or in part, for the award of any degree. It is my own work. Each significant contribution to, and quotation in, this dissertation from the work, or works, of other people has been attributed, and has been cited and referenced.

Signature: _

Signed by candidate

Date: 3/8/18

ACKNOWLEDGEMENTS

Thank you to both of my parents for their continued support. To my supervisor, Mark Solms, whose generosity and vast knowledge of neuropsychology was of great reassurance, and who, despite his demanding schedule, made himself available to review last minute drafts and provide invaluable feedback. To Ross Balchin for his tireless optimism, encouragement and the many hours he made available for our marathon discussions. To Jill Mosdell for always making time for “just one more meeting”. To Luna, for his (mostly) good behaviour and forbearance. To Jacqui, for her kindness, patience and support, as well as a steady supply of tea and hot meals to see me over this final hurdle. To Nolu Ntyam and Mr Fihle from the African Languages Department of the University of Cape Town for assisting with translation. And finally, to the participants of the study who gave up their time.

CONTENTS

ACKNOWLEDGEMENTS	2
LIST OF TABLES	4
LIST OF FIGURES	6
ABSTRACT	7
Introduction	1
Method	28
Results	38
Discussion	57
CONCLUSION	68
REFERENCES	69
APPENDICES	76

LIST OF TABLES

TABLE 1: SHOWING MEANS AND STANDARD DEVIATIONS FOR PERFORMANCES ON THE UPDATED TOWNSHIP FIRE STORY FOR THE THREE DIFFERENT LANGUAGE GROUPS.....38

TABLE 2: DESCRIPTIVE STATISTICS FOR THE TOWNSHIP FIRE STORY.....40

TABLE 3: MEANS AND STANDARD DEVIATIONS OF AGE AND YEARS OF EDUCATION FOR RELIABILITY PHASE.....41

TABLE 4: RELIABILITY COEFFICIENTS FOR EXECUTIVE AND MEMORY SECTIONS.....42

TABLE 5: MEAN SCORES FOR MEMORY SECTION43

TABLE 6: MEAN SCORES FOR MEMORY SECTION (LANGUAGE AND EDUCATION)45

TABLE 7: MEAN SCORES FOR MEMORY SECTION (AGE AND PATHOLOGY).....46

TABLE 8: MEAN SCORES FOR TOWNSHIP FIRE STORY.....48

TABLE 9: MEAN SCORES FOR TOWNSHIP FIRE STORY (EDUCATION AND LANGUAGE)49

TABLE 10: MEAN SCORES FOR DIGIT SPAN TEST.....50

TABLE 11: MEANS AND STANDARD DEVIATIONS FOR EXECUTIVE SECTION.....52

TABLE 12: MEAN SCORES FOR EXECUTIVE SECTION.....53

TABLE 13: MEAN SCORES FOR CONTROL WORD ASSOCIATION TEST.....55

**TABLE 14: MEAN SCORES FOR CONTROLLED ORAL WORD ASSOCIATION
TEST (COWAT)56**

LIST OF FIGURES

FIGURE 1: REPEATED DRAWING TEST.....25

ABSTRACT

In this study, a new screening battery is proposed as a replacement for the Mini-Mental State Examination (Folstein, Folstein, & McHugh, 1975), which has proven to have restricted diagnostic utility in the assessment of neurological patients in a South African Neurology ward. The authors know of no other screening instrument which has been translated into Afrikaans and isiXhosa and has been validated in South Africa; given the incidence of head injury and stroke in the Western Cape there is compelling evidence for the existence of an accurate, affordable, culturally appropriate neurocognitive screening instrument. The Groote Schuur Neurocognitive Assessment Battery (GSNAB) is comprised of well-established Euro-American neuropsychological tests, which over the last three years, have been adapted and translated into isiXhosa and Afrikaans. This study reports on the final stage of this research which consisted of two phases: in the first phase problematic tests from the initial pilot study were re-piloted and adjusted, and in the second phase, the reliability and validity of the Memory and Executive sections of the (GSNAB) were evaluated in administration to a group of patients with anterior lesions (n = 15), patients suffering from memory deficits due to hippocampal lesions (n = 15) and neurologically intact controls (n = 15). The findings suggest that overall, both sections of the GSNAB are able to differentiate between patient groups, and between patient and controls at a statistically significant level. One of the tests from the Executive section, the 18-Book Problem, yielded an unacceptably high false positive rate in controls and recommendations were made for the test's improvement.

Introduction

Background

This study investigates the validity and reliability of the Groote Schuur Neurocognitive Assessment Battery (GSNAB) and marks the final stage of the initial development and testing of this battery. The original version of the GSNAB was created out of the need for an alternative, more accurate screening instrument to the Mini-Mental State Examination (MMSE) (Folstein et al., 1975), which, over the years, had been used extensively among neurologists at the Neurology Ward of Groote Schuur Hospital. However, in the experiences of the neuropsychologists and neurologists working in the ward, the MMSE was found to be inadequate as a screening instrument. Many patients, who were clearly impaired, appeared able to score within the normal range of the MMSE. Or alternatively, many patients who were neurologically intact, yet performed poorly on the test, and were considered impaired according to the cut-off score. Although there are other screening instruments available for purchase from overseas publishing companies, they have not been developed for the South African population.

In this introduction, the origins of the GSNAB up to the present study shall be traced. A survey of relevant epidemiological data will be provided and the need for culturally sensitive screening underlined. The particular challenges facing neuropsychological assessment in South Africa will then be considered, as will more general considerations of the affects of culture, language and education. Two main theoretical approaches to clinical neuropsychology will be contrasted and the theoretical framework within which the battery falls is described. Reasons for the suitability of this approach in a South

African context will be provided. Lastly, a brief description of the neurocognitive domains tested in the GSNAB, and the constituent tests which make up the two sections, will be outlined.

The original version of the GSNAB was created by the Groote Schuur Hospital neuropsychologists. This early form of the GSNAB was a compilation of well-established Euro-American neuropsychological tests and comprised five sections: Orientation, Memory, Language, Right Hemisphere and Executive Function sections. However, not long after the creation of the GSNAB, clinicians working with it noticed problematic test items, which were culturally unfamiliar to patients. Many of the tests used in the GSNAB had been developed in the United Kingdom and the United States of America, with content that was often unfamiliar to most South Africans. This meant that the items in the test could be failed for reasons other than cognitive deficit resulting from brain damage. Another problem was that the GSNAB existed only in English, and given that most of the population of the Western Cape speak either isiXhosa or Afrikaans as a first language, this proved another obstacle to assessment for clinicians using the instrument. A decision was then made to formalise the process of developing the GSNAB by adapting some of its problematic tests and by translating it, then evaluating success of these changes both qualitatively and quantitatively on a group of patients and normal participants.

This process was begun by reviewing the constituent tests making up the GSNAB. Then, in a process of consultation with focus groups and a panel of clinical and language experts at the University of Cape Town, culturally unfamiliar items were replaced with

more appropriate ones. The new tests, which were the products of this process, were then translated into Afrikaans and isiXhosa with the help of the language experts at the African Language Department at the University of Cape Town (King, 2005; Lopich, 2005; Madadi, 2005; Mosdell, 2005). The new version of the GSNAB was then administered to a group of neurologically intact control participants to assess the success of these changes. The results of this research informed a further round of adjustments to problematic test items and once again the translation of these tests.

The first phase of the current study followed on from this initial pilot study, and involved making further changes to the tests which had proven problematic. A further round of discussion with the panel of clinical and language experts resulted in new versions of one test, which was then translated into Afrikaans and isiXhosa with the help of Language experts in the African Languages Department. The second phase of the current study details an account of efforts to evaluate the validity and reliability of the Executive and Memory sections of the GSNAB in a clinical population.

Description of the GSNAB

The GSNAB is a theory-driven, bed-side screening tool, which integrates the strengths of both the qualitative and quantitative approaches to neuropsychological assessment. The five sections that make up the GSNAB, Orientation, Memory, Visuo-spatial, Executive and Language Function, are designed around a decision-tree structure that guides the clinician through the screening procedure. In each section, concise information about neuropsychological signs and symptoms typically associated with that particular domain

of cognitive function is provided. Performances are usually scored out of two or three levels: 0 for marked impairment, 1 for mild impairment or 2 for a normal performance, similar to Luria's brief outline for neuropsychological examination (Luria, 1999). The GSNAB is designed to be administered in a flexible fashion, and includes a number of supplementary tests, which can be administered for further clarification if necessary. This replicates the decision making process of the hypothetico-deductive approach to clinical neuropsychology.

The Need for Neurocognitive Screening in South Africa

Traumatic Brain Injury (TBI)

Two of the leading causes of injury in South Africa are violence and motor vehicle accidents. Violence accounts for approximately, 45 – 55% of injuries and transport-related injuries make up for between 20 – 25% of injuries (Gilbert & Tollman, 2007). Data gathered in the Western Cape on head injury profiles collected by the South African Medical Research Council, Cape Metropolitan Study (CMS) showed the greatest amount of head injuries occur in young adults; more than 37% in the 15-29 age group. Almost one third (29.7%) of the head injuries occur in children (0-14 years old). Most noticeable was that these injuries appeared to fall along socioeconomic lines with 84.1 % of the traumatic brain injury occurring in families with incomes of less than R1000 per month. Making up 29.2% of head injuries were people who were unskilled/semi-skilled workers and 19.6% were unemployed.

Bruns and Hauser (2003) report that in Johannesburg, 43% of all nonnatural deaths have an associated TBI, with 20% of all TBIs resulting in death. There is a marked disparity in gender of fatal TBI incidence, with 138 of 100 000 for males and 24 of 100 000 for females.

Stroke

According to the South African Medical Research Council stroke was ranked the 4th single cause of death in South Africa, accounting for 6% of deaths in 2000 (Norman, Bradshaw, Schneider, Pieterse, & Groenewald, 2006). In the Western Cape, stroke is ranked as the second single cause of death accounting for 8% of deaths (Bradshaw et al., 2000). Other data for South Africa, revealed that in Limpopo Province stroke had a prevalence of 300/100 000 (Steyn, Fourie, & Temple, 2006).

When considering the prevalence of head injuries and stroke alone, and that the burden falls largely on poorest members of society, those who are unable to afford private medical aid, the argument for adequate neuropsychological screening instruments, which may assist in diagnosis and guide further management and rehabilitation is compelling. Many of those who have been affected by stroke or head injury at some point are likely to have been screened with the Mini-Mental Screening Examination (MMSE). The next section presents literature on the MMSE and outlines some of the known difficulties with this test.

Problems with the Mini-Mental State Examination (MMSE)

The Mini-Mental State Examination is one of the most widely used screening instruments in research and clinical practice in the developed world (Lezak, 2004). This popularity extends to clinical practice in South Africa where the MMSE is used in psychiatric and medical wards around the country. The MMSE assesses a limited number of cognitive functions and can be administered in about five to ten minutes. The 30 item screening instrument was initially devised as a tool to assist in the differential diagnosis of psychiatric patients, but is also widely used to screen for dementia (Lezak, 2004). Neurologists have also used the MMSE as an instrument to assess cognitive impairment in hospitalised stroke patients. In a recent study (Nys et al., 2005), which examined the accuracy of the MMSE in detecting cognitive impairment in a group of hospitalised stroke patients the MMSE was found to be no more accurate in detecting impairment than chance. More specifically, the researchers noted that the MMSE was particularly insensitive to impairments in executive functioning, abstract reasoning, visual perception/construction (Nys et al., 2005). In addition to this criticism, a number of cross-cultural studies have found the MMSE to be significantly affected by ethnic group, age and educational level, producing an unacceptably high rate of false positives for minority groups (Gurland, Wilder, Teresi, & Barrett, 1992; Ostrosky-Solis, Lopez-Arango, & Ardila, 2000). Adaptations to the test have attempted to compensate for these effects, and a number of variants of the MMSE have been created for specific patient groups across cultures (Lezak, 2004).

Neuropsychological Assessment in South Africa

Neuropsychological testing in South Africa has been historically associated with intelligence (IQ) testing and the psychometric measurement of mental ability. This has been a history with few high points. Given the role of intelligence testing in South Africa in the past and its use by the apartheid regime to demonstrate fundamental differences between Whites and Blacks, which it employed in its rhetoric regarding the limited educability of the “natives” (Louw & Foster, 2004). In practical terms, the argument that Blacks possessed an innate limit to their potential for education, legitimised the racist policies of Bantu education. These policies led to a dramatic disparity in spending on education between Whites and Blacks during apartheid, the pernicious effects of which, are still impacting on the lives of millions of South Africans today. Nell (2000) has observed that this “racist taint” continues to negatively reflect on ability measurement, which is an integral part of clinical neuropsychology. These associations have perhaps hampered the development of cross-cultural neuropsychology in South Africa and delayed more research being done in this area.

Clinical neuropsychology in South Africa is dominated by the psychometric approach to assessment (Shuttleworth-Jordan, 1996). One of the crucial components of this approach is the availability of valid normative data which is referred to in making sense of neuropsychological performance, allowing for the meaningful differentiation of a normal performance from an abnormal one (Anderson, 2001). However, most of the tests used in clinical practice have not been normed on the South African population, and where there is normative data available, it is usually derived from small sample sizes, which increases

the chance of error in the sample, compromising the accuracy of quantitatively evaluating test performance. This has led to the clinician's uneasy reliance on normative data that has been taken from overseas populations.

The reliance on inappropriate norms compromises the accuracy of test interpretation, the implications of which will be discussed in further detail later in this section. In addition to the problems with availability of normative data, the neuropsychologist's task is further complicated by a scarcity of tests that have been developed for South Africans. This has led to the widespread use of neuropsychological measures that were created for use in Europe and America, many of which contain items that are culturally unfamiliar to people in South Africa. Most often these tests exist only on English, which adds another level of difficulty for both clinician and patient. Cumulatively, these limitations can present the neuropsychologist with the arduous task of being required to detect and describe neuropsychological impairment with instruments that may contain culturally inappropriate items, for which there is no valid normative data, and very often the assessment may be further complicated by administration in a language which is not the first language of the patient.

These confounding factors may lead to an increase in both Type I (false positive) and Type II (false negative) diagnostic errors (Anderson, 2001). This point is illustrated by research conducted by Anderson (2001) where the presence of impairment was tested for in 20 neurologically intact individuals using a small battery of commonly used neuropsychological tests. Results revealed an unacceptably high number of false positive

cases (Anderson, 2001); in fact, 5 out of the sample of 20 people were classified as having brain impairment. All of the subjects in this study were of European descent and had English as a first language. The results may have been substantially worse had the subjects been isiXhosa or Afrikaans speaking and were they not as well acquainted with the cultural norms which the tests implicitly assumes.

The lack of valid normative data, and the reliance on inappropriate tests for demonstrating cognitive deficit, has practical ramifications for people in those populations where no, or insufficient normative data exists; this is a great proportion of the population of South Africa. Nell (1997) provides the example of insurance claims where a plaintiff is required to provide the court with evidence of cognitive deficit due to a sustained brain injury. Inadequate evidence of cognitive impairment means that the plaintiff is unlikely to be able to substantiate the grounds for their claim. In cases where there are insufficient norms with which to substantiate these claims, evidence is then provided by a medical examination, which has been demonstrated to be highly unreliable in detecting very "subtle but devastating cognitive and behavioural defects" (Nell, 1997, p. 5). This is complicated further by the uncomfortable relationship between politics and science when insurers like the Multilateral Motor Vehicle Accident Fund or private third party companies fund research into norms. These companies may have a vested interest in norms which are low, placing those who are not represented by well established norms at an even greater disadvantage.

As it stands today, very little effort has been directed toward establishing culturally fair tests in South Africa. In his paper, arguing for the collection of local neuropsychological normative data, Anderson (2001) comments on the efforts to grapple with this issue in other countries and warns that the lack of similar efforts in South Africa threaten to negatively impact on service delivery to a large number of people in South Africa. This may impede the development of neuropsychological services in government and private sectors. In response to this problem some have argued overseas tests should be discarded in favour of the development of uniquely South African tests. However few have actually begun developing South African measures.

In response to these problems facing neuropsychological assessment in South Africa Shuttleworth-Jordan (1996), offers an alternative to what she sees as an attitude of “nihilism” regarding test usage. In her paper entitled, “On Not Reinventing the Wheel: A Clinical Perspective on Culturally Relevant Test Usage in South Africa,” she calls on clinicians not to abandon attempts to adapt Euro-American tests. Instead, she advocates against a pessimistic outlook, which overemphasises cultural differences, discounting the increasing degree of acculturation taking place in South Africa and the brain-behaviour commonalities which all human beings share (Shuttleworth-Jordan, 1996).

“Existing tests, which have the advantage of being accompanied by the attributes of familiarity, experience, and often a vast body of research data, can serve as a baseline for modification of culturally loaded test items in the South African context, and the gradual development of localised norms. In the meantime such

tests can be used with discretion in clinical work until South African specific procedural refinements and standardization data are available” (Shuttleworth-Jordan, 1996, p. 99).

Some further comment is required on the other influences in test performance, before moving onto considering the theoretical approach underlying the design of the GSNAB.

The Influences of Culture, Language and Education on Neuropsychological Assessment

Ardila (2007a) defines culture simply as “the specific way of living in a human group”; he delineates five aspects of culture which may impact on neuropsychological test performance. Firstly, “*patterns of abilities*”; while acknowledging basic universal cognitive processes as a backdrop, Ardila (2007a) emphasises the *context* in which specific cognitive processes are applied which accounts for why these processes exist in one group but not in another. In this way culture determines what is learnt, at what stage in a person’s life and by which gender. Variations between cultures on test performances can be understood, when considering the way in which culture provides a framework for how people feel, think and act.

Secondly, “*cultural values*” will determine what qualifies as situationally relevant or non-relevant. Neuropsychological testing may confront people with conditions and demands that may be unfamiliar and in some cases transgress cultural norms.

Thirdly, there is "*familiarity*," which includes not only the various elements used in testing (houses, cars, animals etc.), but includes cultural relevance of these elements making up the test. The concept of familiarity is also used to refer to strategies as well as attitudes of the testee which are required for successful completion of the task. A practical example here would be a Boston Naming Test item, which is a picture of a Pretzel that must be identified by the patient; this item is known to be unfamiliar in many countries outside the USA. Relevance is also important, as test items which have been developed in one culture may not have the same meaning in another.

Fourthly, "*language*," which represents a major cognitive instrument, and plays a profound role in determining how the world is conceptualised. Ardila provides an example of how Latin languages differ fundamentally from English in their conception of time. Language may influence test performance particularly when formal language is used in instructions with test takers who have limited education and who find these instructions difficult to understand.

Finally, "*education*" is considered to play a dual role in test performance: firstly, school and cognitive testing often share similar content. Secondly, schooling develops learning strategies and positive attitudes towards intellectual matters and possibly cognitive testing. Illiterate individuals have been consistently documented to perform at a significantly decreased level in most cognitive domains, including naming, verbal memory, verbal fluency, conceptual functions, numerical abilities and visuo-spatial abilities.

Further consideration of the effects of education are provided by Nell (1999; 2000), who describes how most psychological tests assume a certain amount of test-wiseness and knowledge of the implicit rules and schemas that are to be applied in a test situation. Test-wiseness is most powerfully conferred through formal education, and ten to twelve years of education is enough to develop a repertoire of test-taking skills. Developing an awareness of the rules of test-taking is difficult for those who have grown up without formal education. Not knowing about these rules could lead to uncertainty about how to react in the unfamiliar situation and may lead to uncertainty, which may manifest as slow or incorrect responses. For example, a person who is familiar with being tested verbally will be able to recognise a subtle pause from the questioner, indicating that they have made an error and should try again. However, someone who is not familiar with this “rule” may continue to sit in silence, unaware that they have made an error and are being given an unspoken opportunity for them to try again. A practical, although some may argue cumbersome, solution to this problem could be to identify those patients who may not be test-wise, and provide them with an opportunity to practice before their assessment begins, with the tester coaching them in their efforts. This requires that the neuropsychologist be aware of the non-obvious and implicit rules of testing, and remember that stimulus equivalence cannot always be assumed; the test given is not always the test received (Nell, 1999).

Lastly, the quality of education is another important consideration to bear in mind (Nell, 2000). The educational level of someone who has completed 12 years of education at an

underresourced, rural school in a developing country cannot be compared with the same level of education in places like Toronto or Tokyo. Therefore years of schooling must be used with caution when taken as an estimate of educational level.

Quantitative vs Qualitative approaches

Broadly speaking, there are two theoretical approaches to neuropsychological assessment which exist today (Lezak, 2004; Luria & Majovski, 1977). The first, which is most widely practiced by clinical neuropsychologists, is the psychometric or quantitative approach. As mentioned earlier, practitioners located in this approach make use of quantitative information, where a standard score is derived by reducing a substantial range of different behaviours to a single numerical system (Lezak, 2004). A standard score, representing the patient's performance can then be meaningfully compared with the appropriate normative data. Assessment is usually conducted in the form of a comprehensive neuropsychological battery, which is administered in a systematic and standardised manner, to ensure the integrity of comparisons to relevant normative data.

Deviation from the manual in the procedure of psychometric test administration is considered to degrade the objective integrity of a score and decrease its potential for meaningful interpretation. Assessment sessions span an exhaustive range of cognitive functioning, and for this reason, testing may take up to eight hours. The batteries and tests used are expensive, costing anywhere between R6 000 and R15 000 for a full battery ("Category Listing for Adult Cognition, Neuropsychology and Language," 2008) and for this reason neuropsychological assessment is a costly undertaking. However, as Shapiro

(1951), quoted in Walsh (2005), points out, this approach is useful for facilitating inter-individual or intra-individual comparisons. For instance, to track the progression of degenerative brain disease, a patient could be tested early in the course of the illness to provide a baseline from which to judge the extent and pattern of cognitive deterioration in the future.

The second approach to neuropsychological assessment, is the qualitative approach, which has its roots in Soviet Psychology, and in one of the founding fathers of clinical neuropsychology, Aleksander Luria. In contradistinction to the quantitative approach, in qualitative neuropsychological assessment, standardised scores are considered to be of secondary importance to a broader description of behavioural responses to testing.

“A test response is not a score; ...to reason – or do research – only in terms of scores or score patterns is to do violence to the nature of the raw material. *The scores do not communicate the responses in full*” (Walsh’s emphasis) (Shapiro (1951) cited in Walsh, 1987, p. 335).

Walsh (2005) goes on to explain that while quantitative assessment may be efficacious at measuring the extent of the deficit in terms of a score, it does not provide useful clinical information. To say that someone who has sustained Traumatic Brain Injury (TBI) has suffered a decrease of 30 IQ points does not provide the clinician with meaningful information about the cause of the decrease (e.g. functional versus organic) or about

specific regions of the brain that have suffered damage and to what extent. Two patients who obtain the same score on a test may do so for completely different reasons.

The qualitative assessment is guided by theoretical assumptions about the functional organisation of the brain, using a process which has been called “syndrome analysis”. Walsh (1985) succinctly defines a neuropsychological syndrome as “a unique constellation of signs and symptoms which occur frequently enough to suggest an underlying process” (p. 19). A key concept in this assessment area is that of a “functional system” (Luria, 1966; Luria & Majovski, 1977). This concept, which derived from internal medicine, refers to how psychological processes are served by the structural architecture of the brain. In this conceptualisation, a psychological process is analogous to a physical process like digestion, which is served by its own functional system with various areas of specialisation. This functional system may become disrupted at different points, leading to an array of different consequences in that function. In contrast with the psychometric approach, the qualitative approach to assessment proceeds in a flexible manner, making use of a theory of how the brain functions, and making tentative hypotheses about the patients presenting complaint, which guide the assessment.

The hypothesis-testing approach to neuropsychological assessment has obvious advantages over a pure psychometric approach in detecting possible cultural factors which may impact on test performance. This is illustrated by Nell (2000) who explains how, as a young neuropsychologist, he found himself vexed by an African woman’s responses on the Raven’s Coloured Matrices which were “consistently and inexplicably

wrong". (This task requires that a patient choose one of six alternative designs to best match the size and shape of the pattern in the image above.) This led to Nell beginning to formulate a hypothesis of a focal right parietal lesion. However later that day, after puzzling over the problem, he asked the interpreter to question the patient about how she had chosen her responses. "She readily explained that she chose her response not because it matched the pattern (that seemed too easy to her) but because it made the most colourful and aesthetically pleasing patch on what she took to be a sheet of fabric with a piece torn out of it. In her own terms, as a dressmaker, her bizarre answers had been perfectly reasonable – although her score on the Ravens was of course in the defective range" (Nell, 2000, p.17). This charming example underlines the potential for misdiagnosis due to cultural reasons, if performance is reduced to a simple score.

One of the disadvantages of the qualitative approach, if one could call it a disadvantage, is that a vast amount of knowledge about neuropsychological syndromes as well as the thorough knowledge of the associated disciplines of psychiatry and neurology must be acquired before competent practice (Walsh, 2005). The GSNAB attempts to fill this gap for screening purposes. The GSNAB is designed to do this by making use of a decision tree format, which guides the assessment of cognitive functions in a systematic manner, providing rudimentary information of neuropsychological syndromes and a series of heuristics for those who possess a lesser degree of clinical acumen and knowledge.

Although cut-off scores are used in the GSNAB, they are based on qualitative observations about a patient's performance. The calculation of cut-off scores, as with

tests like the Controlled Oral Word Association Test, makes use of available normative data, however, here, a poor score on a measure would lead to further testing for clarification using the supplementary measures provided. As Walsh (2005) reminds us, a good performance does not indicate that there is a lack of deficit, while a poor performance should always lead to further clarification.

Although a composite score is provided for each section, these scores should not be used alone without referring to the specifics of test performance at the test level. Using the total sections of the GSNAB, without considering the qualitative information the tests provide, would defeat the purpose of the tool and would result in the same loss of information to which the purely psychometric approach is prone.

“Transferable Technology”

Considering the great need of brain-injured people in the developing world, Nell (2000) has argued for clinical neuropsychology to be conceptualised as “transferable technology”, one which can be successfully devolved by trained neuropsychologists to those with lesser levels of specialisation. Nell (2000) sets out three levels of increasingly complex forms of neuropsychological assessment. At the first level of basic screening, which involves answering simply, whether the documented brain damage has in fact affected thinking and behaviour; the second level, would require a description of thinking and behaviour in hierarchical sequence of intellectual and behavioural functioning. Finally, at the most sophisticated level of complexity, the clinician attributes signs and symptoms to the underlying origins of impairment, providing causal explanations which

can enable accurate prediction regarding the level of performance in other tasks and social functioning.

The GSNAB could be located broadly within the second level of neuropsychological assessment. While its brief form is clearly not intended as a substitute for comprehensive neuropsychological assessment, it is proposed that the GSNAB be used, in the appropriate hands, to provide a basic form of neuropsychological assessment to those who, for socioeconomic reasons, do not have access to specialised clinical neuropsychological services. The decision-tree structure and inclusion of brief information about neuropsychological signs and symptoms related conforms with Nell's (2000) notion of "transferable technology". In addition to this, the tool itself includes basic information in the decision-tree which may serve as an educational tool, orienting clinicians with little experience in neuropsychological assessment with an overview of basic cortical functions.

Description of Tests Used in the GSNAB

Summary of Memory Functioning Assessed by the GSNAB

Memory function can be broadly separated into three primary functions: working memory, encoding of memory and retrieval of memory. Working memory involves the ability to retain information in conscious thought (fronto-parietal). The encoding of memory refers to the ability to lay down new, continuous memories, and is mostly a function of the hippocampal formation bilaterally (with the left hemisphere predominantly for verbal memory and the right hemisphere for visual memory). Lastly,

the retrieval of memory refers to the ability to retrieve appropriate memories, in a chronological and organised manner, with this process being mediated by the organisational control of the frontal lobes and anterior limbic structures. Therefore, encoding of memory principally involves posterior brain functions, whilst retrieval of memory predominantly involves anterior functions of the brain (Walsh, 1985).

The aspects of memory functioning that are tested in the GSNAB include: encoding and retrieval, of both visual and verbal memory, and working memory. Verbal memory is assessed using the 4 Hidden Objects Test, or the Township Fire Story (as an optional test). Visual memory is assessed using the Rey Complex Figure. Finally, working memory function is assessed using the Digit Span Test.

Descriptions of the tests in the GSNAB Memory section

Township Fire Story

This memory test is a story consisting of 21 semantic units, similar to the Logical Memory subtest in the Wechsler Memory Scale. In the instructions in the GSNAB, the patient is first told that this is a memory test and that they are going to be asked to remember the story that is about to be read to them. The story is then read aloud to the patient and they are then asked to remember as many details as possible. The score is recorded by counting the amount of semantic units the patient remembers. This is followed by a second reading and recall from the patient and a third recall, which occurs 30 minutes after the second reading of the story.

The Four Hidden Objects

For this test of memory, four common objects (e.g. a key, bracelet, pen and coin) are hidden in various places in the examination room; the patient is asked to remember where each item is hidden (Lezak, 2004). In the GSNAB version of the test there are trials. First, all four objects are shown to the patient who is asked to name each. Secondly, all four items are then hidden in one place and the patient is asked to name them again. Next, there is a brief distraction after which the patient is asked to name the items again. Finally, the same procedure is repeated, however now each object is hidden in a different location. The patient is once again distracted and asked to remember where each item is hidden. In this way, registration is tested with the first step through the naming of the objects, the second step is an indication of simple recall, whilst the final trial tests complex organisation recall. The Four Hidden Objects Test is scored out of a total of 18 points.

The Digit Span Test

In Digit Span, the patient has to repeat back to the tester a series of random digits; the length of each trial has one more digit than the last, with the test beginning with two digits. A normal performance is usually around seven digits which is the average amount of information that can be stored in short-term memory at any given moment. In GSNAB, only one trial for each string of numbers is administered. A normal score is 7 digits, and below six is considered defective.

Summary of Executive Functioning Assessed by the GSNAB

The frontal lobes have been widely regarded as the seat of the higher-order functions in man, closely associated with our ability to reason, our imagination, our judgment, our ethical behaviour and our social awareness. However, Damasio (1979), points to the contradiction here, that it is still possible for many patient's intelligence to remain intact after extensive damage to the frontal lobes. Emphasising the importance of qualitative information he states, "signs and symptoms of frontal lobe dysfunction do not lead themselves easily to quantitative measurement ... frontal lobe dysfunction is more readily described as changes in quality" (Damasio, 1979, p. 362).

In the GSNAB the Executive section is broken up into four sections: Deep White Matter, Mesial, Orbital/Basal and Dorsolateral. Some have regarded these subdivisions being closely associated with a particular set of subsyndromes of the frontal lobes (Walsh, 1985). Focal lesions in deep white matter may produce signs of adynamia, impersistence and in severe cases akinetic mutism. Damage to the mesial section may disrupt the regulation of voluntary arousal and the ability to inhibit responses, this may manifest in confabulation, perseveration, paramnesia and contaminated consciousness. With focal orbital/basal lesions, damage leads to difficulties with response suppression and inhibition, which may manifest in disinhibition, impulsiveness, utilisation behaviour, distractibility and socially inappropriate behaviour. The final subsection is the dorsolateral prefrontal cortex, which is associated with the subordination of goal-directed action. Differentiation here is made between, premotor functions, which regulate complex motor programs and prefrontal functions, regarded as higher order pre-

programming or ideational preparation. Lesions in this area are often evident in the patient's defective approach to problem solving. There may also be signs of inability to shift sets, concrete attitudes and lack of critical self-awareness.

Descriptions of the tests in the GSNAB Executive section

The Controlled Word Association Test (COWAT)

Patients are asked to produce as many words as they can, beginning with a given letter in a minute. In the English test the letters are F, A and S. In English, these letters occur at different frequencies with F occurring more frequently than A, and A occurring more frequently than S. The rules are that there may be no repetition of words and the use of suffixes, prefixes and pronouns are also not allowed. In the isiXhosa version of the COWAT the letters N, P and S were used and in Afrikaans, B, H and P. As with the English version of the test, these letters were chosen for their relative frequencies.

This test is used in the deep white matter subsection of the GSNAB to evaluate a patient's generativity in word production, which has proven to be a sensitive indicator of dysfunction in frontal lesions, on either side (Lezak, 2004). In the Mesial subsection of the GSNAB, it is also used to detect rule-breaking in patients who are disinhibited, impulsive or distractible, this is often indicative of damage to the orbital or basal regions of the frontal lobes.

In the Deep White Matter subsection of the GSNAB, the COWAT is scored out of two, with more than 25 words out of the three trials considered normal and scoring the

maximum, two. A score between 15 and 25 is given a one, and less than 15 words is given zero.

Township Fire Story

In the Executive section of the GSNAB, the Township Fire Story is used to detect confabulation, contamination or irrelevant intrusions in recall. Questions like “Was there an ambulance in the story?” are intended to provoke confabulation in the presence of lesions to the mesial prefrontal cortex. The highest score, 2, is achieved through lucid recall without any confabulation; a 1 is given if misleading probes lead to confabulation or irrelevant associations, and 0 is given for spontaneous confabulation or irrelevant associations.

The Red/Green test

In this test the patient is asked to squeeze the clinician’s hand on the command “green” and to let go on the command “red”. The clinician observes whether the patient is able to learn the rule, and whether they are able to change their behaviour when the pattern is changed. A perfect performance with one or two errors is given a score of 2. This occurs in the Mesial subsection and with the COWAT, is used to detect disinhibition, distractibility, impulsiveness, inappropriateness and utilisation behaviour.

Fist, Side, Palm Test

This involves a patient observing a repeated three-step hand movement sequence. The clinician places their fist with fingers down on a surface, then with an open hand rests the

side of the hand on the surface and the last position is with the palm flat on the surface. The patient is asked to do the same, with the clinician verbalising the movements and initially performing the sequence with the patient, after few trials the model is withdrawn. This test occurs in the Dorsolateral subsection and is used to mainly test the patient's ability to subordinate goal-directed action to verbally-regulated commands. Performing the task correctly with little error scores a maximum of one and inability after repeated trials scores 0.

Tapping Test

Also included in the Dorsolateral subsection, this test the patient is required to repeat rhythms tapped out by the clinician. The complexity of rhythms are gradually increased. A full score of 1 is given for a perfect performance with one or two errors and zero is given for failing to achieve perfect performance after repeated trials.

Repeated Pattern Drawing Test

Here the patient is asked to draw the pattern in figure 1.

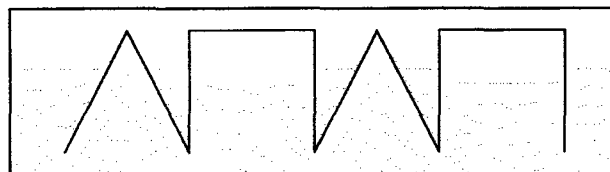


Figure 1. Repeated Drawing Test

The test is scored out of one for a perfect performance and zero for failing to achieve perfect performance after repeated trials.

18-Book Problem Test

This is a test occurs in the Dorsolateral subsection of the GSNAB and was originally devised by Luria. The patient is asked to solve the following problem:

“There were 18 books on two shelves, and there were twice as many books on one as on the other. How many books were on each shelf?” (Luria, 1966).

The test is scored out of two: zero for two incorrect answers; one for a wrong and then right answer; and two for a correct answer.

Aim

The aims of the first phase of this study were firstly, to test the changes made to the Township Fire Story, which had proven unsatisfactory in the initial pilot study, and secondly, to make appropriate adjustments on the basis on these finding. The second phase of the study evaluated the validity and reliability of the Memory and Executive sections of the GSNAB. For this second phase, both these sections were administered to two groups of patients, those with frontal lesions and those with hippocampal lesions, and a group of controls. Concurrent to this part of the study the Language and Spatial Cognition sections of the GSNAB were tested for validity and reliability. It was hypothesised, firstly that the GSNAB would be able to correctly identify and differentiate

between members of the patient population on the basis of lesion site and secondly, that the GSNAB could successfully discern between neurologically intact individuals and the patients with brain damage. Lastly, the reliability of the GSNAB was evaluated, specifically examining whether there was an adequate level of test/re-test reliability over time, and between different raters.

Method

Phase 1: Pilot Study

Sample

The sample for this pilot study involved 30 neurologically intact participants who were individually screened for a range of relevant associated diseases and disorders, including stroke, epilepsy, traumatic brain injury and HIV/AIDS, using a screening questionnaire (see Appendix 1). Participants were randomly selected from the relatives of patients at Groote Schuur Hospital, in order to match the culture, education, socioeconomic circumstances of patients seen at Groote Schuur Hospital.

The sample ranged in age from 16 – 74 years of age ($M = 41.57$, $SD = 14.97$), and in years of education from 1 – 12 years ($M = 8.77$, $SD = 2.98$). The sample was divided into three linguistic groups. In the Xhosa group, the age of participants ranged from 18-57 years of age ($M = 35.6$, $SD = 12.31$) with a mean of 8.3 years of education ($SD = 3.16$). The Afrikaans group ranged from 16-70 years of age ($M = 41.4$, $SD = 17.21$) with a mean education of 7.8 years ($SD = 3.36$). The English group ranged from 32 - 74 years of age ($M = 49.7$, $SD = 12.76$) with a mean education of 10.2 years ($SD = 1.93$).

Materials

The updated version of the Township Fire Story, available in three languages (isiXhosa, English and Afrikaans), was used (see Appendix 2). A screening questionnaire (see Appendix 1), was used to screen potential participants, excluding those who had suffered a neurological disorder or any pathology associated with neurocognitive dysfunction

Before the beginning of each administration an information sheet was handed out and informed consent was given. During this time were participants informed about the study and their rights as participants, and time was allocated for questions. During testing all of the participants were administered the new version of the Township Fire Story which involved two consecutive trials and a delayed recall at 30 minutes. The new version of the Township recall story was administered in the participant's language with the help of translators from the University of Cape Town African Languages Department who had also sat on the assembled panel of language and cultural experts and had also served as interpreters in the previous study. The participant's responses were recorded verbatim by the researcher, and all three recall trials of the story – immediate recall, second recall and delayed recall – were scored out of 21.

Ethics

Each participant was given an information sheet (see Appendices) and informed about the details and purpose of the study. All patients were informed that their responses would be confidential and that they were entitled to withdraw from the study at any time without being expected to provide a reason. Furthermore, participants were informed that withdrawal from the study would not have any adverse consequences for the current, or future treatment of themselves or their family members at Groote Schuur Hospital.

*Phase 2: Testing the Validity and Reliability
of the GSNAB in a Clinical Population*

Sample

A sample group of 45 participants which comprised one control group of 15 participants, and two experimental groups with 15 patients in each (i.e. 15 for the executive section and 15 for the memory section), was used. This sample size was decided on after considering the time restrictions of the study and the likelihood of finding suitable patients from each group within the given time frame of the study. The experimental groups were comprised of patients from Groote Schuur Hospital who had had Computed Tomography (CT) or Magnetic Resonance Imaging (MRI) scans, neurological assessments, and had been assessed by the neuropsychologists, to confirm lesion site. The control group was matched as closely as possible to the experimental group in terms of socioeconomic status, age and first language, and screened to exclude possible pathologies that might affect cognition (see Appendix 1). The control group consisted of family and relatives of members in the experimental group and patients who were screened using the screening schedule (see appendices). The patients and the matched sample group were all recruited by a student from the neuropsychology division of University of Cape Town Psychology Department.

A total of nine participants, three participants from each of the two lesion groups, and three participants from the control group, were retested by different researchers as part of the evaluation of the reliability of the GSNAB. The mean age for the nine participants was 62.11 ($SD = 19.56$), and there was a mean of 8.44 ($SD = 3.64$) years of education.

The age range of the sample was from 17 – 80 years of age ($M = 53$ and $SD = 18.175$), and education ranged from no education to 16 years ($M = 9.00$ and $SD = 3.261$). There were 24 female and 21 male participants, and the breakdown for language was: 20 English, 8 Xhosa and 17 Afrikaans speakers. In the group containing patients with hippocampal lesions ages ranged from 53 – 80 years of age ($M = 69.13$ and $SD = 9.249$) and level of education from 4 – 12 ($M = 8.67$ and $SD = 3.266$). The group of frontal patients, ages ranged from 17 – 72 years ($M = 50.00$ and $SD = 17.059$) and years of education from 6 – 14 ($M = 8.80$ and $SD = 2.513$). For the control group, ages ranged from 19 – 64 year of age ($M = 39.87$ and $SD = 13.721$) and years of education was from no education to 16 ($M = 9.53$ and $SD = 3.998$).

Materials

For this phase of the study, the entire Executive and Memory sections of the GSNAB in English, Afrikaans and isiXhosa were used. All the adapted tests comprising these sections were administered including supplementary tests. A scoring sheet (see Appendix 5) which was specifically designed for the study was used to record the responses of participants. A screening questionnaire (see Appendix 1) was given to controls, to exclude participants with a history of confounding medical or neurological conditions. A patient information sheet (see Appendix 4), with information about the study and the rights of patients and contact details of the supervisor for the project was handed out at the beginning of each assessment. A consent form (see Appendix 3) was used to record

that consent had been given by participants or their family and that the information sheet had been read and any questions had been satisfactorily answered.

Design

The design of this second phase of the study focused on evaluating the reliability and validity of the GSNAB. A single-blind study was used, whereby two researchers were blind as to whether they were assessing a member of one of the two experimental groups or a healthy control. The performances of the three groups (control, frontal and hippocampal) on the Memory and Executive sections, as well as selected measures, were examined using a combination of quantitative and qualitative methods. Through converging lines of evidence, quantitative methods provided a means of comparing group performances on the sections and constituent measures, while qualitative observations provided important detail about the characteristics of performances and the ways in which tests were failed. This combination of perspectives was also adopted as a framework for the reliability component of the study, where correlations of inter-rater reliability and test-rest reliability were computed from the scores of participants and qualitative observations of the scripts guided allocations to the appropriate group by the two raters.

Data Analysis

Descriptive statistics (means and standard deviations) were calculated for each of the clinical groups, as well as the control group using the statistical software package SPSS

16. The data analyses were partitioned into two sections: the reliability component and the validation component.

In analysing the data concerning the investigation of the GSNAB's reliability, the first and second administration scores of the 9 participants who were retested, were correlated using Pearson product moment correlation coefficients (r). The total scores of each participant were first converted into a percentage in order to standardise the scores.

Data analysis in the validation component of the study followed a hierarchical sequence, beginning with a one-way ANOVA on group performances on the Executive and Memory sections of the battery, to see whether each of these tests were able to discern between patients with frontal and hippocampal lesions, as well as controls from both of the patient groups. Then these sections were individually analysed using factorial ANOVA, in order to ascertain whether performances could be attributed to another factor such as level of education, first language or age. The next level of analyses concentrated on selected individual tests. Under the Memory section, the Township Fire Story was subjected to one-way ANOVA, testing effectiveness of this test in differentiating between the two experimental groups and the control groups. Factorial ANOVA was calculated to see whether level of education and first language could better account for performances on this measure. In addition to this, a one-way ANOVA was performed on data from performances on the Digit Span and subsequently a factorial ANOVA was conducted to ascertain whether the performances could be explained by education or language. Under the Executive section, the performances on the Controlled Oral Word Association Test

(COWAT) were also examined using one-way ANOVA to evaluate the potential for differentiating between the three groups of participants. As before, factorial ANOVA was computed in order to rule out other factors which may explain the group performances. Lastly, data gathered from performances on the 18-Book Problem were studied using the Chi-Squared test in order to ascertain whether controls, patients with frontal lesions and patients with hippocampal lesions performed differently.

Procedure

The entire GSNAB was blindly administered to participants in both experimental groups and the control group in their first language with the help of translators from the University of Cape Town African Languages Department. The researchers assessing the participants did not know whether they were seeing a control or a participant from one of the two experimental groups. Testing of participants took place in three locations at Groote Schuur Hospital. Each administration of the battery took roughly 35 – 60min, depending on the speed of the participant. The same interpreters from the University of Cape Town African Languages Department who assisted in the translation and development of the GSNAB, assisted in the administration of the adapted and translated versions of the GSNAB when required, to the isiXhosa and Afrikaans participants.

The participants' scores as well as qualitative observations made about their test performances and behaviour during testing, were recorded on the specifically designed scoring sheet (see Appendix 5). Information about each of the subject's diagnosis including pathology and lesion site were recorded from the patient's file and stored

separately by another student assisting in the study. Once the data collection was completed, the protocols were blindly assigned to each of the three groups by two different raters using the completed protocols of three groups (controls, frontal and hippocampal). Once this was completed the assignment of the cases to the three groups were recorded, the researcher was un-blinded and the accuracy of the allocation documented.

Ethics

Ethical permission for the study was granted by the Groote Schuur Hospital Research Ethics Committee and the Department of Psychology at the University of Cape Town. All participants agreed to participate in the study and signed the consent form (see Appendix 3) which stated that their results would be confidential and that they could withdraw from testing at any point without having to provide a reason for doing so. It was clearly communicated that withdrawal from participating in the study would in no way effect their current or any future treatment. Patients were given an information sheet (see Appendices 4), informing them of the details and purpose of the study, what participation would involve as well their right to withdraw from the study at any point without having to give reasons for doing so and the contact details of the project supervisor Professor Solms. All of the completed protocols were handed over to the assisting student on a weekly basis where they were securely stored in a locked cabinet that was available only to the members of the research team. Results of the study were made available to any interested participants.

Results

Re-piloting Phase

Township Fire Story

The three groups of normal participants were divided equally ($n = 10$) by language. Means and standard deviations of the performances of each group can be seen in Table 1.

Table 1

Showing means and standard deviations for performances on the updated Township Fire Story for the three different language groups

	Language		
	English	Afrikaans	isiXhosa
	Township Fire Story		
<i>M</i>	35.8	34.5	40.7
<i>SD</i>	16.164	19.323	11.729

Table 1 shows that all three language groups performed similarly on the updated version of the test. A one-way ANOVA was calculated to ascertain whether there were significant differences between the means of the three groups. While assumptions of normality were upheld, assumptions of homogeneity of variance were not. However

given that ANOVA is a robust test (Howell, 2002), and the equal sample sizes, the analyses could proceed. No significant effects were noted, $F(2, 27) = .415, p = .664$.

A Factorial ANOVA was then calculated in order to ascertain whether performances of the controls could be attributed to language or education differences in the groups. Before the analysis was run, education was divided into two equal groups (below 9 years and 9 years and above). This division was done due to the small size of the sample. While the analysis revealed a significant result for education $F(1, 30) = 7.5, p = 0.012$, language was not significant, and $F(2, 30) = 1.24, p = 0.307$ and there was no significant interaction between these two factors $F(2, 30) = 0.574, p = 0.571$. *Eta-squared* was calculated to estimate the effect-size for Education, which was 0.03; therefore, education accounted for 3.33% of the variance.

Table 2***Descriptive Statistics for the Township Fire Story***

Factor A: Education	Factor B: Language			A marginal means	
	English	Afrikaans	isiXhosa		
9 years or more	M	39.88	46.75	45.25	42.94
	SD	14.015	19.97	10.468	
	N	8	4	4	
less than 9 years	M	19.5	26.33	37.67	30.21
	SD	17.678	15.253	12.42	
	N	2	6	6	
Factor B marginal means		35.80	34.50	40.70	

Validation and Reliability Phase***Reliability***

Estimations of test-retest and inter-rater reliability of the Executive and Memory sections of the battery were derived from results obtained by testing three participants from each group twice. Reassessments were conducted within forty-eight hours of the initial assessment in order to minimise the effects of changes in the patient's condition. First

and second assessments were conducted by different researchers. All researchers were blind to which of the three groups the participants belonged. 18 assessments were done in total, 9 assessments and 9 reassessments. See Table 3 for demographic details for participants.

Table 3

Means and standard deviations of Age and Years of Education for reliability phase (N=9, Male = 4, Female = 5)

Age	
<i>M</i>	62.11
<i>SD</i>	19.56
Years of Education	
<i>M</i>	8.44
<i>SD</i>	3.64

Pearson product moment correlation coefficients (r) were used to correlate individual scores between performances on the first and second administrations for individuals on the Frontal and Memory sections of the GSNAB. Further correlations were made between the totals of the abovementioned sections.

Each individual score from the first administration of the GSNAB was first converted into a percentage in order to normalise the scores, then the summated individual scores were correlated with reassessment scores. See Table 4 for correlation coefficients.

Table 4
Reliability coefficients for Executive and Memory sections

Section	Correlation Coefficient
Executive	.99
Memory	.97

Validation

Qualitative

The results of allocations made by two blind raters were as follows: Out of a total of 90 allocations, between the two raters, 11 scripts were misallocated out of a total of 90 allocations (88% success rate), with rater A making 6 misallocations (87% success rate) and rater B incorrectly classifying 5 of the 40 protocols (89% success rate). Further breakdown of errors revealed that for rater A: 1 control was misallocated as a frontal patient; 3 amnesic patients were misallocated as frontal patients and 2 frontal patients as amnesics. For rater B, 2 frontals were designated as amnesic patients and 3 amnesic patients were misallocated as frontal patients with no misallocation of controls into either of the patient groups.

*Quantitative**Memory Section*

One-way ANOVA was calculated to ascertain whether the total Memory section of the GSNAB could discriminate between patients with frontal lesions, hippocampal lesions and control groups. Assumptions of normality were maintained but the assumption of homogeneity of variance was violated ($p = 0.003$). Table 5 displays descriptive statistics (means and standard deviations). There was a significant main effect, $F(2, 42) = 39.50$ ($p < 0.000$). *Eta-squared* was calculated to determine the effect size, which was 0.65. Therefore, group (frontal, hippocampal and control) explains 65% of the variation in the Memory section performances.

Table 5*Mean scores for Memory Section*

	Group		
	Hippocampal	Frontal	Control
<i>M</i>	5.87	13.27	17.27
<i>SD</i>	4.32	4.350	.80
<i>N</i>	15	15	15

To ascertain the location of differences of performances between the means of the three groups, a post-hoc test (Tukey's HSD) was calculated. A strong significant difference was noted between members of the group with frontal and hippocampal lesions ($p <$

0.0000), as well as between the hippocampal lesion group and controls ($p < 0.0000$). Likewise, a significant difference was found between frontal lesions and controls ($p = .01$).

Factorial ANOVA was calculated in order to determine whether factors other than neurological pathology could account for performances on the Memory section. The interaction between language and education was investigated. The assumption of normality was upheld; however, the assumption of homogeneity of variance was violated. Analysis was able to proceed since ANOVA is a robust technique (Howell, 2002) and the sample groups were of equal size ($N = 15$). Table 6 shows descriptive statistics for mean scores of the memory section. There were no significant effects for either education $F(1, 39) = 3.873, p = 0.56$, or language $F(2, 39) = 0.904, p = 0.413$. A significant interaction effect was found, $F(2, 39) = 6.584, p = 0.003$. This would suggest that first language and level of education did not significantly affect the total Memory section score.

Table 6*Mean Scores for Memory Section (Language and Education)*

Factor A: Education		Factor B: Language			A marginal means
		English	Afrikaans	isiXhosa	
9 years or more	M	10.45	15.00	0	8.48
	SD	6.170	3.266	0	
	N	11	7	1	
less than 9 years	M	13.00	9.60	16.14	12.913
	SD	6.423	6.096	1.345	
	N	9	10	7	
Factor B marginal means		11.725	12.3	8.07	

A second factorial ANOVA was conducted in order to investigate the relationship between age and pathology on performances of the memory section. The assumption of normality was upheld, but, the assumption of homogeneity was violated. Analysis could continue since the pathology was equal and age roughly equal. For the purpose of the analysis, age was divided into two roughly equal groups: those who were 53 years of age (N = 21) and younger and those who were older than 53 years (N = 24). Table 7 shows descriptive statistics for the analysis.

A significant main effect for pathology was found, $F(2, 39) = 10.86, p < 0.0000$; however for age there was no significant effect, $F(1, 39) = 0.147, p = 0.704$. No significant interaction effect was noted between pathology and age $F(2, 39) = 1.356, p = 0.270$.

Table 7

Mean Scores for Memory Section (Age and Pathology)

Factor A: Age	Factor B: Pathology			A marginal means	
	Memory	Executive	Control		
older than 53 years	<i>M</i>	5.57	14.67	17.5	14.76
	<i>SD</i>	4.327	1.751	.577	
	<i>N</i>	14	6	4	
53 years or younger	<i>M</i>	10	12.33	17.18	9.83
	<i>SD</i>	.	5.362	.874	
	<i>N</i>	1	9	11	
Factor B marginal means	5.87	13.21	17.27		

Lastly, the sensitivity (true positives/true positives + false negatives) and specificity (true negatives/true negative + false positives) were determined using the cut-off scores of the Memory section. Sensitivity is the ability of the measure to identify memory impairment,

and is good when above 80%, while specificity represents the rate of normal people falsely identified as having memory impairment which should be above 60%. Sensitivity for the Memory section was 93% and specificity, 74%.

Township Fire Story

One-way ANOVA was performed to establish whether the Township Fire Story (TFS) could discern between frontal lesions and hippocampal lesions. Both assumptions of normality and homogeneity of variance were not upheld. As mentioned in the previous section, due to the equal groups and the robustness of ANOVA, analyses could continue. Table 8 shows descriptive statistics for group performances on the Township Fire Story. A significant effect for pathology was found, showing that pathology influenced performances at $F(2, 42) = 26.7$ $p < 0.0000$.

Tukey's HSD was calculated to determine where the differences between the groups lay. Significant difference was seen between the performances of hippocampal lesion and control groups ($p < 0.0000$). Additionally, a significant difference was noted between frontal lesion and control groups ($p < 0.0000$). There was also a significant difference between frontal lesion and hippocampal lesion groups ($p = 0.015$). The effect size was calculated as 0.56, showing that 56% of the variance could be accounted for by group.

Table 8.
Mean scores for Township Fire Story

	Group		
	Hippocampal	Frontal	Control
<i>M</i>	8.47	19.47	35.8
<i>SD</i>	8.81	10.83	11.13
<i>N</i>	15	15	15

Factorial ANOVA was calculated in order to determine whether other factors than neurological pathology could account for performances on the Township Fire Story. Interaction between language and education were examined. Assumptions of normality were violated; however, the assumption of homogeneity of variance was upheld. Again, education was partitioned into two groups: those with 9 or less years of education and those with more than 9 years education. Table 9 shows descriptive statistics for the analysis (means and standard deviations). No significant effect for education was found, at $F(1, 39) = 0.280$, $p = 0.600$ nor language $F(2, 39) = 0.399$, $p = 0.674$. Similarly, no significant interaction effect was found between these two factors, at $F(2, 39) = 2.617$, $p = 0.086$. This would suggest that first language and level of education did not significantly affect performances on the Township Fire Story.

Table 9.*Mean Scores for Township Fire Story (Education and Language)*

Factor A: Education	Factor B: Language			A marginal means	
	English	Afrikaans	isiXhosa		
9 years or more	<i>M</i>	22.00	28.43	1	23.26
	<i>SD</i>	16.935	15.447	.	
	<i>N</i>	11	7	1	
less than 9 years	<i>M</i>	19.89	14.80	26.71	19.77
	<i>SD</i>	16.937	12.770	10.468	
	<i>N</i>	9	10	7	
Factor B marginal means	21.05	20.41	23.50		

Digit Span

A one-way ANOVA was calculated in order to establish whether the Digit Span Test was able to discriminate between frontal lesions, hippocampal lesions and control groups. The assumptions of ANOVA were examined. Normality and homogeneity of variance ($p = 0.26$) were both upheld. Table 10 displays descriptive statistics (means and standard deviations). The groups showed significant differences in their performance on the Digit Span Test, $F(2, 42) = 5.232$ ($p = 0.009$). *Eta*-squared was calculated to determine the

effect size, which was 0.2. Therefore, group (frontal, hippocampal and control) could account for 20% of the variation in performances on the Digit Span test.

Tukey's HSD was calculated in order to examine how the three groups differed in their performances and showed that performances between members of the groups with hippocampal lesions and frontal lesions were not significantly different ($p = 0.394$), as was the case between the hippocampal lesion and control groups ($p = 0.151$). However, a significant difference was found between performances of the frontal lesion and control groups ($p = 0.007$).

Table 10.

Mean scores for Digit Span Test

	Group		
	Hippocampal	Frontal	Control
<i>M</i>	5.13	4.53	6.00
<i>SD</i>	1.13	1.30	1.31
<i>N</i>	15	15	15

Executive Section

To ascertain whether the total Executive section of the GSNAB was able to discriminate between frontal lesion, hippocampal lesion and control groups, a one-way ANOVA was calculated. Assumptions of normality were upheld, but the assumption of homogeneity of

variance was violated ($p = 0.008$). Table 11 displays descriptive statistics (means and standard deviations). A significant main effect was noted, at $F(2, 42) = 39.50$ ($p < 0.000$). *Eta-squared* was calculated to determine the effect size, which was 0.63. Therefore, group (frontal, hippocampal and control) explained 63% of the variation in the Executive section performances.

To ascertain the location of differences of performances between the means of the three groups, Tukey's HSD was calculated. A significant difference was noted between members of the group with frontal and hippocampal lesions ($p < 0.013$), as well as between the hippocampal lesion group and controls ($p < 0.0000$). Furthermore, a significant difference was found between the frontal lesion and control groups ($p = 0.0000$).

Table 11
Means and standard deviations for Executive Section

	Group		
	Hippocampal	Frontal	Control
<i>M</i>	5.40	3.27	9.33
<i>SD</i>	2.85	.96	1.59
<i>N</i>	15	15	15

Factorial ANOVA was then calculated to determine whether level of education or language were factors in performances on the Executive section. Table 12 shows descriptive statistics for this analysis. ANOVA's assumptions of normality and homogeneity of variance were upheld ($p = 0.311$). No significant effects were found for language, at $F(2, 39) = 3.23$, $p = 0.726$, and for education, at $F(1, 39) = 0.31$, $p = 0.861$. Additionally, there was no significant interaction effect between $F(1, 39) = 1.312$, $p = 0.281$. Therefore, language and level of education were both found not to significantly influence performances on the Executive section.

Table 12**Mean Scores for Executive Section**

Factor A: Education	Factor B: Language			A marginal means	
	English	Afrikaans	isiXhosa		
9 years or more	<i>M</i>	7.09	7	3.00	6.84
	<i>SD</i>	3.081	3.830	.	
	<i>N</i>	11	7	1	
less than 9 years	<i>M</i>	4.56	5.40	6.43	5.38
	<i>SD</i>	3.283	3.239	2.225	
	<i>N</i>	9	10	7	
Factor B marginal means		5.95	6.06	6.00	

Finally, the sensitivity and specificity were calculated on the basis of cut-off scores provided by the Executive section. Sensitivity shows the success of the executive section at detecting impairment, (> 80%, is good). Specificity represents the rate of controls falsely identified as having executive impairment and should ideally be above 60%. Sensitivity for the Executive section was 100% and specificity, 26%.

18-Book Problem

A Chi-squared test was conducted to ascertain whether the frontal lesion, hippocampal lesion and control groups performed differently on the 18-Book Problem. The Chi-squared statistic was calculated as $\chi^2(4, N = 45) = 8.479, p = 0.076$. Therefore, participant's performances on the 18-Book Problem were not contingent on the group to which they belonged. Fourteen of the frontal lesion participants failed the 18-Book Problem, with one participant passing. Eleven participants from the hippocampal group failed and 4 passed, while 7 of the control group failed and eight passed.

Controlled Oral Word Association (COWAT)

One-way ANOVA was calculated to ascertain whether the total Controlled Oral Word Association Test (COWAT) (Benton & Hamsher, 1989; Strauss, Sherman, & Spreen, 2006) was able to discriminate between performances of frontal lesion, hippocampal lesion and control groups. Assumptions of normality were maintained but the assumption of homogeneity of variance was violated ($p = 0.008$). Table 13 displays descriptive statistics. There was a significant main effect, at $F(2, 42) = 9.394 (p < 0.0000)$. *Eta*-squared was calculated to determine the effect size, which was 0.69. Therefore, group (frontal lesion, hippocampal lesion and control) explained 69% of the variance on the COWAT.

Table 13
Mean scores for Control Word Association Test

	Group		
	Hippocampal	Frontal	Control
<i>M</i>	17.6	10.8	29
<i>SD</i>	15.445	4.799	11.982
<i>N</i>	15	15	15

Tukey's HSD was calculated in order to investigate how groups differed in their performance on the COWAT. No significant difference was noted between members of the group with frontal and hippocampal lesions ($p = 0.256$). Comparing the means of the hippocampal lesion group and control group performances, showed a significant difference ($p < 0.027$). Those from the frontal lesion group and the control participants showed the greatest significant difference ($p < 0.0000$).

Factorial ANOVA was used to determine whether language and education influenced performances on the COWAT. Assumptions of normality and homogeneity were upheld. Education was divided up into two groups: those with 9 years or more and those with less than 9 years education. Table 14 shows descriptive statistics (means and standard deviations). No significant main effect was found for level of education at $F(1, 39) = 0.290$, $p = 0.593$, or for language $F(2, 39) = 1.299$, $p = 0.284$. There was also no

significant interaction between these two factors, at $F(2, 39) = 1.318, p = 0.279$. These results showed that neither language nor level of education influenced performances on the COWAT.

Table 14

Mean Scores for Controlled Oral Word Association Test (COWAT)

Factor A: Education		Factor B: Language			A marginal means
		English	Afrikaans	isiXhosa	
9 years or more	<i>M</i>	25.36	26.29	3	24.53
	<i>SD</i>	13.626	14.130	.	
	<i>N</i>	11	7	1	
less than 9 years	<i>M</i>	17.22	13.40	15.14	15.19
	<i>SD</i>	15.643	10.814	9.788	
	<i>N</i>	9	10	7	
Factor B marginal means		21.70	18.71	13.62	

Discussion

Re-pilot

Township Fire Story

This phase of the study was conducted to test content improvements that were made to the Township Fire Story after normal participants performed poorly in the original pilot study. Statistical analyses of neurologically intact participants' performances on the updated Township Fire Story showed that all the groups performed at an equal level on the updated test, with the isiXhosa group performing at a slightly better level than the other two groups. In addition to this, all three groups performed above the GSNAB cut-off level, which was a total of 30 points on all three trials. From these results, it would appear that controls were now performing more consistently across group and at a better rate than in the previous pilot (Lopich, 2005).

The first language of the participants was found not to be a significant factor in influencing performances on the updated Township Fire Story, as it had been with the previous test. On the other hand, education was found to significantly influence performances on the new test, albeit with a small effect-size. It is possible that test-wisness was a contributing factor in performances, as has been well described in the literature (Ardila, 2007a; Nell, 1999, 2000).

Reliability and Validation

Reliability

In order to examine whether the Groote Schuur Neurocognitive Assessment Battery (GSNAB) was reliable across participants and scorers, test-retest and inter-rater reliability were examined concurrently. Nine participants were randomly selected and were each administered the Memory and Executive sections of GSNAB twice, by a different researcher, within a 48-hour period. A high degree of test-retest reliability was found for participant's performances on both sections across assessments and between raters. Although these results should be interpreted with some caution due to the small sample size, these are positive preliminary findings.

Validation

Quantitative

This section of the study set out to establish whether the Frontal and Memory sections of the GSNAB were able to accurately discern between patients with frontal lesions and those with hippocampal lesions, and a group of controls. For this phase of the study, all participants were administered the Memory and Executive Sections of the GSNAB. These performances were subjected to statistical analysis to see whether there was a significant difference between these groups in their performance on these sections. In addition, the influence of other factors, such as language, age and level of education was examined.

Statistical analyses of the mean performances between and within groups on the constituent tests were used to assess the accuracy of these tests at being able to differentiate between the two patient groups, and controls, and to see whether these results were influenced significantly by other factors such as education and language. The statistical analysis was augmented by qualitative observations, which provided a richer account of test performances.

Qualitative

This aspect of the study involved blind allocation of scripts to their correct groups for (either control, frontal or non-frontal) according to the qualitative analysis of the scripts. This meant that the raters were requested to not rely entirely on the total scores of sections, but to include qualitative observations in their evaluation of the scripts, such as level of arousal, cooperativeness and other noted qualitative features of performance, which had been recorded on the scripts. There was a high degree of success for each of the raters at correctly designating patients to their appropriate groups and a low rate of false positives, with 1 out of 90 allocations being false. There was also a high level of agreement between the rater's allocations. This indicates that the use of qualitative information greatly aided the raters in accurate allocations.

Memory Function Section – Quantitative Findings

Comparisons of group means on the Memory section showed that this section too was able to differentiate, at a statistically significant level, between groups of hippocampal and frontal patients, and controls. Additionally, group was able to explain 65% of the

variation in performances on this section. When further analysis was conducted, to ascertain whether other factors were contributing to these performances, statistical results did not yield any positive result. Participant's level of education and first language were shown to be non-significant factors in performances on the Memory section, and no interaction effect could be found between the age and pathology group of participants on performances in the Memory section.

A closer examination of the accuracy of allocations according to the cut-off score of the GSNAB showed a good level of sensitivity and specificity.

Township Fire Story

On closer examination of tests making up the Memory section of the GSNAB it was found that the Township Fire Story was able to differentiate, at a statistically significant level, between controls and patients, and between the two patient groups. Neither level of education, nor first language, were found to significantly influence the scores obtained on the Town Ship Fire Story by participants.

A more detailed analysis of the errors in allocation during this phase of the reliability study revealed that some difficulty occurred for both raters in being able to distinguish between hippocampal and frontal patients, for the reason that the patients in both groups may perform equally poorly on memory tasks, but for different reasons. Patients with frontal lesions, while not possessing "true" amnesic disorder, would be better described as having impairment in the *control* of memory (Shimamura & Baldo, 2002). This

disruption of memory processes occurs at both the level of encoding and retrieval. This is in contrast with patients who have lesions to the medial temporal lobe, who have a syndrome of “pure forgetting,” where encoding is impaired (Walsh, 1985). While patients with frontal lobes are likely to benefit from structured cuing on recall, those with medial temporal lobe lesions cannot benefit, due to a primary deficit in encoding (Walsh, 1985). Although the GSNAB was designed to include questions that could elicit confabulation, as part of the Executive section, there is a lack of structured cuing or multiple-choice questions, which would aid in distinguishing between these two kinds of memory problems.

Digit Span Test

On examining the group performances on the Digit Span Test, it was found that the patients with frontal lesions performed significantly worse than normal subjects; however there was no significant difference between the controls and patients with hippocampal lesions. This may be accounted for by the fact that Digit Span Test is largely reliant on working memory, which is known to be adversely affected by lesions to the dorsolateral prefrontal cortex (Kramer & Quitania, 2007). This finding may account for why patients with hippocampal lesions performed slightly better than patients with lesions to the frontal lobes.

Out of the fifteen controls, 5 obtained a score of 1 (which is 5 digits) while another 3 failed the test completely. It is possible that with only a single trial, some of the tests were discontinued prematurely. It is likely that participants would have benefited from a

second trial, as the test is noted to be vulnerable to effects of distraction, level of anxiety and lapses in attention in the testee (Lezak, 2004).

Executive Function Section – Quantitative Findings

An examination of group means of performances on the Executive section found that this section was able to differentiate, at a statistically significant level, between normal participants and patients with hippocampal and frontal lesions. When effect-size was calculated, it was found that pathology group explained 63% of the variance in performances on the Executive section. In addition to this finding, first language of participants and level of education, were both found not to significantly influence scores obtained on the Executive section across the three groups.

One of the individual tests from the executive section that was examined was the Controlled Oral Word Association Test (COWAT), with participants being tested with the appropriate letters for their first language: F, A, S for English, N, P, S for Xhosa and B, H, P for Afrikaans speakers. COWAT performances by members of the frontal group were significantly worse than the control group, and performances by those with hippocampal lesions showed a significantly worse result in relation to normal participants. Furthermore, patients with hippocampal and frontal lesions did not differ in their performances at a statistically significant level. However, at the level of the cut-off score for the COWAT, patients with hippocampal lesions would be performing in the adequate range (between 15- 25 words). In a comparison between the effect-sizes for the

Executive section and the COWAT, the COWAT accounted for slightly more than the whole section, indicating a strong potential for identifying patients with frontal lesions.

A closer investigation into the 18-Book Problem, revealed not only a high rate of failure by normal participants, but also that the test failed to differentiate between members of the patient groups at a statistically significant level. This test, which was devised by Luria (1966), might well be too difficult for normal participants in South Africa. It is possible that this could be accounted for by a discrepancy between the level of mathematical ability in modern South Africans and that of people in the Soviet Union at the second half of the last century. It is also possible that the demands of everyday living in that time, may have demanded a higher level of numerical literacy given the absence of modern calculation instruments.

Executive Function Section – Qualitative Findings

On the Executive section, according to the cut-off scores, 7 controls passed and 8 failed, all fifteen frontals failed and 1 person from the hippocampal group passed. Although this is an unacceptably high rate of false positives, when looking at the controls who failed, poor performances on the 18-Book Problem stand out. Out of the 8 participants who failed the Executive section according to the cut-off, all but one failed the 18-Book Problem. Furthermore, if these participants were to have passed the 18-Book Problem, 7 out of the 8 would have passed the Executive section. It therefore would seem that performances on the 18-Book Problem were responsible for the high rate of false positives on the Executive section.

Also, the relative weighting in the GSNAB of the COWAT is possibly too low given that it was a good differentiator between the groups.

Although participant's performances were scored according to the GSNAB, additional information was added to the scoring protocol, describing performance characteristics and error types. General comments about behaviour such as psychomotor abnormalities, attitude towards researcher, and level of arousal helped to guide the raters in their allocations. These kinds of qualitative observations are particularly important in the assessment of the frontal lobes, which are known to be difficult to measure with conventional neuropsychological tests (Damasio, 1979).

Limitations

As mentioned earlier, the small sample size of the re-pilot ($N = 30$) increased the chances of the results being due to error variance. Therefore, for greater confidence in this test, it would ideally be necessary to test the results on a bigger sample in order to determine whether there are equal performances across language groups and levels of education. Studies with larger samples that would be able to gather more reliable normative data would be needed. Given the results of the Township Fire Story in the validation section of the GSNAB, it would appear that this test is able to function in its current form as part of memory screening.

Due to the time restrictions and the availability of appropriate patients, it was not possible to obtain a larger sample, which must be seen as a major limitation for the validity and particularly the reliability section of the study. Despite the encouraging direction of the results, these must be evaluated with caution.

Recommendations

General recommendations

As mentioned in the previous section, the small sample size of the validation phase of this study increases the chance that statistical results may be due to error. Although the findings were highly significant, a larger sample would improve confidence in the results. Therefore, future research should study the effectiveness of the GSNAB with a greater number of participants.

One important supplement to the final version of the GSNAB would be a document outlining some of the theoretical principles underlying the approach to assessment which informs the battery, brief information regarding the functions assessed and some guidelines for cross-cultural assessment. These guidelines could include sections on the effects of education, culture and language with the aim of increasing the clinician's sensitivity to patients from other cultures and improving the clinician's capacity for recognising potential confounding influences during assessment.

Recommendations Specific to the Memory Section

From the statistical results of the re-piloted changes made to the Township Fire Recall Story, it is suggested that in future versions of the GSNAB, this test could yield useful qualitative information as a means to differentiate between memory deficits of a frontal or hippocampal origin. These may take the form of structured multiple-choice questions which would test whether the patient is able to benefit from cueing. These multiple choice questions would be used in combination with the more open-ended questions, designed to elicit intrusions or confabulations, which already exist in the GSNAB.

Given the high failure rate of controls on the Digit Span Test it would be prudent to include a second, or optional third, trial to compensate for effects of culture, education or anxiety.

Recommendations Specific to the Executive Section

The 18-Book Problem was failed by an unacceptably high number of normal participants. Since this may have something to do with level and quality of education, particularly level of numerical literacy, it is recommended that a simpler test with a smaller set of numbers be devised.

Although the statistical analyses conducted on group performances on the COWAT found that language and education did not significantly, in the current study, the literature indicates that education does influence performance on this task (Ardila, 2007a; Nell, 1999, 2000). As mentioned before, it is also the quality of education which influences

performances on neuropsychological test. Therefore, it is suggested that in future versions of the GSNAB, there should be an alternative test for fluency for patients with 9 or lower years of education, or when there is a concern about the quality of education. Category fluency (e.g. Animals) has been proposed by many as an alternative to the COWAT for those with a low level of education (Ardila, 2007b; Ardila & Ostrosky-Solís, 2006; da Silva, Petersson, Faisca, Ingvar, & Reis, 2004; Lezak, 2004; Oberg & Ramírez, 2006; Rosselli et al., 2002).

Since the COWAT is known to yield rich qualitative information relevant to frontal lobe dysfunction (Kramer & Quitania, 2007), it is suggested that the COWAT be given a proportionately greater weighting in the scoring of the Executive section.

Finally, it is suggested that for future versions of the GSNAB, a practice trial for the COWAT be included as part of what Nell (2000) refers to as “coaching the executive,” where the patient’s understanding of the instruction can be assessed and further clarification can be provided. The tester and participant could take turns in guessing words beginning with a practice letter, allowing the tester to correct any rule-breaking and clarifying any parts of the instruction not understood. Coaching the patient in this is likely to reduce the probability of a poor performance due to a lack of test-wiseness or misunderstanding of the instruction.

CONCLUSION

This dissertation contributed to the development of the GSNAB as a much needed alternative to the Mini-Mental State Examination in the South African context by examining the validity and reliability of the Memory and Frontal function sections, as well as through the further development of the Township Fire Story. Overall, this investigation has shown promising results in terms of the GSNAB's potential to both correctly identify patients with hippocampal and frontal brain lesions, and to differentiate between these groups, with an acceptably low rate of false positives. Problematic items within each of the sections were identified, and recommendations for further changes were made accordingly.

REFERENCES

- Anderson, S. J. (2001). On the Importance of Collecting Local Neuropsychological Normative Data. *South African Journal of Psychology, 31*(3).
- Ardila, A. (2007a). The Impact of Culture on Neuropsychological Performance. In B. P. Uzzell, M. O. Pontón & A. Ardila (Eds.), *International Handbook of Cross-Cultural Neuropsychology*. Mahwah: Lawrence Erlbaum.
- Ardila, A. (2007b). Towards the Development of a Cross-Linguistic Naming Test. *Archives of Clinical Neuropsychology, 22*, 297-307.
- Ardila, A., & Ostrosky-Solís, F. (2006). Cognitive Testing Toward the Future: The Example of Animals. *International Journal of Psychology, 41*(5), 324-332.
- Babcock, H. (1930). An Experiment in the Measurement of Mental Deterioration. *Archives of Psychology, 117*, 105.
- Babcock, H., & Levy, L. (1940). *The Measurement of Efficiency of Mental Functioning (revised examination). Test and Manual of Directions*. Chicago: Stoelting.
- Benton, A. L., & Hamsher, K. (1989). *Multilingual Aphasia Examination*. Iowa City: AJA Associates.

Bradshaw, D., Nannan, N., Laubscher, R., Groenewald, P., Joubert, J., Nojilana, B., et al. (2000). *Mortality Estimates for the Western Cape*. Cape Town: South African Medical Research Council.

Bruns, J., Jr., & Hauser, W. A. (2003). The Epidemiology of Traumatic Brain Injury: A review. *Epilepsia*, 44(10), 2-10.

Category Listing for Adult Cognition, Neuropsychology and Language. (2008). from <http://www.pearson-uk.com/OccupationFocus.aspx?n=1316&s=1321>

da Silva, C. G., Petersson, K. M., Faisca, L., Ingvar, M., & Reis, A. (2004). The Effects of Literacy and Education on the Quantitative and Qualitative Aspects of Semantic Verbal Fluency. *Journal of Clinical and Experimental Neuropsychology*, 26(2), 266-277.

Damasio, A. (1979). The Frontal Lobes. In K. M. Heilman & E. Valenstein (Eds.), *Clinical Neuropsychology*. New York: Oxford University Press.

Folstein, M. F., Folstein, S. E., & McHugh, P. R. (1975). Mini-Mental State. *Journal of Psychiatric Research*, 12, 189-198.

Gilbert, L., & Tollman, S. (2007). Epidemiological, Social and Cultural Aspects of Illness: A Case Study of Brain Injuries, Stroke and HIV/AIDS in South Africa. In

B. P. Uzzell, M. O. Pontón & A. Ardila (Eds.), *International Handbook of Cross-Cultural Neuropsychology*. Mahwah: Lawrence Erlbaum.

Gurland, B. J., Wilder, D. E., Teresi, J., & Barrett, V. W. (1992). Screening Scales for Dementia: Toward reconciliation of conflicting cross-cultural finding. *International Journal of Geriatric Psychiatry*, 7, 105-113.

Howell, D. C. (2002). *Statistical Methods for Psychology* (5th ed.). Pacific Grove: Duxbury.

King, W. G. (2005). Testing the Tests: Culture, Language-of-Assessment and Education Effects on the Digit Span and Four Hidden Objects Memory Tests. Unpublished Honours Thesis. University of Cape Town.

Kramer, J. H., & Quitania, L. (2007). Bedside Frontal Lobe Testing. In B. L. Miller & J. L. Cummings (Eds.), *The Human Frontal Lobes* (2nd ed.). New York: Guilford.

Lezak, M. D. (2004). *Neuropsychological Assessment*. Oxford: Oxford University Press.

Lopich, D. (2005). Pilot Study for a South African Neurocognitive Battery. University of Cape Town.

- Louw, J., & Foster, D. (2004). Race and Psychology in South Africa. In A. S. Winston (Ed.), *Defining Difference: Race and Racism in the History of Psychology* (pp. 171-197). Washington D.C.: American Psychological Association.
- Luria, A. R. (1966). *Higher Cortical Functions in Man*. London: Tavistock Publications.
- Luria, A. R. (1999). Outline for the Neuropsychological Examination of Patients with Local Brain Lesions. *Neuropsychology Review*, 9(1), 9-22.
- Luria, A. R., & Majovski, L. M. (1977). Basic Approaches Used in American and Soviet Neuropsychology. *American Psychologist*, 32, 959-968.
- Madadi, N. (2005). Adaption of Neurocognitive Tests of the Right Hemisphere. Unpublished Honours Thesis. University of Cape Town.
- Mosdell, J. (2005). Adaptation of Aphasia Tests for a South African Context. Unpublished Honours Thesis. University of Cape Town.
- Nell, V. (1997). Science and Politics Meet at Last: The Insurance Industry and Neuropsychological Norms. *South African Journal of Psychology*, 27(1), 43-51.
- Nell, V. (1999). Standardising the WAIS-III and the WMS-III for South Africa: Legislative, Psychometric, and Policy Issues. *South African Journal of Psychology*, 29(3), 128-138.

- Nell, V. (2000). *Cross-Cultural Neuropsychological Assessment: Theory and Practice*. New Jersey: Lawrence Erlbaum Associates.
- Norman, R., Bradshaw, D., Schneider, M., Pieterse, D., & Groenewald, P. (2006). *Revised Burden of Diseases Estimates for the Comparative Risk Factor Assessment, South Africa 2000* (Methodological Note). Cape Town: South African Medical Research Council.
- Nys, G. M. S., van Zandvoort, M. J. E., de Kort, P. L. M., Jansen, B. P. W., Kappelle, L. J., & de Haan, E. H. F. (2005). Restrictions of the Mini-Mental State Examination. *Archives of Clinical Neuropsychology*, *20*, 623-629.
- Oberg, G., & Ramírez, M. (2006). Cross-Linguistic Meta-Analysis of Phonological Fluency: Normal Performance Across Cultures. *International Journal of Psychology*, *41*(5), 342-347.
- Ostrosky-Solis, F., Lopez-Arango, G., & Ardila, A. (2000). Sensitivity and Specificity of the Mini-Mental State Examination in a Spanish-Speaking Population. *Applied Neuropsychology*, *7*(1), 25-31.
- Rosselli, M., Ardila, A., Salvatierra, J., Marquez, M., Matos, L., & Weekes, V. A. (2002). A Cross-Linguistic Comparison of Verbal Fluency. *International Journal of Neuroscience*, *112*, 759-776.

- Shapiro, M. B. (1951). Experimental Studies of a Perceptual Anomaly, 1. Initial Experiments. *Journal of Mental Sciences*, 97, 90-100.
- Shimamura, A. P., & Baldo, J. P. (2002). Frontal Lobes and Memory. In A. D. Baddely, M. D. Kopelman & B. A. Wilson (Eds.), *The Handbook of Memory Disorders* (2nd ed.). Chichester: John Wiley & Sons.
- Shuttleworth-Jordan, A. B. (1996). On Not Reinventing the Wheel: A clinical perspective on culturally relevant test usage in South Africa. *South African Journal of Psychology*, 26(2), 96-102.
- Steyn, K., Fourie, J., & Temple, N. (2006). *Chronic Diseases of Lifestyle in South Africa: 1995-2005*. Cape Town: Medical Research Council.
- Strauss, E., Sherman, E. M. S., & Spreen, O. (2006). *A Compendium of Neuropsychological Tests: Administration Norms and Commentary* (3rd ed.). New York: Oxford University Press.
- Walsh, K. W. (1985). *Understanding Brain Damage: A Primer of Neuropsychological Evaluation*. New York: Churchill Livingstone.
- Walsh, K. W., & Darby, D. (2005). *Walsh's Clinical Neuropsychology: A Clinical Approach*. London: Elsevier.

APPENDICES

Appendix 1

Screening for Controls

Please indicate whether you have had any of the following (either currently or previously):

Please be assured of the confidentiality and anonymity of any personal information that you give when participating in this study.

	<i>Please tick all that apply:</i>
A stroke	
A heart operation to treat coronary artery disease, e.g. coronary artery bypass graft surgery or stenting.	
Epilepsy or other seizures/fits	
A severe head injury	
Brain tumour or cancer	
Hydrocephalus ('water on the brain')	
Herpes encephalitis	
TB (tuberculosis)	
Diabetes (sugar disease)	
High blood pressure (hypertension)	
Multiple sclerosis	
Meningitis	
Alzheimer's disease	
Parkinson's disease	
Systemic Lupus Erythematosus (SLE)	
Syphilis	
HIV/AIDS	
Neurocysticercosis	
Recreational drugs (e.g. dagga, tik, cocaine etc)	
Any psychiatric condition (e.g. schizophrenia, bipolar)?	
Any other disease that you've had/currently have that may affect the brain?	

Appendix 2

On January the 15th / last year / a fire broke out / in a township / 20 km / from Cape Town /. The flames / spread to many houses/ and destroyed some / nearby cars /. Three people / were killed / and 40 people / were injured / while trying to save / their possessions /. In rescuing / a child / who was trapped in a shack/ a woman / broke her arm/.

*Appendix 3***Consent Form****TITLE OF PROJECT: A South African Neurocognitive Assessment Battery**

Please cross out as necessary

Have you read the Subject Information Sheet? YES/NO

Have you had an opportunity to ask questions and discuss the study? YES/NO

Have you received satisfactory answers to all your questions?
YES/NO

Have you received enough information about the study? YES/NO

Who have you spoken to? Dr/Mr/Mrs/Ms/Prof.

Do you understand that you are free to withdraw from the study:

-at any time

-without having to give a reason for withdrawing

-and without affecting your future treatment?

YES/NO

Do you consent to the unattributed and confidential use of these recordings for scientific purposes?

YES/NO

Signed

Date:

(NAME IN BLOCK LETTERS)

*Appendix 4***PATIENT INFORMATION SHEET****TITLE OF PROJECT:****A SOUTH AFRICAN NEUROCOGNITIVE ASSESSMENT BATTERY**

- You are invited to participate in a neuropsychological study conducted at Groote Schuur Hospital. Please read this information sheet carefully and do not hesitate to ask the researcher for any additional information.
- The overall purpose of the investigation is to adapt and validate a South African neurocognitive assessment battery, which comprises neuropsychological tests.
- You are asked to take part in this study by participating with different neuropsychological tests and tasks. You will be asked to attend two half-hour testing sessions a week apart.
- There are no anticipated risks involved in this research, but if you should experience mental and/or physical fatigue, or any form of psychological distress please be aware that you could inform the researcher immediately.
- It is up to you to decide whether or not you take part. If you decide to take part you will be given this information sheet to keep and asked to sign a consent form. If you decide to take part you are still free to withdraw from the study at any time, without having to give a reason and without this affecting future treatment.
- The confidentiality of your answers and your identity will be protected. All data collected will be suitably anonymous, securely stored, made accessible only to the researcher, and destroyed at the end of the project.
- This study is an educational project, forming part of a Ph.D. degree at the University of Cape Town (UCT). The research will be carried out by researchers from UCT and will be funded by the same university.
- The study has been reviewed by the UCT Psychology Department's ethics committee.
- If you have any questions regarding this study, or concerns regarding the manner in which the study was conducted, or would like to be informed of the results when the study is completed, please feel free to contact the principal researcher.
- Address for communications:

Professor Mark Solms, Department of Psychology, University of Cape Town, Rondebosch, 7701

Appendix 5

Scoring sheet

Patients name: _____ No.: _____
 Folder no.: _____ Date: _____
 Place: _____
 Language: _____ HLOE: _____
 Handedness: _____

1. Orientation**1.1 Place**

Can you tell me where you are?

Why are you here? (*Look for a spontaneous report of deficit*)

Score 2 if the patient knows:
... he/she is in hospital (1)
... due to brain pathology (1)
Normal score = 2/2

1.2 Person

Score 1 if the patient knows the
name of the hospital, 1 if he/she
knows what ward he/she is in and
2 if he/she knows what city he/she
is in.
Normal = 3/4

1.3 Time

Score 1 if the patient knows the
year, 1 if he/she knows the month,
1 if he/she knows the date,
1 if he/she knows the day of
the week and 1 if he/she
knows the approximate time
(correct within an hour)
Normal = 3/5

If there is no spontaneous report of deficit, ask if there's anything wrong with arms/legs (wherever applicable)

Keep prompting and make a note of any denial of deficit

2. Memory

2.1 Auditory Span

Procedure:

"I am now going to read some numbers to you and I want you to repeat them when I finish. Just say what I say".

-> Record patients response on the lines provided:

2, 7	_____
5, 7, 2	_____
1, 9, 6, 4	_____
1, 4, 2, 7, 9	_____
8, 3, 7, 4, 6, 2	_____
7, 3, 5, 2, 4, 1, 9	_____

7 Digits = 2/2

5 Digits = 0/2

Normal = 6 digits

Note:

-> Try to leave about a second inbetween each number (say "1 crocodile" to yourself before giving the next number. ☺)

-> Make a note if pt starts giving numbers back before you have finished

2.2 Four Hidden Objects

Procedure:

1. Explain that this is a memory test and explain that you are going to show them four objects and that you are going to take them away in a moment and ask them to say what the objects were;
 2. Show the 4 objects (a key, pipe, flower and bangle) and ask the patient to name them – *record items left out*;
-
-

4 Objects = 2/2

3 Objects = 1/2

2 Objects = 0/2

Normal = 4 objects

3. Hide all 4 objects in one location e.g. under the sheet and immediately ask the patient what the objects were – *record items left out*;

4. Distract the patient (eg. ask them about names and ages of children);
5. Repeat the question (NB: do not tell the patient how many objects or where you hid them);

4 Objects = 2/2

3 Objects = 1/2

2 Objects = 0/2

Normal = 4 objects

6. If patient fails, repeat the process. If patient successful, proceed to step 7 – *record how many repetitions*;

7. Hide all 4 objects in different locations;

8. Distract patient again;

9. Ask patients where the objects were; *record items left out or confused locations*.

4 Objects = 2/2

2 Objects = 0/2

Normal = 3 objects

Comments:

2.3 Township Fire Story

Read out slowly, try to allow one second per unit of meaning:

On January / the 15th / last year / a fire broke out / in a township / 20 km / from Cape Town. / The flames / spread to many houses /, and destroyed some nearby cars. / Three people / were killed / and 40 people / were injured / while trying to save / their possessions. / In rescuing / a child / who was trapped in a shack, / a woman / broke her arm.

First Recall

Distract and then read again:

Second Recall

Ask: "Was there an ambulance in the story?"

"Was there a flood in the story?"

"Who put the child in the shack?"

"Tell me all the things I said about Cape Town?"

Delayed - 30min later

2.4 Rey Complex Figure

Tick one:

- Near perfect copy *Score 3*
- Recognisable but manifestly distorted in details and overall configuration *Score 2/3*
- Barely recognizable *Score 1/3*
- Discontinue after only part of figure is very defectively attempted *Score 0*

2.4 Rey Complex Figure - Copy

Name: _____ Date and time administered: _____

Rey Complex Copy – Delayed recall at thirty minutes

Name: _____ Date and time administered: _____

3. Language tests

Washing Line test

Procedure:

"I am now going to show you a picture and I want you to tell me about it. What is happening in the picture?"

Procedure:

Show patient the washing line story and record verbatim what s/he says. Give the patient one minute to discuss the picture.

Fluency .../2
Normal = 2
Mild defect = 1
paraphasia .../2
Normal = 2
mild defect = 1

Writing

Procedure:

Ask patient to: write their own name

Write the following to dictation: "They took their water from the well."

Write spontaneously (a full, grammatical sentence)

Were these commands correctly followed? Was the writing the same as spoken production or normal/better than spoken production?

Same as spoken
production = 0/1
Normal or better
than spoken
production = 1/1

Comprehension tests

Procedure: Utter the following verbal commands and comment on the appropriateness of the patient's responses

"Close your eyes"

"Touch your left ear"

"With your right hand, touch my left ear" (Note: If defective, exclude L/R distinction)

.../3

Normal = 3

"Is oil thicker than water?"

"Do trees sit in birds?"

"The cat was chased by the mouse; who did the chasing?"

"Your father's brother; what relation is he to you?"

"Your sister's daughter; what relation is she to you?"

.../5

Normal = 4

Mary Selo story

Procedure: "Read out loud and do":

Show me three fingers

Procedure: "I'm going to give you a short story. Please read it aloud."

.../5

Normal = 4

Mary Selo story

Mary Selo from Port Elizabeth went to the beach on Saturday. She went with her three small children in the early morning but it started to rain. They all ran to a bright, yellow bus stop for shelter but the roof of the shelter was leaking and they all got wet. The family then had to walk three kilometres in the rain before arriving home. As a result, Mary's daughter caught a cold.

Fluency: Make a note of time taken to read aloud story

Were all words properly enunciated? Make notes of problematic words

Other comments

.../2

Mild defect = 1
Normal = 2

Repetition

Procedure: Ask the patient to repeat exactly what you say:

"Why am I sitting here?" (score =1)

"The painter painted many beautiful scenes" (cumulative score = 2)

"This doctor does not visit all the patients in the ward" (cumulative score =3)

"Why do the members of the committee not ask their representatives for aid?"
(cumulative score=4)

Procedure: Compare to production

.../4
Normal = 3

Naming

Procedure: Ask patient to name body parts and objects at the bedside:

"Elbow, ankle, wrist, knee, shoulder"

.../5
Normal =4

"Pillow, sheet, spectacles, collar, winder (on watch)"

.../5
Normal =4
Total

Procedure:

"I am now going to show you some drawings. I want you to name the drawings."

Proceed to show all drawings, making notes of errors, and semantic or literal paraphasias. A literal paraphasia involves the substitution of letters in a word. For example, house becomes louse. A semantic paraphasia refers to the substitution of one word for another and are semantically related. For example, shirt becomes tie.

Also make

Drawing shown:

Response from patient:

Incorrect/correct

Comments:

Auditory: Ask patient to identify unilateral stimuli randomly interspersed with bilateral stimuli (click fingers softly in close proximity to ear/s)

Comments:

Make comments on the following: Does the patient identify both unilateral (L) and ® stimuli correctly but frequently neglects (L) on bilateral stimulation (in modalities without primary sensory impairment)

Make comments on the following: Does the patient consistently neglects (L) even on unilateral stimulation (in modalities without primary sensory impairment)

- (a) *All stimuli correctly identified consistently in all modalities not affected by primary sensory impairment = 2/2*
 (b) *Consistently identifies both unilateral (L) and (R) stimuli correctly but frequently neglects (L) on bilateral stimulation (in modalities without primary sensory impairment) = 1/2*
 (c) *Consistently neglects (L) even on unilateral stimulation (in modalities without primary sensory impairment) = 0/2*

5. Visual-spatial assessment

a. Anosognosia

Procedure: Comment on patient's spontaneous report of deficit during assessment of orientation

If the patient does not spontaneously describe deficit, ask "Please describe all your current symptoms/deficits"

Score 3/3 if they can

If they do not describe deficit, ask "What about your legs/arms/hands/eyes, etc. (where applicable), are they all functioning normally?"

Score 2/3 if they can

If still denies deficit, demonstrate deficit to patient by physical examination, then ask: "Do you still think that your... is functioning normally?"

Score 1/3

Is there still a denial of deficit?

Score 0/3

4. Executive

4.1 Controlled Oral Word Association Test

Procedure:

Ask patient to tell you as many words beginning with the letter F, A and S. They must exclude proper names like the names of their friends and family or products like "Nike", must only be objects, give some examples.

Make a line for each 15 seconds to mark where the patient is. Allow *60 seconds* for each trial.

->Please record repetitions with an "r" and rule breaks

F

A

S

Total F:

Total A:

Total S:

Total: _____

(a) *More than 25 words (normal) = 2/2*

(b) *Between 15 and 25 words = 1/2*

(c) *Less than 15 words = 0/2*

4.2 Red/Green

Procedure:

1. Ask patient to squeeze your hand only when you say "green" and release it only when you say "red".

NB: (1) ensure the rule is learnt, (2) random alternation, (3) setting up of stereotype and then breaking it, (4) repeat 3

2. Reverse rule: ("red" = squeeze, "green" = release) and repeat (1) - (4)

Perfect with one or two mistakes = 2

Consistently imperfect performance = 1

Gross-evidence of imperfect impulsivity, rule breaking, stereotyped responses = 0

4.3 Fist-Side-Palm

Procedure:

Demonstrate repeated three-step hand movement sequence, placing own hand in three successive positions. Fist (face down on surface), side (edge of open hand on surface) and

palm (flat palm on surface). Initially do it together with patient, verbalizing the steps, then withdraw model.

Perfect performance after one or initial errors = 1
Inability to achieve perfect performance despite repeated trials = 0

4.4 Tapping Test

Procedure:

Ask patient to imitate each of the following rhythms immediately after you demonstrate them.

...
 ...

Perfect performance after initial errors = 1
Inability to achieve criterion despite repeated trials = 0

4.6 18 Book Problem

Procedure:

Say: "You have 18 books and two book-shelves. You have to sort the books onto the shelves in such a way that you put twice as many books on the one shelf as the other. How many books do you put on each shelf?"

Correct response at first attempt = 2
Correct response after initial impulsive or stereotyped response = 1
Two incorrect responses = 0

4.5 Repeated Pattern Drawing**Procedure:****Ask patient to continue drawing the following pattern along the length of an A4 page.****Draw here:**

Summary of Scores

Assessment of Orientation	Subtotal	Total	Normal
Orientation to Person			
Orientation to Place			
Orientation to Time		.../11	8
Assessment of Memory Function			
Digit Span			
Registration			
Simple Recall			
Complex Recall		.../18	14
Assessment of Language Function			
Production			
Comprehension			
Repetition			
Naming		.../30	26
Assessment of Right Hemisphere Syndrome			
Spatial Cognition and Perception			
Neglect			
Anasognosia		.../15	12
Assessment of Frontal Function			
Deep White Matter			
Mesial			
Orbital / Basal			
Dorsolateral		.../11	10
Total		.../85	70